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Net-Zero Skills

What will Canada need for the coming energy transition?

Cedric Smith and Sarah Winstanley

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The Pembina Institute
#802, 322–11 Avenue SW
Calgary, Alberta T2R 0C5
Phone: 403-269-3344

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About the Pembina Institute

The Pembina Institute is a national non-partisan think tank that advocates for strong, effective policies to support Canada's clean energy transition. We employ multi-faceted and highly collaborative approaches to change. Producing credible, evidence-based research and analysis, we consult directly with organizations to design and implement clean energy solutions, and convene diverse sets of stakeholders to identify and move toward common solutions.

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Interview participation does not reflect endorsement of the report.

Net-Zero Skills

What will Canada need for the coming energy transition?

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Executive summary

A transition of Canada's energy sector is coming, and governments, businesses, workers' associations, and individuals need to prepare, plan, and reskill so that the country can take advantage of the ensuing opportunities. Countries, sub-regions, and cities have signed on to try to keep the world from overheating by trying to reach "net-zero" by 2050. Earlier this year, the Government of Canada released the 2030 Emissions Reduction Plan, which outlined a sector-by-sector path for Canada to reduce emissions to 40% below 2005 levels by 2030. Now governments, including Canada, need to plan for how to reach climate goals without causing undue disruption to workers and the economy.

The energy transition will result in a decline in fossil-fuel based energy industries (oil and gas and coal) and a growth in renewable and other low-carbon energy-producing industries, such as solar, wind and hydrogen. Exactly how this transition will occur, as well as which low-carbon energy producing technologies will be adopted, is unknown and subject to policy levers by Canadian governing bodies as well as international market demands.

Not only are the sources of energy going to change, but the sectors that use that energy, such as buildings and transportation, will also face disruptions as systems need to be retrofitted, rebuilt, and redesigned.

This report reviews literature to analyze the degree to which existing skillsets in Canada's fossil fuel labour force can be transferred to a net-zero–aligned economy and the potential skills gaps that may exist. This report also examines the skills that will be required in Canada's energy end-use sectors including buildings and transportation, and skills gaps that may exist there as well. Finally, this report examines existing equity issues within Canada's energy sector, particularly as they relate to Indigenous rights and reconciliation, as well as gender equity, and how they may be addressed on the path to net-zero.

Key findings

- **Skillsets will change but some are transferrable:** Both energy production and energy use in the future will require a different worker skillset than Canada currently has. Nevertheless, the valuable skillsets that exist in Canada's

workforce in the energy-production sectors are transferrable to emerging clean energy sectors. Alignment may not be perfect, and upskilling may be required.

- **Inequities persist in the energy labour force:** Canada's net-zero transition offers an opportunity to address long-standing social equity issues in the workforce and create a more equitable economy. Women have been historically excluded from the energy sector due to barriers that show up for them all along the energy career pathways. Costs for training and reskilling have been a barrier for many marginalized groups, and newcomers may face difficulties in accessing job opportunities without policy intervention.
- **Significant investments in STEM education, high technical, and soft skills are required:** The low-carbon economy (both energy production and energy end uses) will require more technical expertise, spread across the country. The transition to net-zero will continue to require soft skills to support collaboration and partnership-building, and greater literacy on sustainability and climate principles and standards.
- **Further labour data analysis and research is needed:** Further data collection and research is needed to understand what skills are transferable as well what skills are needed in each sector as Canada transitions to a net-zero economy. Having more certainty about Canada's unique path to net-zero will greatly help the planning for the labour force.

Recommendations for the federal government

1. Chart a clear course to net-zero for Canada:

Canadians need to know where we are going and how fast we are trying to get there. While the federal 2030 Emissions Reductions Plan is an important signpost for net-zero planning, the federal government should continue work to set an ambitious course to 2050, acknowledging that much depends on the rigorous implementation of necessary policies and regulations, many of which cannot be dictated by the federal government. To achieve the necessary reductions, the federal government must partner with, coordinate between, and support other levels of government, Indigenous peoples and communities, educators, business, and labour groups. In order to ensure Canadians and communities are not left behind, part of that planning needs to identify pathways that will result in well-paying jobs across the country.

Some steps that the federal government can take:

- Deliver Canada's commitment to a net-zero transition by implementing supportive policies and plans
- Consult with stakeholders and partners to set Canada's net-zero pathway and establish sectoral milestone targets along the way
- Plan and invest in low- and zero-emission technologies and economic development activities that will support a net-zero transition

2. Fund research to understand labour and skills impacts

Support research that will help employers and policymakers understand how the net-zero transition will impact the energy sector and labour force. Detailed modelling on future skills in a net-zero economy will help relevant stakeholders better prepare for changes and fill skills gaps.

3. Support fair outcomes for impacted labourers

Support fair outcomes for labourers impacted by the net-zero transition by listening closely to the results of Canada's ongoing Just Transition consultation and providing support for worker upskilling that is commensurate to the needs of a net-zero transition.

- Provide financial support for worker upskilling and training
- Align ongoing federal skills programming with climate change efforts
- Support workers with career pathways including the choice of early retirement

4. Improve outcomes for historically excluded groups

When developing policies and investments to support the net-zero transition, governments should continue to implement practices that strives to create equitable working conditions and work force.

- Continue to apply a GBA+ lens to federal transition policies and programs, and publicly report on the impact
- Prioritize the collection and transparent, ethical use of disaggregated data
- Address mental health as part of skills training as shifts in one's job and skillsets may cause emotional distress, sense of loss or mental health impacts. Policies and practices that prevent harassment and violence should also be prioritized.

5. Support Indigenous rights and reconciliation

The energy transition must result in the self-determination, sovereignty, and economic security of Indigenous peoples and communities. The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) states that Indigenous peoples have the right, without discrimination, to improve their economic and social conditions, and the right to determine and develop strategies to develop or use their lands, territories and other resources. UNDRIP provides a framework for developing renewable energy projects.

- Invest in and scale up Indigenous-led training, employment, and mentorship programs
- Invest in Indigenous-led renewable energy and energy efficiency projects

1. Introduction

Efforts to achieve a net-zero–aligned energy system that limits global warming to below 1.5 degrees are well underway globally, transforming the way nations produce and use energy. The transition to a net-zero economy is expected to significantly change the global economy and labour force, as fossil fuel–based industries sunset and give way to cleaner energy and renewable energy options. According to modelling results by the International Energy Agency, the global net-zero pathway to 2050 would mean a decline in oil, gas, and coal employment by 5 million by 2030 and an increase in clean energy employment by 14 million.[1] The changing jobs landscape will result in a different suite of skills required by workers. As Canada joins over 120 countries committed to achieving net-zero emissions by 2050,[2,3] it too must plan for the evolution of the workforce by upskilling and retraining the current labour force as well as preparing future generations to join this growing sector.

Net-zero aligned sectors that are poised for market growth and subsequent employment opportunities include renewables; critical minerals; nature-based solutions; carbon capture, utilization, and storage (CCUS); low-carbon buildings; and low-carbon and zero-emission transportation.

What is net-zero?

Achieving a net-zero emissions future by 2050 means that Canada's economy either no longer emits greenhouse gas emissions or captures any residual emissions through negative-emissions methods including carbon capture and nature-based solutions. The IPCC special report states that 1.5 degrees is the safe limit to global warming and concludes that staying below this threshold will require global emissions to drop by 45% by 2030 compared to 2010 levels and to reach net-zero by 2050.

[1] International Energy Agency, *Net Zero by 2050: A Roadmap for the Global Energy Sector* (2021), 151. https://www.iea.org/reports/net-zero-by-2050

[2] Government of Canada, "Net-Zero Emissions by 2050." https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html

[3] Environment and Climate Change Canada, "Government of Canada confirms ambitious new greenhouse gas emissions reduction target," media release, July 12, 2021. https://www.canada.ca/en/environment-climate-change/news/2021/07/government-of-canada-confirms-ambitious-new-greenhouse-gas-emissions-reduction-target.html

Canada has committed to a strengthened 2030 climate target of 40-45% below 2005 levels and formalized its commitment to achieving net-zero emissions by 2050 with the Canadian Net-Zero Emissions Accountability Act.[4,5] Sub-national Canadian jurisdictions that have committed to net-zero include Quebec, Newfoundland and Labrador, Toronto and Vancouver.[6]

The transition will affect Canadians in different ways, including labour market changes and potentially financial gains and losses. To ensure a fair transition, Canada's pathway to net-zero must put people first, avoid disproportionate impacts on potentially affected workers, and prioritize economic change that benefits all, including women, Indigenous communities, workers, trade unions, local communities, racialized communities, new Canadians and economically vulnerable populations.[7] A just transition to a low-carbon economy in Canada will require that economic, environmental and social policy aim to create decent work, quality jobs, and an equitable and prosperous future for all workers and communities. As a signatory to the Paris Agreement, Canada is committed to consider the imperatives of a just transition in the workforce and to prioritize the creation of decent work and quality jobs.[8]

Building a strong net-zero labour force includes supporting existing workers in the fossil fuel sector, as well as equipping young Canadians, newcomers, and other working individuals with the necessary skillsets to drive growth in low- and zero- carbon sectors. The transferability of existing skills and roles from the fossil fuel sector into net-zero aligned sectors is anticipated to offer opportunities for workers.

Understanding the labour market impacts associated with a net-zero transition and examining the magnitude of workers and skills needed to support the growth in sunrising clean energy sectors is a substantive undertaking. Predicting changes in energy demand and use between now and 2050 is complex; layering on the associated changes to the labour force, including location of workers and skills needed, makes this question even more challenging.

[4] "Net-Zero Emissions by 2050."

[5] "Government of Canada confirms ambitious new greenhouse gas emissions reduction target."

[6] "Net-Zero Emissions by 2050."

[7] Isabelle Turcotte and Nichole Dusyk, *How to Get Net-Zero Right: Principles, tools and steps for safe, inclusive net-zero pathways* (2021), 2-3. https://www.pembina.org/pub/how-get-net-zero-right

[8] Government of Canada, "Just Transition." https://www.rncanengagenrcan.ca/en/collections/just-transition

As well, while the impact on Canada's workforce in a net-zero transition is anticipated to be substantial, there are many additional forces at play that will undeniably shape Canada's workforce across a multitude of sectors. Population and employment dynamics, immigration, automation, and emerging technologies like artificial intelligence will influence future work. According to C.D. Howe, approximately one in five Canadians are employed in a job that could, in theory, become automated.[9] And Statistics Canada found that the impact of global events like COVID-19 could encourage a faster shift to automation in response to the staffing and safety challenges.[10]

Within the context of this complex labour force ecosystem, the purpose of this paper is to begin to answer the following research questions:

1. How can we draw on "net-zero energy futures" modelling analysis by the IEA and CICC to understand the potential impacts to sectors and associated jobs?
2. What skillsets in Canada's traditional energy producing sectors can be transferred into a net-zero-aligned economy? Where are the skills gaps?
3. How will the demand for clean energy impact the buildings and transportation sectors and what kinds of new skillsets are needed to support them?
4. What information and actions are needed to plan for and manage changes in the labour force as a result of a net-zero energy transition?
5. How can the federal government work with others to address long-standing equity concerns in the energy sector and support Indigenous rights and reconciliation in the transition?

Methodology

This paper is based on a review of existing literature on net-zero energy modelling globally and in Canada, as well as research that identifies the labour and skills requirements in various economic sectors. To complement the desktop research, the Pembina Institute conducted interviews with subject matter experts from academia and environmental and non-governmental organizations on issues related to labour, skills, equity and Canada's energy economy.

[9] Rosalie Wyonch, *The Next Wave: Automation and Canada's Labour Market* (C.D. Howe Institute, 2020), 1. https://fsc-ccf.ca/research/the-next-wave-automation-and-canadas-labour-market/

[10] Kristyn Frank, Zhe Yang, Marc Frenette, *The changing nature of work in Canada amid recent advances in automation technology* (Statistics Canada, 2021). https://www150.statcan.gc.ca/n1/pub/36-28-0001/2021001/article/00004-eng.htm

The literature review examined the skillsets of workers in the current, high-carbon energy industries and how well those skills and workers will transfer to low-carbon energy-production and other net-zero aligned sectors and activities. It also examined skills needs in energy end-use sectors including buildings and transportation.

The search for climate change solutions is broad, therefore the initial analysis offered in this paper focused on energy production, both clean and polluting; carbon removal activities such as CCUS and nature-based solutions; critical minerals; and hydrogen. For energy end-use sectors, including buildings and road transportation, it examined new skills that will be required as the sectors become less emissions intense.

Future research should extend to areas including climate solutions offered by and/or for nuclear; biofuels; industry (including steel and cement); agriculture; non-building energy efficiency; air, rail, and marine transportation; and cross-cutting clean technology. Such an extension would allow for a more exhaustive understanding of the skills shifts associated with the transition to net-zero.

This paper begins by examining established models of options for net-zero pathways to 2050. Then it examines the Canadian energy sectors — both the fossil fuel sector, which is predicted to decline, and the clean energy sector, which is predicted to increase — and the skillsets of those labour forces and how they might transfer from one to the other. Next it looks at two sectors, ground transportation and buildings, and the skills that will be required as they transition to low- and zero-carbon energy sources. Lastly it examines how the above changes can be done in equitable ways, by offering job opportunities to a broad array of Canadians and advancing Indigenous rights and reconciliation.

Based on a literature review and informed by interviews with subject matter experts, this paper then makes recommendations on next steps for understanding the impact of the net-zero transition on skills needs as well as for supporting labour and advancing equity through the transition.

2. Modelling net-zero pathways to 2050

The International Energy Agency (IEA) and the Canadian Institute for Climate Choices (CICC) have conducted energy modelling analysis which lays out scenarios for the global and Canadian transition to net-zero, respectively. The two studies are:

- *Net Zero by 2050: A Roadmap for the Global Energy Sector*, published in May 2021 by the IEA.
- *Canada's Net Zero Future: Finding Our Way In The Global Transition*, published in February 2021 by the CICC.

The Pembina Institute references these sources throughout the paper to summarize the anticipated impacts of the transition to net-zero on fossil fuel-based industries that are likely to sunset and on clean energy and/or net-zero aligned sectors.

2.1 IEA's Net-Zero Emissions by 2050 scenario

The IEA examines a Net-Zero Emissions (NZE) by 2050 Scenario, which outlines how energy demand and supply will have to change to achieve global net-zero emissions by 2050.[11] The IEA outlines milestones on the path to net-zero across sectors of the economy and examines the costs of net-zero and potential ramifications for the economy and employment.[12]

The NZE is based on a number of assumptions: energy sector methane emissions are minimized; emissions reductions as of 2030 are consistent with global warming of 1.5 degrees Celsius; consistency with significant reductions in air pollution; and consistency with United Nations Sustainable Development Goals relevant to universal energy access as of 2030.[13] The NZE is also built on principles especially important to a low-carbon workforce, including global co-operation towards net-zero emissions, with all countries recognizing the need for a just transition; as well as an orderly transition in

[11] IEA, *Net Zero by 2050,* 31.

[12] IEA, *Net Zero by 2050,* 30.

[13] IEA, *Net Zero by 2050,* 48-49.

the energy sector which ensures secure electricity and fuel supplies, seeks to avoid energy market volatility and seeks to minimize stranded assets.[14]

2.2 CICC's net-zero by 2050 pathways

The CICC modelled 60 different pathways for Canada to achieve net-zero GHG emissions by 2050, with three potential energy systems that could emerge if Canada achieved this goal:

- fossil fuels and negative emissions
- biofuels
- electrification and hydrogen[15]

CICC scenarios only consider emissions generated within Canada, and do not account for potential international transfer mechanisms of emission cuts.[16] The CICC generally presents results not for a specific scenario, but rather as a range across all scenarios.[17] The CICC's three potential energy systems are described here. It should be noted that the CICC allowed for the possibility of one of the systems becoming dominant, or a mixture of the three:

- Under the fossil fuels and negative emissions system, fossil fuels continue providing significant energy, with emissions offset through negative emission solutions.
- Under the biofuels system, "second-generation" biofuels produced from waste and plants are the primary providers of energy.
- Under the electrification and hydrogen system, the dominant form of energy is emissions-free electricity.[18]

As Canada continues setting targets and policies to drive the energy transition, and engages with Canadians on pathways to 2050, it will become increasingly clear which system is most likely to emerge dominant.[19] Canada's June 2021 commitment towards

[14] IEA, *Net Zero by 2050,* 50.

[15] Canadian Institute for Climate Choices, *Canada's Net Zero Future: Finding Our Way In The Global Transition* (2021), 16, 17-19. https://climatechoices.ca/reports/canadas-net-zero-future/

[16] CICC, *Canada's Net Zero Future,* 8-9.

[17] CICC, *Canada's Net Zero Future,* 17.

[18] Canadian Institute for Climate Choices, *Canada's Net Zero Future: Finding Our Way In The Global Transition — Summary Report* (2021), 17-19. https://climatechoices.ca/reports/canadas-net-zero-future/

[19] CICC scenarios are independent of specific policy choices. *Source:* CICC, *Canada's Net Zero Future,* 16.

100% electrification of new light-duty car and passenger truck sales,[20] for example, decreases the likelihood of a biofuels system and increases that of the electrification and hydrogen system. For the purpose of this report, a transition that leans towards the CICC's electrification and hydrogen system is assumed to be a likely pathway to net-zero by 2050.

Finally, the CICC separates potential emissions-reducing technologies and solutions into "safe bets" and "wild cards." The CICC defines "safe bets" as "emission-reducing technologies and solutions that are already commercially available and face no major constraints to widespread implementation." It defines "wild cards" as "high-risk technologies and solutions with potentially high rewards."[21] The CICC notes that a minimum of two-thirds of required emissions reductions as of 2030 would be due to "safe bets" but that "in scenarios where wild card solutions prove cost-effective and scalable, they could provide up to two-thirds of Canada's emissions reductions by 2050."[22,23] Given the inherently uncertain nature of "wild cards," this report will, for the most part, focus on energy transitions related to "safe bet" solutions — including electric vehicles, non-emitting electricity, and energy-efficiency equipment.[24]

[20] Transport Canada, "Building a green economy: Government of Canada to require 100% of car and passenger truck sales be zero-emission by 2035 in Canada," media release, June 29, 2021. https://www.canada.ca/en/transport-canada/news/2021/06/building-a-green-economy-government-of-canada-to-require-100-of-car-and-passenger-truck-sales-be-zero-emission-by-2035-in-canada.html

[21] CICC, *Canada's Net Zero Future — Summary Report,* 10.

[22] CICC, *Canada's Net Zero Future — Summary Report,* 11.

[23] The CICC has stated, however, that "In scenarios where numerous wild cards do not prove to be sufficiently cost-effective and scalable, safe bets take on much greater significance – driving as much as 89 per cent of reductions by 2030…" The IEA, meanwhile, has opined that "All the technologies needed to achieve the necessary deep cuts in global emissions by 2030 already exist, and the policies that can drive their deployment are already proven." *Sources:* CICC, *Canada's Net Zero Future,* 78; IEA, *Net Zero by 2050,* 14.

[24] CICC, *Canada's Net Zero Future — Summary Report,* 12.

3. Declining energy production industries

Canada's oil and gas economic sector yields the highest GHG emissions in the country. Canada's oil and gas sector emitted nearly 200 megatonnes (Mt) of carbon-dioxide equivalent in 2019, which accounted for over a quarter of Canada's total emissions.[25] Coal- and natural gas–generated electricity emitted over 55 Mt of carbon-dioxide equivalent in 2019, which accounted for nearly 8% of Canada's total emissions and over 90% of total electricity sector emissions.[26,27] In spite of this, coal and natural gas made up only about 16% of Canada's electricity generation that year.[28]

These emissions will need to decline quickly to realize the levels of deep emissions reductions required in a net-zero economy.

With the IEA and CICC's net-zero energy models indicating a decline in fossil fuel-based industries globally and in Canada, we can expect an associated decline in employment in these energy producing sectors. This section takes stock of the current workforce in Canada's oil and gas production and coal- and gas-fired electricity generation, anticipated impacts, and how existing job skills applied in these sectors can be transferable to growing net-zero aligned sectors.

3.1 Current labour market characteristics

- Canada's oil and gas sector employs about 175,000 individuals. This includes conventional oil and gas extraction; crude oil and other pipeline transportation; natural gas distribution; non-conventional oil extraction; petroleum refineries; pipeline transportation of natural gas; and support activities for oil and gas extraction.[29]

[25] Government of Canada, "Greenhouse gas emissions." https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html

[26] Environment and Climate Change Canada, *National Inventory Report 1990-2019: Greenhouse Gas Sources and Sinks in Canada: Part 3* (2021), 60. https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/inventory.html

[27] "Greenhouse gas emissions."

[28] *National Inventory Report 1990-2019, Part 3,* 60.

[29] "Employment Characteristics for Selected Energy Industries."

- Three-quarters of oil and gas workers do not have a university degree and 15% are in the trades.[30]
- The oil and gas sector is geographically concentrated, with Alberta accounting for three-quarters of its labour force and nearly 100% of its workers in non-conventional oil extraction.[31]
- Nearly three-quarters of coal mining jobs are located in British Columbia.[32] Coal-fired generating stations, as well as domestic thermal coal mines,[33] employ between 3,000 and 3,900 workers.[34]
- According to the Canadian Centre for Energy Information, in 2019, only 31.3% of all energy jobs were held by women, 29.3% were held by newcomers to the country, 4.9% were held by Indigenous workers and 18.4% were occupied by visible minorities.[35]

3.2 The net-zero energy transition

Oil and gas production

In the IEA's NZE, oil demand declines by 75% between 2020 and 2050, from 88 million barrels per day to 24 million. Natural gas trade as LNG declines by 60% and natural gas trade by pipeline declines by 65%.[36]

CICC's pathway analysis, meanwhile, indicates that Canadian oil and gas production would depend mainly on global trends, and suggests that in scenarios involving a drop in prices due to one or both of market trends and international climate policy, Canadian

[30] "Employment Characteristics for Selected Energy Industries."

[31] Statistics Canada, "Table 36-10-0480-01: Labour productivity and related measures by business sector industry and by non-commercial activity consistent with the industry accounts" (2019), spreadsheet. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610048001

[32] "Table 36-10-0480-01: Labour productivity and related measures by business sector industry and by non-commercial activity consistent with the industry accounts."

[33] In 2019, Canada produced 57 Mt of coal, 53% of which was metallurgical coal, used in the manufacturing of steel, and 47% of which was thermal coal, used for electricity. *Source:* Government of Canada, "Coal facts." https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/coal-facts/20071

[34] Government of Canada, *A Just and Fair Transition For Canadian Coal Power Workers and Communities* (2018), vii. https://publications.gc.ca/site/eng/9.867000/publication.html

[35] Canadian Centre for Energy Information. "Energy and employment." https://energy-information.canada.ca/en/subjects/energy-and-employment

[36] IEA, *Net Zero by 2050,* 101, 102-103.

oil production would decrease between 89% and 96% as of 2050 while natural gas production would decline between 56% and 74%.[37] The CICC notes that steady or increasing production is consistent with net-zero only under "a set of very specific conditions," including net-zero production emissions and continued international demand along with the expectation therefore.[38,39]

Coal- and gas-fired electricity generation

In the IEA's global NZE, existing coal- and gas-fired electricity generation assets can be retrofitted with CCUS or retrofitted to co-fire with hydrogen-based fuels. Unabated coal-fired electricity generation is phased out in developed countries by 2030 and globally by 2040. Natural-gas fired generation without carbon capture increases in the short term but declines by 90% as of 2040 relative to 2020.[40] In December 2018, the Canadian federal government announced regulations to phase out traditional coal-fired electricity as of 2030 as well as regulations for greenhouse gases in natural gas-fired electricity.[41] Canada also has a target of achieving 90% non-emitting electricity generation by 2030[42] and achieving a net-zero grid by 2035.[43,44]

[37] CICC, *Canada's Net Zero Future,* 62.

[38] CICC, *Canada's Net Zero Future,* 64.

[39] Canada's 2030 Emissions Reduction Plan (ERP) committed to capping and cutting emissions from the oil and gas sector "at the pace and scale needed to get to net zero by 2050" but noted that it does not intend to bring cuts in production that are "not driven by declines in global demand". *Source:* Environment and Climate Change Canada, *2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Strong Economy* (2022), 52-53. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/emissions-reduction-2030.html

[40] IEA, *Net Zero by 2050,* 115-116.

[41] Government of Canada, "Coal phase-out: the Powering Past Coal Alliance." https://www.canada.ca/en/services/environment/weather/climatechange/canada-international-action/coal-phase-out.html

[42] Government of Canada, "Annex: Clean electricity." https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy/annex-clean-electricity.html

[43] Prime Minister of Canada Justin Trudeau, "Prime Minister Trudeau concludes productive United Nations Climate Summit," media release, November 2, 2021. https://pm.gc.ca/en/news/news-releases/2021/11/02/prime-minister-trudeau-concludes-productive-united-nations-climate

[44] Canada's 2030 ERP committed to putting in place a Clean Electricity Standard to support its target of a net-zero emitting electricity grid by 2035. *Source: 2030 Emissions Reduction Plan*, 42.

3.3 Impacts to the labour force

As Canada's economy transitions away from fossil fuels to align with a net-zero economy, investments will be needed to grow and diversify industries including clean energy and climate friendly technologies, particularly in jurisdictions with a high number of traditional energy sector workers. And such private sector investments in renewable energy projects are already being seen.[45] These changing dynamics create both opportunities and complex challenges for workers and communities linked to traditional energy producing sectors. The magnitude of impacts will undoubtedly vary widely depending on demographic factors and geographic locations. For example, in communities where coal mining or a coal plant is the primary industry, retiring coal power results in economic and labour force challenges, where workers must seek other employment opportunities.[46] Workers will need support from employers, educators, and government to bridge their career paths. This may mean a transition to a new job in the energy sector, a new job in a different industry, early retirement, or relocation to find alternate employment. These movements in the work force will necessitate a reassessment on people's skillsets. In the next section, we discuss how skills from workers in fossil fuel–based industries can be transferrable in several clean energy sectors.

Energy gender equity

There are many current gender inequities in the current energy sector workforce, with women being underrepresented particularly in leadership positions.[47] While representation of women is slightly higher in the renewable energy sector, these inequities persist.[48] There remain barriers for women in working in the energy sectors such as lack of opportunity to access training and jobs, lack of good jobs and supports (in particular, affordable childcare) that accommodate the responsibilities of many women, an income gap in similar jobs and across professions, inability to advance into leadership

[45] Business Renewable Centre Canada, "Deal Tracker." https://businessrenewables.ca/deal-tracker

[46] Grace Brown, Binnu Jeyakumar, *Supporting Workers and Communities in a Coal Phase-out: Lessons learned from just transition efforts in Canada* (Pembina Institute, 2022) https://www.pembina.org/pub/supporting-workers-and-communities-coal-phase-out

[47] Geneve Doiron, Emma Severson-Baker and Laura Hughes, *Women in Alberta's Energy Transition: Barriers to participation and leadership* (Pembina Institute, 2021), 2. https://www.pembina.org/pub/women-albertas-energy-transition

[48] International Renewable Energy Agency (IRENA), *Renewable Energy: A Gender Perspective* (2019), 10. https://www.irena.org/publications/2019/Jan/Renewable-Energy-A-Gender-Perspective

and into roles with better compensation, and a traditionally male-dominated industry culture.[49]

[49] *Women in Alberta's Energy Transition.*

4. Growing clean energy sectors

In the transition to a net-zero energy system by 2050, a range of clean energy sectors are expected to expand, and as a result, are expected to increase in labour demand and need for new skillsets, knowledge, and expertise. A report by RBC indicates that as many as 400,000 new jobs will be added in Canada's economy that will necessitate a demand of enhanced skills.[50] Further, RBC projects an increased demand in green occupations over the next 10 years in fields related to trades, transport and equipment, manufacturing and utilities, and sales and service, among others. There are opportunities for workers in fossil fuel–based energy-producing sectors to apply and transfer their knowledge and skillsets to jobs in net-zero aligned sectors.

This paper examines the transferability of skills to a select few sunrising sectors: solar, wind, geothermal, critical minerals, hydrogen, nature-based solutions and CCUS. Transferrable skills can be generally understood in three ways: skills that have a direct correlation; skills that need some refocus or upgrading; or completely new skills that need to be developed because the work is substantially different.[51]

While the scope of this paper has been limited to these areas, we recognize that the net-zero pathway will consist of many other solutions such as nuclear, biofuels, cross-cutting clean technology and so on. Further investigation is required to fully understand the future work and skills needs in each sector.

The electricity generation sector is expected to grow with increased electrification of energy end uses such as building heating, transport, and industrial processes. CICC has noted that every net-zero scenario it analyzed "consistently shows non-emitting primary energy sources supplying a growing share of energy on the path to net-zero."[52] The IEA's NZE has projected the global share of renewables in total electricity generation to increase to 88% in 2050.[53]

While there are opportunities for workers in fossil fuel–based energy-producing sectors to apply and transfer their knowledge and skillsets to jobs in net-zero aligned sectors,

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[50] RBC, *Green Collar Jobs: The skills revolution Canada needs to reach Net Zero* (2022). https://thoughtleadership.rbc.com/green-collar-jobs-the-skills-revolution-canada-needs-to-reach-net-zero/

[51] PetroLMI, "Assess Your Career Change." https://careersinenergy.ca/assess-your-career-change/

[52] CICC, *Canada's Net Zero Future,* 25.

[53] IEA, *Net Zero by 2050,* 117.

efforts are needed to manage anticipated challenges, and to ensure the transition in the labour force is as smooth as possible. It cannot be assumed that all displaced fossil fuel workers will be able to find satisfactory employment in clean energy:

- Clean energy jobs might not be located in the same provinces and in the same quantities as displaced fossil fuel jobs — and fossil fuel workers may be reluctant to relocate.
- Jobs in net-zero aligned sectors may pay less than traditional fossil fuel jobs,[54] though clean-tech jobs are still better paying than average jobs in Canada.[55]
- Energy sector workers may choose retirement over transition — 20% are currently at or within five years of Canada Pension Plan eligibility.[56,57]
- New net-zero aligned jobs may not open in tandem with the displacement of fossil fuel workers — and fossil emigrants may have to compete with labour market entrants for positions. Experiences and skillsets may not map perfectly with the skills required. It is anticipated that many workers will need to upskill and enhance their skillsets in a net-zero aligned economy.

That said, many of the skills and positions in fossil fuel work have been found to be compatible with clean energy and net-zero aligned sectors. The next section will outline what the modelling shows about net-zero aligned sectors, and then it will outline what's known about skills transferability in these growth industries.

4.1 The net-zero energy transition

Solar, wind, and geothermal

The net-zero transition is expected to benefit the solar and wind sectors in Canada, with the IEA's global NZE projecting the share of solar photovoltaic and wind in total electricity generation to increase from 9% in 2020 to 68% in 2050.[58]

[54] Reuters, "Nuclear, coal, oil jobs pay more than those in wind, solar: report," April 6, 2021. https://www.reuters.com/article/us-usa-energy-jobs-idUSKBN2BT2OT

[55] Statistics Canada "Average annual salaries in the environmental and clean technology sector." https://www150.statcan.gc.ca/n1/daily-quotidien/210326/dq210326e-eng.htm

[56] Statistics Canada, "Employment Characteristics for Selected Energy Industries," https://www150.statcan.gc.ca/n1/pub/25-26-0003/252600032021001-eng.htm

[57] Government of Canada, "CPP retirement pension: Do you qualify," https://www.canada.ca/en/services/benefits/publicpensions/cpp/cpp-benefit/eligibility.html

[58] IEA, *Net Zero by 2050.* 117.

That said, solar currently only accounts for less than 1% of Canada's electricity generation.[59] In 2020, Canada had about 3,000 MW of installed solar energy capacity.[60]Additionally, wind currently accounts for over 5% of Canada's electricity generation.[61] In 2020, Canada had nearly 13,600 MW of installed wind capacity.[62]As of 2020, Canada did not produce electricity from geothermal due to factors including upfront costs, competition from other forms of power generation and a lack of a policy and regulatory framework. Geothermal is not as developed in Canada as it is in other similar countries globally. Nevertheless, there are a number of geothermal projects underway, including Alberta-based Alberta No. 1, Razor Energy Corp., and Eavor-Lite Project.[63] In the IEA's global NZE, other renewables, which includes geothermal, sees its share of the total energy supply increase from 1% in 2020 to 6% in 2050.[64]

Critical minerals

The Government of Canada has characterized critical minerals as the "building blocks for the clean and digitized economy."[65] Critical minerals are necessary for clean technology and renewable energy applications.[66,67] Copper and zinc, for example, are required by the solar industry while lithium, graphite, nickel, and cobalt are required for the manufacturing of batteries.[68]

Canada is already a key global player when it comes to a number of critical minerals. It ranks among the top-10 producers of graphite, nickel, cobalt, and aluminum and has

[59] Natural Resources Canada, "Electricity facts." https://www.nrcan.gc.ca/science-and-data/data-and-analysis/energy-data-and-analysis/energy-facts/electricity-facts/20068

[60] Canadian Renewable Energy Association, "By the numbers." https://renewablesassociation.ca/by-the-numbers/

[61] "Electricity facts."

[62] "By the Numbers."

[63] Clean Energy Canada, "Media Brief: Geothermal energy and its potential in Canada," July 26, 2020. https://cleanenergycanada.org/media-brief-geothermal-energy-and-its-potential-in-canada/

[64] IEA, *Net Zero by 2050*, 193-195.

[65] Government of Canada, "Critical minerals". https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/critical-minerals/23414

[66] "Critical minerals."

[67] Demand for and economic and jobs opportunities in critical minerals can also come from areas that are not strictly part of the clean economy. Critical minerals are, for example, necessary inputs in supply chains for advanced manufacturing, in areas including consumer electronics, defence technologies, security technologies, medical applications, agriculture and infrastructure. *Source:* "Critical minerals."

[68] CICC, *Canada's Net Zero Future,* 61.

one of the largest identified lithium reserves.[69] Canada also has significant resources and reserves of rare earth elements, estimated to be over 15 million tonnes.[70,71]

The transition to net-zero can be expected to increase demand for Canadian-produced critical minerals as it decreases demand for Canadian-produced coal. The IEA's NZE, for example, projects the change in the global value of coal and select critical minerals to inversely mirror one another between 2020 and 2050, with the value of critical minerals increasing from about USD 50 billion to over USD 400 billion.[72]

Nature-based solutions

Nature-based solutions (NBS) refers to the deployment of natural assets for the absorption and prevention of the release of greenhouse gas emissions.[73] NBS are considered a form of negative emission solutions.[74] Examples of NBS include tree planting, the use of low- or zero-till agriculture to reduce soil erosion and the allowance of agricultural land to revert to wilderness.[75,76] Canada has committed to conserve 30% of its lands and oceans as of 2030.[77] The CICC has projected the contribution of NBS to

[69] Natural Resources Canada, "Minerals and Metals Facts." https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/20507

United States Geological Survey, *Mineral Commodity Summaries 2021* (2021), 21, 51, 99. https://www.usgs.gov/centers/nmic/mineral-commodity-summaries

[70] Natural Resources Canada, "Rare earth element facts." https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/minerals-metals-facts/rare-earth-elements-facts/20522

[71] Within Canada, significant amounts of cobalt, nickel and platinum production occur in the two populous provinces of Ontario and Quebec. Nevertheless, there are critical mineral opportunities in other provinces as well. In November 2021, for example, British Columbia produced nearly 24 million kilograms of copper (recoverable) and Saskatchewan produced over 200,000 kilograms of uranium (recoverable) and over 1.2 million tonnes of potash (potassium oxide). *Sources:* Statistics Canada, "Production and shipments of metallic minerals, monthly." https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1610001901; Statistics Canada, "Production and shipments of non-metallic minerals, monthly." https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1610002001

[72] IEA, *Net Zero by 2050,* 163.

[73] Morrigan Simpson-Marran, Jan Gorski and Nina Lothian, *Nature-based climate solutions* (Pembina Institute, 2021), 2. https://www.pembina.org/pub/nature-based-climate-solutions

[74] CICC, *Canada's Net Zero Future,* 69.

[75] CICC, *Canada's Net Zero Future,* 69.

[76] *Nature-based climate solutions,* 2.

[77] *Nature-based climate solutions,* 4.

emissions reductions to increase to less than 50 Mt. CO_2e as of 2050, noting that "credible estimates of its potential" remain limited.[78,79]

Carbon capture, utilisation, and storage

Canada currently accounts for about 20% of global installed carbon capture, utilisation, and storage (CCUS) capacity[80]. The use of CCUS is likely to increase further as Canada transitions to net-zero. The CICC, for example, has estimated that engineered forms of negative emissions solutions, including direct air capture and CCUS, could supply negative emissions of up to 426 Mt CO_2e annually as of 2050.[81] In the IEA's NZE, the share of unabated natural gas in the total energy supply declines from 23% in 2020 to 3% in 2050 while the share of natural gas with CCUS increases from 0% to 8%.[82]

Hydrogen

Canada is a top 10 global hydrogen producer.[83] Canada's hydrogen sector could potentially benefit from the net-zero transition, with the IEA's global NZE having the hydrogen share in total final energy consumption increase from 0% in 2020 to 6% in 2050.[84] CICC, meanwhile, has investment in the hydrogen sector in Alberta and Saskatchewan increase between 2020 and 2050 in all of its scenarios.[85] Finally, according to the Hydrogen Strategy For Canada, hydrogen could account for up to 30% of Canadian energy delivered as of 2050.[86]

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[78] CICC, *Canada's Net Zero Future,* 69-70.

[79] Research by Nature Canada indicates that Canada is under-reporting forest sector emissions by over 80 million tonnes annually, due to flaws in its method of forest carbon accounting. These flaws include "overstating natural carbon removals while not reporting the emissions from wildfires"; "under-measuring emissions associated with industrial logging"; "using an altered baseline for assessing forestry emission reductions over time," and "excluding logging emissions from the carbon pricing system." *Source:* Nature Canada, *Missing the Forest: How Carbon Loopholes for Logging Hinder Canada's Climate Leadership.* (2021). https://naturecanada.ca/missingtheforestreport/#1635369497765-aae059ce-4e61

[80] Nnaziri Ihejirika, *The Role of CCUS in Accelerating Canada's Transition to Net-Zero* (The Oxford Institute for Energy Studies, 2021), 1. Available at https://www.econstor.eu/escollectionhome/10419/246503.

[81] CICC, *Canada's Net Zero Future,* 73.

[82] IEA, *Net Zero by 2050,* 195.

[83] Clean Energy Canada, "Media brief: Hydrogen as part of Canada's energy transition," July 2, 2020. https://cleanenergycanada.org/hydrogen-as-part-of-canadas-energy-transition/

[84] IEA, *Net Zero by 2050,* 196.

[85] CICC, *Canada's Net Zero Future,* 67.

[86] According to the strategy, further potential benefits of seizing "the opportunities for hydrogen" include about 350,000 jobs and over $50 billion in hydrogen sector revenue. *Source:* Natural Resources Canada,

Not all hydrogen is created equal, however, and the climate benefit of hydrogen depends on the method of its production. Green hydrogen, for example, which is produced through electrolysis using renewable energy, offers the largest climate benefit, while grey hydrogen, which is produced through the extraction of hydrogen from natural gas without carbon capture, offers minimal climate benefit. While low-carbon hydrogen can be used to decrease emissions in difficult-to-decarbonize sectors, its production remains nascent.[87]

4.2 Opportunities for skills transferability

Solar, wind, and geothermal

PetroLMI has defined three "transferability pathways" for oil and natural gas workers seeking to transition into other areas of the energy industry:

- Direct: "Essentially the same core qualifications, technical knowledge, skills and work environment with a high likelihood of recruitment and retention in the sector."
- Refocus: "Similar work but some skill or knowledge upgrading is likely required to increase the chance of a successful transition."
- Reboot: "The work is very different; there is a need to invest significant effort to qualify for a position."[88]

Within renewables, solar, wind and geothermal are often focused on as subsectors to which oil and natural gas workers' skillsets may be transferable.[89,90] Appendix A outlines about 70 occupations that PetroLMI has indicated as having some level of skills transferability to either wind, solar or geothermal, generally requiring either minor or no skills upgrading, and in areas including business and operations support; engineers; environmental, regulatory, and stakeholder engagement; geoscience professionals; information technology roles; operators, technicians and technologists; and the trades.

Hydrogen Strategy for Canada: Seizing the Opportunities for Hydrogen (2020), xvii-xviii. https://www.nrcan.gc.ca/climate-change/canadas-green-future/the-hydrogen-strategy/23080

[87] Maddy Ewing, Benjamin Israel, Tahra Jutt, Hoda Talebian and Lucie Stepanik, *Hydrogen on the path to net-zero emissions: Costs and climate benefits,* (Pembina Institute, 2020) https://www.pembina.org/pub/hydrogen-primer

[88] PetroLMI, "Assess Your Career Change." https://careersinenergy.ca/assess-your-career-change/

[89] PetroLMI, "Working in Renewables." https://careersinenergy.ca/plan-your-future/working-in-renewables/

[90] Iron & Earth, "Climate Career Portal." https://www.climatecareerportal.com/

In general, it is anticipated that, among geothermal, solar and wind, the level of transferability for the latter two is lower and the amount of required skills upgrading is higher.[91] Soft skills have also been identified as helpful in the renewable sector, including "forward-thinking" and readiness "to build relationships with stakeholders and Indigenous communities."[92]

Solar

Solar energy jobs include positions in manufacturing, construction labour, operations and maintenance, warehousing and distribution and installation and sales.[93, 94] It is anticipated that the predictive maintenance[95] skills of oil and gas workers are likely to be highly transferable to solar.[96]

In addition to the roles identified in Appendix A below, Iron & Earth's Career Climate Portal indicates that roles, including welders; structural metal and platework fabricators; and industrial, non-industrial and power-system electricians are transferable to solar.[97]

Industrial electricians, for example, can apply their skills in solar in the repair, maintenance and installation of industrial equipment and machinery.[98,99] Welder

[91] "Working in Renewables."

[92] "Working in Renewables."

[93] Green Skills Network, *Emerging Green Jobs in Canada: Insights for Employment Counsellors into the Changing Labour Market and its Potential for Entry-Level Employment* (2012), 22. http://www3.cec.org/islandora-gb/en/islandora/object/islandora%3A1193

[94] Climate Career Portal, "Solar." https://www.climatecareerportal.com/solutions/solar

[95] Predictive maintenance skills involve the ability to predict and address equipment failure in advance, to avoid time-consuming, costly repairs. These skills can involve the collection and use of real-time data and analytics, gathered through tools like sensors and imaging devices. *Source:* Won Jin, Jeongyun Han, Wongjung Rhee, "AI-assistance for predictive maintenance of renewable energy systems," *Energy* (221), 2021, 1. https://www.sciencedirect.com/science/article/pii/S0360544221000244

[96] PetroLMI, *Labour Market Outlook 2021 to 2023: Canada's Oil and Gas Industry* (2021), 13. https://careersinenergy.ca/reports/

[97] "Solar."

[98] Climate Career Portal, "Industrial Electricians." https://www.climatecareerportal.com/search/industrial-electrician

[99] This and other granular skills transferability information in the "Solar, Wind, and Geothermal" section is based on Iron & Earth's Climate Career Portal, which is a digital platform which seeks to connect fossil fuel workers, as well as Indigenous community members, "with career pathways in the net-zero economy." The CCP matches "the skills of the occupation you searched (as listed by the Government of Canada's National Occupational Code), to different climate solutions that also need these same skills." *Source:* Iron + Earth Climate Career Portal, "Advice." https://www.climatecareerportal.com/advice

helpers can apply their skills in solar in the installation of sheet metal flashings; the cutting of openings into floors and walls for the accommodation of pipes and pipe fittings; and the operation of welding equipment to fuse metal segments.[100]

Wind

Numerous oil and gas occupations, many of which are listed in Appendix A, have skillsets that are highly transferrable to wind. Wind energy jobs include occupations in manufacturing (including turbine equipment manufacturing), project development, sales, construction, decommissioning and operations and maintenance.[101,102] Oil and gas skills, including predictive maintenance are expected to be transferrable to wind.[103]

Skills and expertise related to Canada's offshore oil and gas sector may be transferrable to offshore wind. Canada's offshore oil and gas industry includes six producing projects, along with additional exploration in Atlantic Canada.[104] Expertise and experience in offshore location work may be transferrable to the construction of offshore wind farms — including subsea structures and foundations. Experience and expertise in the maintenance of oil and gas safety standards may also be transferrable to the inspection and maintenance of offshore wind locations once in operation.[105]

Numerous oil and gas occupations, many of which are listed in Appendix A, have skillsets that are highly transferrable to wind. Offshore petroleum operators can apply their skills in wind to the development of electrical and electronic systems and equipment standards.[106] Environmental engineers can apply their skills in wind to the development of safety procedures.[107]

[100] Climate Career Portal, "Welders Helpers." https://www.climatecareerportal.com/search/welders-helper

[101] *Emerging Green Jobs in Canada,* 21.

[102] Climate Career Portal, "Wind." https://www.climatecareerportal.com/solutions/wind

[103] *Labour Market Outlook 2021 to 2023: Canada's Oil and Gas Industry,*

[104] Canadian Association of Petroleum Producers, "Canada's Oil Industry." https://www.capp.ca/oil/

[105] IEA, *Net Zero by 2050,* 161.

[106] Climate Career Portal, "Offshore Petroleum Operators." https://www.climatecareerportal.com/search/offshore-petroleum-operator

[107] Climate Career Portal, "Environmental Engineers." https://www.climatecareerportal.com/search/environmental-engineer

Geothermal

Oil and gas skills including well servicing, drilling and completions are transferrable to geothermal.[108] In addition to the occupations listed in Appendix A, roles including plumbers; pipefitters; steamfitters and sprinkler installers; surface mining drillers and blasters; oil and gas drillers, services, testers, and related workers; and industrial, non-industrial and power system electricians have been identified as transferrable to geothermal[109]. Boilermakers, for example, can apply their skills in geothermal in the repair and adjustment of machinery; in the fabrication of heavy-metal products such as piping, vessels and boilers and in the operation of welding equipment to fuse metal segments.[110] Steamfitters, pipefitters, and sprinkler system installers can apply their skills in geothermal in areas including the use of testing equipment to test systems for leaks.[111]

Critical minerals

The skills and experience of coal mining workers and oil and gas extraction workers can be transferrable to the mining of critical minerals.[112] According to Statistics Canada, between 1995 and 2015, an average of 75% of workers laid off from coal mining and oil and gas extraction found paid employment in the 12 months following job loss. For those laid off in the 1995-2000 and 2010-2015 years, about 20% and 28%, respectively, were re-employed in the mining and oil and gas extraction sector.[113]

One prominent occupational group in mining, for example, is "underground production and development miners." Common titles in this group include "miner," "chute blaster," and "driller" and common skillsets and duties include the set up and operation of drilling machines and mining machinery and the loading and detonation of explosives. This occupational group will often have completed secondary school and significant formal and specialized training and may be in possession of a provincial

[108] *Labour Market Outlook 2021 to 2023: Canada's Oil and Gas Industry,* 13.

[109] Climate Career Portal, "Geothermal." https://www.climatecareerportal.com/solutions/geothermal

[110] Climate Career Portal, "Boilermakers." https://www.climatecareerportal.com/search/boilermaker

[111] Climate Career Portal, "Steamfitter, Pipefitter and Sprinkler System Installers." https://www.climatecareerportal.com/search/steamfitter-pipefitter-and-sprinkler-system-installer

[112] IEA, *Net Zero by 2050,* 162.

[113] Wen-Hao Chen and Rene Morissette, *How Do Workers Displaced from Traditional Energy-producing Sectors Fare after Job Loss? Evidence from Coal Mining* (2020), 2-4. https://www150.statcan.gc.ca/n1/pub/11-626-x/11-626-x2020022-eng.pdf

blasting license. The group can be employed by both coal, metal, and non-metallic mineral underground mines, indicating transferrable skillsets.[114]

Equity considerations in mining

A just transition should ensure it is avoiding negative impacts associated with transient workers and allow for the opportunity for skills development among locals. For example, in Northwest Territories, a recent benefits report found that about 55% of the mining workforce was flown-in from outside of the region. Northern Canada more generally has experienced negative impacts associated with fly-in, fly-out workers such as Covid-19 outbreaks on remote work sites that have spilled over into communities as fly-in workers often work alongside local residents.[115] Gender-based violence is also connected to the existence of resource projects that rely on a transient workforce, both towards women workers and the often-Indigenous women in neighbouring communities.[116] To reduce these impacts and increase local capacity, several approaches to supporting remote communities in accessing training and skills development are referenced in the report. A just transition should ensure it is avoiding negative impacts associated with transient workers and allow for the opportunity for skills development among locals.

Critical minerals and Indigenous communities

Beyond extraction activities, critical minerals value chains can create opportunities in monitoring, exploration, processing, manufacturing, and battery recycling.[117] There are also indirect economic opportunities for infrastructure development, and capacity enhancement in remote and Indigenous communities. Indigenous workers are highly represented in the mining sector, and it is important that they can continue to lead and

[114] Government of Canada, "8231 – Underground production and development miners." https://noc.esdc.gc.ca/Structure/NocProfile?objectid=sQBin3r%2BbaZmJBXXxOeA4z%2BbkH9MBfYt6mnpU40IDIo%3D

[115] John Last, "Governments lack key data on fly-in workers. Experts say it's putting them at risk," *CBC North,* March 4, 2021. https://www.cbc.ca/news/canada/north/fly-in-workers-arctic-1.5930216

[116] National Inquiry into Missing and Murdered Indigenous Women and Girls, *Reclaiming Power and Place: The Final Report of the National Inquiry into Missing and Murdered Indigenous Women and Girls,* Volume 1a (2019). 584-587. https://www.mmiwg-ffada.ca/wp-content/uploads/2019/06/Final_Report_Vol_1a-1.pdf

[117] James Maloney, *From Mineral Exploration to Advanced Manufacturing: Developing Value Chains for Critical Minerals in Canada* (Standing Committee on Natural Resources, 2021), 25. https://www.ourcommons.ca/Content/Committee/432/RNNR/Reports/RP11412677/rnnrrp06/rnnrrp06-e.pdf

access these opportunities as they emerge.[118] However, it is important to note the tensions here for many communities in accessing economic opportunities while their lands are exploited for minerals.[119] One example of leadership that brings together economic benefit and the application of land stewardship skills has been identified by the BC First Nations Energy and Mining Council. They have explored the benefits of creating Guardian Network Initiatives that focus on training and employing Indigenous community members to monitor and restore the impacts of resource development on their lands, including mining projects.[120]

Nature-based solutions

The increase in the use of NBS projected by CICC on the path to net-zero can be expected to provide employment opportunities for displaced energy workers. It is anticipated that workers in well testing, well servicing, oil and gas transportation services and heavy equipment operation, among others, can find work in oil and gas well cleanup in areas including assessment, plugging, remediation and reclamation.[121] It is further anticipated that workers in remediation and restoration will be well suited to NBS projects in Canada.[122]

CCUS

Oil and gas skills and competencies related to large-scale engineering, pipelines, sub-surface activities and project management are expected to be transferrable to CCUS.[123]

[118] *From Mineral Exploration to Advanced Manufacturing*, 15.

[119] Leah S. Horowitz, Arn Keeling, Francis Lévesque, Thierry Rodon, Stephan Schott, Sophie Thériault, "Indigenous peoples' relationships to large-scale mining in post/colonial contexts: Toward multidisciplinary comparative perspectives," *The Extractive Industries and Society* 5 (2018), 404.

[120] Corbin Greening, Lauren Mar, Ruben Tillman and Calvin Sandborn, *The Case for a Guardian Network Initiative* (BC First Nations Energy and Mining Council and Environmental Law Centre at the University of Victoria, 2020), 11. http://fnemc.ca/wp-content/uploads/2015/07/The-Case-for-a-Guardians-Network-July-2020.pdf

[121] Regan Boychuk, Mark Anielski, John Snow Jr. and Brad Stelfox, *The Big Cleanup: How enforcing the Polluter Pay principle can unlock Alberta's next great jobs boom* (Alberta Liabilities Disclosure Project 2021), 33, 39. https://www.aldpcoalition.com/thebigcleanup

[122] Iron and Earth, *The Prosperous Transition Plan* (2021), 58. https://www.ironandearth.org/prosperous_transition_plan

[123] IEA, *Net Zero by 2050,* 160.

Hydrogen

Oil and gas skills and competencies related to well servicing, drilling,[124] and transporting gases and liquids by ships and pipelines are expected to be transferrable. Oil and gas skills and competencies related to oil and gas processing and refining have potential to be transferrable to the processing of hydrogen into ammonia and synthetic fuels.[125] Finally, the construction of steam-methane reforming facilities with CCUS for the production of blue hydrogen, the construction of CO_2 pipelines and the conversion of orphaned wells and oilfields to the disposal of CO_2 or to the production of hydrogen are expected to require existing oil and gas skills as well.[126]

Conclusion

Overall, much like the fossil fuel sector, the growing clean energy sector is a rich source of a variety of skills and job opportunities. Initial findings indicate that there are many options within net-zero aligned sectors for skills transferability from oil and gas sectors.

However, as with any sector, there are specific skills, including a knowledge of the industry, that businesses and industry will require of the worker. Going forward, further research, as well as interviews with representatives of clean energy sectors should be performed. This will help further clarify gaps in skills transferability specific to industry. Additionally, clarification is needed from multiple levels of government about which clean industries — which pathways to net-zero — will have investments as well as regulatory support. Once those pathways are set, businesses and individuals will feel more confident investing the time and energy in upskilling to find new work.

[124] *Labour Market Outlook 2021 to 2023: Canada's Oil and Gas Industry,* 13.

[125] IEA, *Net Zero by 2050,* 161.

[126] CICC, *Canada's Net Zero Future,* 68.

5. High-demand industries for clean energy

The net-zero transition has real and urgent implications for the workforce in the energy end use sectors if Canada is to meet its short- and long-term climate targets and seize the full opportunity of the net-zero economy. This section explores two such sectors — buildings and transportation — which together represent nearly 40% of Canada's greenhouse gas emissions.[127] The focus in this section is on the necessary upgrades to skills within the existing labour force to accelerate the building and retrofit of zero-carbon buildings and switching to near- and zero-emission transportation.

5.1 Buildings

Current labour market characteristics

Canada's construction sector employed 1.3 million individuals in 2020. Residential building construction (470,000) and non-residential building construction (200,000) cumulatively account for just over half of this workforce. Engineering construction (360,000) and repair construction (270,000) made up the remainder.[128] In contrast to fossil fuels, the sector is geographically dispersed, with employment concentrated in populous provinces including Ontario (36%), Quebec (19%), Alberta (16%) and British Columbia (15%) and with employment above 1,000 in all provinces and territories.[129]

The trades and related occupations make up the vast majority of Canada's construction labour force, accounting for nearly two-thirds in 2017. Most of these are in the industrial, electrical and construction trades (36%) or are working as trades helpers, construction labourers or in related occupations.[130] Table 1, below, provides more detail.

[127] Government of Canada, "National greenhouse gas emissions." https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html

[128] "Labour productivity and related measures by business sector industry and by non-commercial activity consistent with the industry accounts."

[129] "Labour productivity and related measures by business sector industry and by non-commercial activity consistent with the industry accounts."

[130] "Average full-time hourly wage paid and payroll employment by type of work, industry and occupation."

Table 1. Trades in Canada's construction workforce

Trade	Percentage of construction workforce, 2017
Trades helpers and labourers	14%
Contractors and supervisors, industrial, electrical and construction trades and related workers	9%
Electrical trades and electrical power line and telecommunications workers	8%
Carpenters and cabinetmakers	6%
Plumbers, pipefitters, and gas fitters	4%
Other construction trades	4%
Heavy equipment operators	4%
Masonry and plastering trades	4%

Source: Statistics Canada[131]

Architects, engineers, and related professions make up a smaller, but still significant proportion of Canada's construction sector, accounting for about 5% of the workforce in 2017. This includes both professional occupations (1.1%) and technical occupations (4.5%). Table 2, below, provides more detail.[132,133]

[131] "Average full-time hourly wage paid and payroll employment by type of work, industry and occupation."

[132] "Average full-time hourly wage paid and payroll employment by type of work, industry and occupation."

[133] Estimates by ECO Canada indicate that construction firms employed over a quarter of a million energy efficiency workers in 2018, which represented two-thirds of identified energy efficiency workers. Nearly two-thirds of energy efficiency construction workers spent most or all of their time in activities related to energy efficiency. Nearly three-quarters of energy efficiency construction workers were primarily engaged in high efficiency heating equipment, high efficiency cooling equipment, efficient lighting and traditional HVAC. Nearly 60% of energy efficiency construction workers worked in repair or installation. ECO Canada defined energy efficiency as "the production or installation of energy-saving products and/or provision of services that reduce end-use energy consumption." *Source:* ECO Canada, *Energy Efficiency Employment in Canada* (2019), 11, 26-27. https://eco.ca/new-reports/energy-efficiency-canada/

Table 2. Architects and engineers in Canada's construction workforce

Trade	Share of construction workforce, 2017
Technical occupations in civil, mechanical and industrial engineering	2.2%
Technical occupations in electronics and electrical engineering	1.4%
Civil, mechanical, electrical and chemical engineers	1%
Technical occupations in architecture, drafting, surveying, geomatics and meteorology	0.5%
Architects, urban planners and land surveyors	0.1%

Source: Statistics Canada[134]

The net-zero energy transition

Canada's building sector emitted about 91 Mt. CO_2e in 2019, over 12% of Canada's total.[135] Reducing these emissions on the path to net-zero emissions will require a transition towards zero-carbon building solutions. Newly constructed buildings will have to be zero-carbon and the existing building stock will have to be retrofitted.[136] Decarbonization can include solutions such as improved insulation, higher efficiency windows and improved design of buildings.

What are zero-carbon buildings?

Two useful concepts for how a building can be, or may become, "zero-carbon" are provided by the International Energy Agency (IEA) and the Canada Green Building Council (CaGBC).

Zero-carbon-ready buildings (IEA): The IEA defines a "zero-carbon-ready building" as a building that is highly energy efficient and uses an energy source that is either currently fully decarbonized or will be as of 2050. As such a zero-carbon-ready building "will

[134] "Average full-time hourly wage paid and payroll employment by type of work, industry and occupation."

[135] "Greenhouse gas emissions."

[136] Canada Green Building Council, *Trading Up: How Alberta's Trades Can Build a Zero Carbon Future* (2020), 5. https://www.cagbc.org/CAGBC/Advocacy/alberta_skills_report.aspx

become a zero-carbon building by 2050, without any further changes to the building or its equipment."[137,138]

Zero-carbon building (CaGBC): CaGBC defines a "zero-carbon building" as a building that is highly energy-efficient and that either uses fully decarbonized energy or uses "high-quality carbon offsets in an amount sufficient to counterbalance the annual carbon emissions associated with building materials and operations."[139]

The CICC has projected that such solutions could reduce building energy intensity by 45–55% as of 2050.[140] The electrification of heating will be required for yet deeper emission cuts. The CICC has estimated that electric heating systems will heat between 52% and 100% of households as of 2050.[141] In the IEA's NZE, over 85% of buildings are zero-carbon as of 2050, which involves the introduction of mandatory zero-carbon-ready building energy codes as of 2030 and the retrofitting of the majority of the existing building stock as of 2050.[142] The Pembina Institute has put forward a ramping up of deep retrofits and electrification of Canada's vintage stock at a rate that reaches 40% by 2030 and 100% by 2040, when retrofits can slow down to focus on buildings built after 2021 — most buildings built today will not meet net-zero targets.[143,144] Build Smart: Canada's Buildings Strategy, released by NRCan in late 2017, puts forward a plan for "increasingly stringent national model energy codes for new buildings… requiring new buildings to be 'net-zero energy–ready' by 2030."[145,146]

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[137] IEA, *Net Zero by 2050,* 144.

[138] The IEA has noted that "Zero-carbon-ready building energy codes should cover building operations (scope 1 and 2) as well as emissions from the manufacturing of building construction materials and components (scope 3 or embodied carbon emissions)." *Source:* IEA, *Net Zero by 2050,* 144.

[139] *Trading Up*, 10.

[140] CICC, *Canada's Net Zero Future,* 38.

[141] CICC, *Canada's Net Zero Future,* 40.

[142] IEA, *Net Zero by 2050,* 143.

[143] Madi Kennedy and Tom-Pierre Frappe-Seneclauze, *Canada's Renovation Wave: A plan for jobs and climate* (2021), 14. https://www.pembina.org/pub/canadas-renovation-wave

[144] Pembina has estimated that 'meeting our climate objectives in the residential and commercial sector' would result in the creation of up to 200,000 jobs across Canada in areas including the trades and professional services. *Source: Canada's Renovation Wave,* 16.

[145] International Energy Agency, *Canada 2022 Energy Policy Review* (2022), 98. https://www.iea.org/reports/canada-2022

[146] Canada's 2030 ERP included the commitment to invest in the creation of a Canada Green Buildings Strategy, which would seek to "drive a massive retrofit of the existing building stock, and construction to the highest zero carbon standards." *Source: 2030 Emissions Reduction Plan,* 36.

Impacts to the labour force

A transition to zero-carbon buildings and deep retrofits needed in Canada's building stock will require a strong construction labour force, including the trades as well as engineers, architects and renewable energy specialists.

While this section cites from a number of resources, it draws heavily from research conducted by the Canada Green Building Council (CaGBC). CaGBC's skills research often refers to the Zero Carbon Building (ZCB) Standard. CaGBC defines the ZCB Standard as providing "a framework to help buildings achieve zero carbon in design and in annual operations"[147] and notes that the standard is "applicable to all buildings except homes and small multi-family residential buildings."[148]

Green literacy and soft skills for trades

According to CaGBC, future skills required for the trades as Canada's building sector transitions to net-zero emissions include soft skills and technical skills. Collaboration and communication skills, "green literacy" and soft skills are important in the buildings work force. These include the ability to co-ordinate with other trades and an understanding of how the tradesperson's work interacts with other tradespeople's work; understanding of general building science principles and green building construction strategies and an awareness of climate change and knowledge of how GHG emissions impact the environment. CaGBC's research has highlighted how the inherent complexity of zero-carbon building construction requires the trades to understand how their contributions fit into the bigger picture and the inputs of other tradespeople and requires significant levels of co-ordination between various workers: "In essence, zero carbon buildings require a working knowledge of the building as a system and an understanding that buildings are not just a sum of their parts."[149]

The CaGBC identified gaps in soft skills and green literacy, such as understanding of general building science principles, project design, co-ordination with other trades, communication, and an understanding of how a tradesperson's work interacts with the work of other tradespeople.[150]

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[147] Canada Green Building Council, "A made-in-Canada solution." https://www.cagbc.org/CAGBC/Zero_Carbon/zero_carbon.aspx

[148] Canada Green Building Council, "CaGBC Zero Carbon Building Standard: Frequently Asked Questions." https://www.cagbc.org//CAGBC/Zero_Carbon/FAQ/CAGBC/Zero_Carbon/CaGBC_Zero_Carbon_Building_Standard__Frequently_Asked_Questions.aspx

[149] *Trading Up,* 19, 20.

[150] *Trading Up,* 20.

Technical skills for trades

In addition, a number of technical skills are required by the trades for zero carbon buildings. It has been noted that "zero carbon buildings are more complicated than conventional construction, requiring the precise installation of sometimes non-traditional components and systems…" and that "the threshold for mistakes in zero carbon buildings is slim, demanding a higher level of sophistication and precision from the entire project team."[151,152]

According to CaGBC, the following technical skills are required by the trades in zero carbon building construction, some of which have gaps: Building performance and verification (gap); mechanical systems commissioning (gap); building science (envelope airtightness) (gap); building automation systems (gap); building envelope commissioning (gap); installation of integrated high-performance building systems; energy storage (gap); determination of most suitable renewable energy technology for a project (gap); installation of solar renewable energy systems; impact of climatic and geographic conditions on systems for renewable energy; low carbon materials; installation of systems for geothermal renewable energy. Two broad areas in which gaps were found were in technical skills related to building components (e.g. mechanical systems, building automation) and in technical skills related to building envelopes (e.g. airtightness and commissioning).[153]

Skillsets for deep retrofits

A study by the Pembina Institute explored the skills required for deep retrofits. While this report's exploration of skills in buildings focuses on the construction sector, a number of the skills mentioned in the study related to prefabrication.[154] The report found that skills and capacity required include:

Off-site construction and prefabrication, including the setup of a prefabrication shop; logistics for transporting, hoisting and construction sequencing and the streamlining of workflow.

[151] *Trading Up,* 21.

[152] CaGBC gathered data for its "Trading Up" report through industry stakeholder roundtable discussion sessions, as well as secondary sources, an industry survey and previous CaGBC research on zero-carbon skills gaps. *Trading Up,* 11.

[153] *Trading Up,* 21.

[154] Betsy Agar, *Training up for deep retrofits: Skilled trades are key to transforming Canada's building sector* (2020), 1. https://www.pembina.org/pub/deep-retrofit-skills-training

Building assessment, including an understanding of historic construction, building performance auditing, condition assessments and suitability for prefabrication.

Integrated design, including integrated design of passive systems, mechanical systems and on-site renewable energy.

Digital capture, including laser scanning, photogrammetry and computer-aided design.

Building preparation, including assessments of required demolition, service disconnects and re-routing.

Advanced building equipment, materials and techniques, including knowledge of supply chain compatibility and availability.

Soft costs, including communication with the occupants of buildings, the navigation of policies and the collaboration with clients, occupants, code officials and others.[155]

Technical skills for engineers, architects and renewable energy specialists

Although they make up a much smaller proportion of Canada's construction workforce than the trades, engineers, architects and renewable energy specialists are "directly involved in the initial design stages for new buildings and retrofits" and make decisions important to the feasibility of buildings becoming zero-carbon — including those associated with material selection, construction practices, performance targets, utility connections and energy sources utilized.[156]

CaGBC categorizes professional competencies related to zero carbon buildings as: "zero carbon balance," "energy efficiency," "renewable energy," "low carbon materials," and "future weather."[157] CaGBC documented zero-carbon building knowledge and skill gaps based on a survey of the building industry. Respondents self-reported on perceived practical experience and knowledge on various competencies and also rated these competencies in terms of importance to their jobs.[158] This section concentrates on the first four competencies, with their related sub-competencies and gaps identified.

[155] *Training up for deep retrofits,* 1.

[156] Canada Green Building Council, *Accelerating to Zero: Upskilling for Engineers, Architects, and Renewable Energy Specialists* (2020), 9. https://www.cagbc.org/CAGBC/Advocacy/upskill.aspx

[157] *Accelerating to Zero,* 15-20.

[158] *Accelerating to Zero,* 5.

1. **Zero carbon balance** refers to the fact that zero carbon buildings will achieve zero or below zero carbon emissions, including both embodied and operational emissions.

   Sub-competencies related to zero-carbon balance include general zero carbon building principles, greenhouse gas (GHG) accounting, zero carbon balance calculations, transition plans (referring to plans for the retrofit of a building to reduce GHG emissions associated with onsite combustion), understanding of the impact of buildings on climate change and passive design to reduce energy demand as well as GHG emissions. GHG accounting and transition plans represent the biggest skill gaps among these.[159]

2. **Energy efficiency** refers to meeting energy needs with a minimum of energy use and GHG emissions as well as decreasing peak demand on the electricity grid.

   Energy efficiency sub-competencies include thermal energy demand intensity (TEDI), cooling demand intensity, energy use intensity (EUI), design strategies for the reduction of energy demand for heating and cooling, design strategies for the improvement of energy efficiency and strategies to reduce peak demand.

   Engineers and architects have skills gaps in strategies for the improvement of energy efficiency, strategies to reduce peak demand, TEDI and cooling demand intensity.[160]

[159] *Accelerating to Zero,* 16, 34, 35.

[160] Thermal energy and cooling demand intensity references the heat loss from the building envelope and ventilation, having accounted for passive heat losses and gains. Thermal energy demand intensity (TEDI) can be calculated on the basis of the quantity of heating energy that is delivered to the project from equipment for space heating. Energy use intensity (EUI) references the sum of site energy consumed on the site of the project, which includes process energy, divided by the gross floor area of the building. *Source: Accelerating to Zero,* 17, 35.

Energy efficiency and zero-carbon buildings

Energy efficiency is crucial to Canada's path to net-zero in the buildings sector. Both the IEA and the CaGBC define zero-carbon buildings as being highly energy efficient.[161,162] The CICC has projected that solutions including improved insulation, higher efficiency windows and improved building design could reduce building energy intensity by 45-55% as of 2050.[163]

ECO Canada has noted that 'many of the pieces' required for a transition to energy efficiency in buildings — including materials, technology, processes and equipment — are in place, but that "Canada's building sector workforce does not have the widespread experience or skills required to perform their roles in a manner that achieves energy efficiency goals."[164]

ECO Canada has noted that builders, designers and energy specialists and managers will be increasingly required to assist building owners to make choices related to the energy efficient building process.

ECO Canada has noted that the development of energy efficient buildings requires the use of data for activities including the evaluation of design options, prediction of maintenance requirements and assessment of technology installation. It has noted that there will be an increasing demand for digital literacy, as well as for information technology specialists.

ECO Canada put forward two categories of occupations and skills in assessing the building workforce in relation to Canada's energy efficient future. The "core" category included occupations and/or skills such as architects, construction trades and building operation and facility managers, which are currently available and "remain especially important." The "growing" category included occupations and/or skills such as passive house design, thermal energy engineering and building systems analysis, which are currently available but are "expected to grow at a faster rate than others."[165]

[161] IEA, *Net Zero by 2050,* 144.

[162] *Trading Up*, 10.

[163] CICC, *Canada's Net Zero Future,* 38.

[164] ECO Canada, *Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Buildings Workforce* (2021), 6. https://eco.ca/new-reports/new-research-an-opportunity-for-energy-efficiency-in-the-building-sector/

[165] *Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Buildings Workforce,* 7-8.

3. **Renewable energy** refers to the use of onsite or offsite renewable energy sources to decrease emissions from buildings. Sub-competencies include onsite and offsite renewable energy generation.[166]

4. **Low-carbon materials** refers to decreased carbon emissions as a result of the construction, transportation and/or manufacturing, as well as the end-of-life phases of built assets. Embodied carbon can be tracked throughout a building's entire life-cycle. Sub-competencies include the performance of life-cycle assessment (LCA), the calculation of embodied carbon and the understanding of embodied carbon in construction. Architects have gaps for all these sub-competencies.[167]

Designing and building sustainable homes

Endeavour, a sustainable building school in Ontario, offers the Sustainable Building & Design course. The course is targeted at a number of groups, including those who 'want to build your own sustainable home to the highest possible standards and get it right the first time."[168] Examples of skills, knowledge, and experience gained by students include:

The definition of sustainable architecture

Knowledge of building science and building structure

Knowledge of renewable energy and mechanical systems

Ability to read construction plans and work with building codes

Installation of structural systems including roofs, walls, and foundations

Creation of energy efficient building enclosures and the achievement of airtightness

Installation of low-carbon and efficient heating, ventilation, and cooling systems

Waste handling

[166] *Accelerating to Zero: Upskilling for Engineers, Architects, and Renewable Energy Specialists,* 18.

[167] While adaptation is less directly connected to net-zero, its consideration can help buildings achieve emissions targets over time. CaGBC included a "Future Weather" competency, and noted that 'Building professionals will need to be well-equipped with the skills required to design, construct, and operate adaptable and resilient buildings that are also zero carbon.' Sub-competencies included resilient building design, adaptable building design and 'designing for future weather conditions'. Engineers and renewable energy specialists were both found to have gaps in resilient building design, while architects were found to have gaps in adaptable building design and 'designing for future weather conditions'. *Source: Accelerating to Zero: Upskilling for Engineers, Architects, and Renewable Energy Specialists,* 19, 20.

[168] Endeavour, "Sustainable Building & Design." https://endeavourcentre.org/sustainable-build-and-design/?v=e4b09f3f8402

Conclusion

In summary, zero-carbon building construction and retrofitting will require upskilling among Canada's construction trades as well as its engineers, architects, and renewable energy specialists. Canada's construction trades will require increased soft skills, including collaboration, communication and "green literacy." Zero-carbon building construction requires the trades to even better coordinate with others. The construction trades will also require upskilling in a number of technical skills — including the determination of the most suitable renewable energy technology for a project and mechanical systems commissioning. Engineers, architects, and renewable energy specialists, meanwhile, will require skills in areas related to energy efficiency, zero-carbon balance, renewable energy, and low-carbon materials.

5.2 Transportation

Canada's transportation sector emitted 185.8 Mt. CO_2e in 2019, accounting for a quarter of Canada's total emissions. On-road transportation makes up at least 80% of Canada's transport sector emissions[169] and nearly two-thirds of jobs in Canada's "transportation equipment manufacturing" and "transportation and warehousing" sectors are related to on-road vehicles.[170]

Current labour market characteristics

Motor vehicle manufacturing accounted for over 100,000 jobs in Canada in 2020, with positions in light-duty vehicle manufacturing (33,000), heavy-duty vehicle manufacturing (6,000) and the manufacturing of related parts and components (79,000). The sector is concentrated in Ontario, which accounts for 80% of positions and 100% of those in light-duty vehicle manufacturing. Quebec and Manitoba, meanwhile, make up the bulk of the smaller heavy-duty vehicle manufacturing sector, accounting for 58% and 36% of positions respectively.[171]

[169] "Greenhouse gas emissions by economic sector."

[170] "Labour productivity and related measures by business sector industry and by non-commercial activity consistent with the industry accounts."

[171] "Labour productivity and related measures by business sector industry and by non-commercial activity consistent with the industry accounts."

On-road transportation of goods and people[172] accounted for over half a million jobs in Canada in 2020, with positions in truck transportation (248,000); urban transit systems (56,000) and taxi and limousine services (38,000). In contrast to motor vehicle manufacturing, the sector is geographically dispersed across Canada, with jobs in populous regions including Ontario (41%), Quebec (24%), Alberta (13%) and British Columbia (10%).[173]

The net-zero energy transition

There are several pathways to decarbonize on-road Canadian transport. In the IEA's NZE, for example, biofuel blending in oil products increases from 5% in 2020 to 41% in 2050.[174] Increased operational efficiency, energy efficiency and modal shifts are important as well, with the CICC estimating that increased use of active transportation (ex: cycling) and transit can reduce emissions by as much as 15 Mt. CO_2e as of 2050.[175]

The IEA, however, has noted that "electrification is the main option to reduce CO_2 emissions from road… modes"; in the IEA's net-zero pathway, key milestones to net-zero include the following: 60% of worldwide car sales are electric by 2030, no new sales of internal combustion engine cars by 2035, and 50% of sales of heavy trucks are electric by 2035.[176] Similarly, the CICC has noted that "transitioning to EVs is a crucial part of Canada's net-zero path in every scenario we examined," modelling EVs making up 47% to 96% of all personal vehicles as of 2050 in its various scenarios.[177]

The CICC also noted that "the high relative likelihood of EVs coming to dominate personal transportation is also being reinforced by ongoing domestic and global policy developments."[178] In Canada, some of these developments have included a June 2021 announcement that, as of 2035, 100% of new light-duty car and passenger truck sales

[172] Statistics Canada, "48-49 – Transportation and warehousing." https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=118464&CVD=118465&CPV=48-49&CST=01012012&CLV=1&MLV=5

[173] "Labour productivity and related measures by business sector industry and by non-commercial activity consistent with the industry accounts."

[174] IEA, *Net Zero by 2050,* 138.

[175] CICC, *Canada's Net Zero Future,* 45-46.

[176] IEA, *Net Zero by 2050,* 20, 138.

[177] CICC, *Canada's Net Zero Future,* 46-47.

[178] CICC, *Canada's Net Zero Future,* 51.

would have to be zero-emission;[179] as well as a November 2021 signature of a Memorandum of Understanding targeting "one hundred per cent zero-emission truck and bus sales by 2040."[180,181] The following sections will therefore focus on skills related to zero-emission vehicles, with a focus on manufacturing, maintenance and infrastructure.

Until recently, Canada's electric vehicle manufacturing lagged competitors globally, with the Chrysler Pacifica plug-in hybrid, the sole light-duty electric vehicle produced in Canada representing less than 1% of its overall production.[182] In 2020, 2021 and 2022, however, Canada gained a foothold in electric vehicle production, with billions of dollars worth of announcements for investments into production in Ontario from actors including Ford of Canada, Fiat Chrysler and General Motors.[183] Canada also has a healthy electric heavy-duty vehicle manufacturing sector, with firms including New Flyer Industries, Nova Bus and the Lion Electric Company. Canada's electric vehicle charging infrastructure is expanding as well, with over 7,200 charging stations as of 2018, over 60% of which were part of the Electric Circuit, ChargePoint and FLO networks.[184] Prominent Canadian charging station providers include AddEnergie[185] and Autochargers.[186]

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[179] Transport Canada, "Building a green economy: Government of Canada to require 100% of car and passenger truck sales be zero-emission by 2035 in Canada," media release, June 29, 2021. https://www.canada.ca/en/transport-canada/news/2021/06/building-a-green-economy-government-of-canada-to-require-100-of-car-and-passenger-truck-sales-be-zero-emission-by-2035-in-canada.html

[180] Mehanaz Yakub, *Electric Autonomy*, "Canada signs global agreement targeting 100 per cent zero-emission truck and bus sales by 2040," November 9, 2021. https://electricautonomy.ca/2021/11/09/cop26-zero-emission-truck-bus-canada/

[181] Canada's 2030 ERP included a commitment for a light-duty ZEV sales mandate of 20% by 2026, 60% by 2030 and 100% by 2035. It also committed to develop a medium- and heavy-duty ZEV regulation that would require all MHDV sales to be ZEVs by 2040 "for a subset of vehicle types based on feasibility…" *Source: 2030 Emissions Reduction Plan.*

[182] Ben Sharpe, Nic Lutsey, Cedric Smith and Carolyn Kim, *Power Play: Canada's role in the electric vehicle transition* (Pembina Institute and ICCT, 2020), 4, 29. https://www.pembina.org/pub/power-play

[183] Cedric Smith, Saeed Kaddoura, Morrigan Simpson-Marran, *Taking Charge: How Ontario can create jobs and benefits in the electric vehicle economy* (Pembina Institute, 2021), 10-11. https://www.pembina.org/pub/taking-charge

[184] Natural Resources Canada, "Electric Charging and Alternative Fueling Stations Locator." https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/electric-charging-alternative-fuelling-stationslocator-map/20487#/analyze?country=CA

[185] AddEnergie, "About". https://addenergie.com/en/about/

[186] The Energy Mix, "Ontario's First EV Charger Manufacturing Plant Opens In Markham," March 25, 2018. https://theenergymix.com/2018/03/25/ontarios-first-ev-charger-manufacturing-plant-opens-in-markham/

AutoChargers.ca, "FAQ." https://www.autochargers.ca/faq.html

Impacts to the labour force

Technical skills for electric vehicle manufacturing

In the IEA's NZE, "vehicle component suppliers and vehicle manufacturers alike retool factories, change designs to incorporate batteries and fuel cells, and adjust supply chains to minimise the lifecycle emissions intensities of vehicles." The IEA's NZE also includes "an immediate scale up of new supply chains for batteries…" with battery production capacity increasing to "more than 6.5 terawatt-hours (TWh) by 2030, compared with less than 0.2 TWh in 2020."[187]

As Canada transitions to net-zero emissions by 2050, its motor vehicle manufacturing sector will increasingly produce EVs, a transition that has, as previously mentioned, already begun. While the production of an electric vehicle has many similarities with the production of an internal combustion engine vehicle, there are some key differences. Battery electric vehicles (BEVs) differ from traditional internal combustion engine vehicles (ICEVs) in two main ways. The first difference is the powertrain. In BEVs a battery pack and an electric motor replaces the ICE engine and auxiliary systems. The second difference is power electronics — including power electronics controllers and converters.[188] According to the Boston Consulting Group (BCG), the shift from ICE vehicles to BEVs will have little impact on certain activities — including those in body, press and paint shops. BCG indicated that vehicle assembly labour hours remain constant, but experience a shift from activities including engine wiring and fuel-tank installation to activities including charging-unit installation and battery alignment. Finally, when it comes to vehicle parts and components, BCG indicated that labour hours would decrease for engine, motor and component manufacturing and increase for battery cell, battery pack and battery module manufacturing. BCG noted that the manufacturing of batteries would require labour in areas such as quality inspection, production process control and equipment operation.[189,190]

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[187] IEA, *Net Zero by 2050,* 165.

[188] Daniel Kuepper, Kristian Kuhlmann, Kazutoshi Tominaga, Aakash Arora and Jan Schlageter, *Shifting Gears in Auto Manufacturing* (Boston Consulting Group, 2020), 1. https://www.bcg.com/en-ca/publications/2020/transformative-impact-of-electric-vehicles-on-auto-manufacturing

[189] *Shifting Gears in Auto Manufacturing,* 9-11.

[190] The degree to which the transition to EVs will impact incumbent automaker market share and Canadian manufacturing capacity cannot be known with certainty. Recent announcements by automakers amounting to about $4 billion in EV investments at Ontario plants, however, are a promising sign of Canada's auto sector's ability to benefit from the transition to electric mobility. *Source:* Government of Ontario, *Driving Prosperity: The Future of Ontario's Automotive Sector*. https://www.ontario.ca/page/driving-prosperity-future-ontarios-automotive-sector

In 2021, the Volkswagen Academy, located at the Volkswagen Chattanooga plant, in Tennessee, introduced new courses on EVs. The Academy "serves as the plant's primary workforce development program — which is key for introducing the new skills and instruction needed to work on EVs." Examples of skills taught include safety-related skills — including basic electrics, advanced electrics and high voltage training; understanding how electric vehicle batteries are different from standard internal combustion engine models; advanced robotics and standard robotics language and aluminum welding for EV batteries. Current employees are eligible to upskill through these courses, and Volkswagen will make high voltage and electro mobility awareness training mandatory for all Chattanooga plant employees.[191]

Technical skills for electric vehicle maintenance and repair

As the number of EVs on the road increases, the number of EVs that breakdown and/or require repair and maintenance will as well. CPA Montreal, a non-profit representing employee and employer associations related to the automotive services industry in the Montreal region[192] offers an EV skill program that "aims to offer a structured training path and recognized certification in the maintenance and repair of electric and hybrid vehicles to workers in the industry throughout Quebec." It targets auto mechanics and auto mechanics apprentices.[193] Examples of skills taught in the program are provided in Table 3, below, in categories such as electrical and electronic systems, general maintenance and diagnostic tools, and advanced training in electronic vehicles.

Table 3. Skills needs examples for EV maintenance and repair

Skill
Electrical and electronic systems (basic)
Use of and understanding of basic multimeter functions in an electrical circuit
Ability to interpret and read electrical plans
Performance of conductor repair and insulation according to best practices
Understanding of the general diagnostic approach process

[191] Volkswagen US, "NEWSROOM: Preparing and upskilling auto workers for the EV revolution," media release, May 10, 2021. https://media.vw.com/en-us/releases/1530

[192] CPA Montreal, "Who We Are". https://www.cpamontreal.ca/en/about-us/who-we-are/

[193] CPA Montreal, "Electric and Hybrid Vehicles." https://www.cpamontreal.ca/en/ev-skill-program/

Electrical and electronic systems (intermediate)
Assessment of car battery condition
Performance of electrical measurements for the validation of the state of a starting and charging circuit
Performance of diagnostic approaches and tests
General maintenance and diagnostic tools
Safe interventions in hybrid vehicle maintenance
Diagnostic tools for hybrid vehicles
Advanced training in electronic vehicles
Electric vehicle operation
Network communication and computer systems
High voltage battery charge management systems
Regenerative braking systems
Thermal management systems

Source: CPA Montreal[194]

Skills and Occupations in the EST sector

In July 2020, Propulsion Quebec (PQ) published a study titled Horizon 2050 and Labour and Training Needs in the Electric and Smart Transportation [EST[195]] Sector in Quebec. The study identified the jobs and skills that will be needed in the sector as it grows and develops over the next 30 years. The scope of the study included essential skills and jobs across Quebec's EST industry value chain, which included component, vehicle and infrastructure manufacturing, and mobility services and vehicle use. Also included in the

[194] CPA Montreal, "Courses in the Skills EV Program." https://www.cpamontreal.ca/en/training-ev/

[195] Smart vehicles include connected vehicles with an on-board communication system that can access the internet, and autonomous vehicles are self-driving. We can assume that connected, autonomous vehicles will be electric, but not necessarily vice versa. Source: Council of Canadian Academies, *Choosing Canada's Automotive Future: The Expert Panel on Connected and Autonomous Vehicles and Shared Mobility* (2021), xv. https://cca-reports.ca/wp-content/uploads/2021/07/Report-Choosing-Canadas-Automotive-Future-UpdatedJuly2021.pdf

scope are vehicle technology, including electrification and smart technology, as well as light, medium and heavy-duty vehicle categories.[196]

Within these industries that make up the EST sector, eight key required skills were identified:[197]

Skill #1: "Robotics – leveraging optical data collected from sensors in autonomous vehicles to optimize their operation."

Skill #2: "Software – understanding and developing applications and embedded software."

Skill #3: "Advanced concepts in mathematics and physics – transforming technical challenges into mathematic equations."

Skill #4: "Basic training in engineering – developing systems that meet auto industry standards."

Skill #5: "Artificial Intelligence – using real-time data to improve vehicle performance."

Skill #6: "Big data – processing and analyzing large quantities of data from autonomous vehicle fleets."

Skill #7: "Practical approaches – being able to identify practical ways to solve problems."

Skill #8: "Holistic vision of the system – understanding the interaction between the different parties involved in building the vehicle."

PQ identified the following occupations to be key in the development and growth of EST:[198]

Occupation #1: Electrical and electronics engineers

Occupation #2: Database analysts and administrators

Occupation #3: Software engineers and designers

Occupation #4: Interactive media programmers and developers

Occupation #5: Electrical and electronics engineering technologists and technicians

Occupation #6: Technical sales specialists

Occupation #7: Automotive service technicians, truck and bus mechanics and mechanical repairers

Occupation #8: Electrical mechanics

[196] Propulsion Quebec, *Horizon 2050 and Labour and Training Needs in the Electric and Smart Transportation Sector in Quebec – Executive Summary (*2020), 5. https://propulsionquebec.com/wp-content/uploads/2020/12/Sommaire_Maindoeuvre_formation_EN.pdf?download=1

[197] *Horizon 2050 and Labour and Training Needs,* 21.

[198] *Horizon 2050 and Labour and Training Needs,* 23.

Technical skills for electric vehicle charging

As Canada transitions to net-zero emissions by 2050 and its sales and stock of EVs increases, its need for electric vehicle charging equipment will grow as well. In the IEA's NZE, EV public charging units increase from 1.3 million in 2020 to 200 million in 2050.[199] The Royal Bank of Canada (RBC), meanwhile, in its 2021 report *The $2 Trillion Transition: Canada's Road To Net Zero,* labelled an EV charging network as a "key need" for the transition of Canadian transportation.[200]

One program seeking to teach electric-vehicle related skills is the Electric Vehicle Infrastructure Training Program. The program provides training for EV charging infrastructure installation to recipients in Canada and the United States. Examples of key skills taught by the program are listed in Table 4, below.

Table 4. Skills needs examples for EV charger installation

Skill
Understanding of auto manufacturer charging performance integrity specifications.
Understanding of EV battery specifications, types and charging characteristics.
Understanding of utility interconnect requirements and policies.
Understanding of technologies for demand response integration and other utility grid stress precautions
Understanding how electric storage devices can function as charging intermediaries
Understanding how to maintain, commission and install electric storage devices
Understanding of the integration of EV charging infrastructure with distributed generation
Understanding of charging infrastructure Internet Protocol (IP) networking

Source: Electric Vehicle Infrastructure Training Program[201]

In summary, the manufacturing of electric vehicles will require safety-related skills — including basic electrics, advanced electrics, and high voltage training; an understanding of how electric vehicle batteries are different from standard internal combustion engine models; skills in advanced robotics and standard robotics language

[199] IEA, *Net Zero by 2050,* 138.

[200] RBC Thought Leadership, *The $2 Trillion Transition: Canada's Road to Net Zero* (2021), 19. https://royal-bank-of-canada-2124.docs.contently.com/v/the-2-trillion-transition-canadas-road-to-net-zero-pdf

[201] Electric Vehicle Infrastructure Training Program, "Training." https://evitp.org/training/

and aluminum welding for EV batteries. The maintenance and repair of electric vehicles will require skills in areas including electrical and electronic systems, general maintenance and diagnostic tools and electric vehicle operation. Finally, examples of skills needs for the installation of EV chargers include understanding of auto manufacturer charging performance integrity specifications and understanding of utility interconnect requirements and policies.

6. Moving towards a more equitable and inclusive future

As the skillsets needed in the transition to net-zero are explored, there is also a collective responsibility to examine and address the imbalance regarding who has traditionally benefitted from Canada's energy sector, and the groups and nations that have been historically excluded. Access to skills development and training is a fundamental step on the pathway towards diverse groups being able participate and lead in the net-zero transition. Ensuring that equitable access to capacity-building opportunities is in place as the transition unfolds will be key to expanding the benefits of the new energy economy.

6.1 Indigenous rights and reconciliation

The energy transition must support the self-determination, sovereignty, and economic security of Indigenous groups. Indigenous leaders have highlighted the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) as a framework for developing renewable energy projects.[202] Article 21 in UNDRIP, which the Canadian government enshrined into law in 2021, states that "Indigenous peoples have the right, without discrimination, to the improvement of their economic and social conditions, including, inter alia, in the areas of education, employment, vocational training and retraining, housing, sanitation, health and social security."[203] Moreover, Article 32 of UNDRIP states that "Indigenous peoples have the right to determine and develop priorities and strategies for the development or use of their lands or territories and other resources."[204]

To that end, this section discusses how the federal government can uphold its commitments stated in Article 21 and 32 of UNDRIP through capacity-building efforts, training and access to economic and employment opportunities led by Indigenous

[202] Rochelle Baker, "Indigenous-led clean energy projects can fuel reconciliation," *Canada's National Observer,* November 4, 2021. https://www.nationalobserver.com/2021/11/04/news/indigenous-led-clean-energy-projects-can-fuel-reconciliation

[203] United Nations. *United Nations Declaration on the Rights of Indigenous Peoples,* (2008), 9. https://www.un.org/esa/socdev/unpfii/documents/DRIPS_en.pdf

[204] *United Nations Declaration on the Rights of Indigenous Peoples,* 12.

peoples and communities, using their own approaches to transferring and developing skills for their own energy futures.

To support capacity-building opportunities, the Government of Canada currently supports several Indigenous-led clean energy programs. The Clean Energy for Rural and Remote Communities program supports communities to reduce their reliance on diesel and other fossil fuels with a focus on bioheat, as well as the demonstration and deployment of sustainable, innovative solutions.[205] The Indigenous Off-Diesel Initiative supports Indigenous remote communities to access "clean energy training, access to expertise and financial resources to develop and start implementing an ambitious diesel reduction plan."[206] The Indigenous Skills and Employment Training Program (ISET) funds Indigenous service-delivery organizations to design and deliver job-training based on their regional knowledge.[207] Other notable federal programs that involve net-zero skill building opportunities include the Northern Responsible Energy Approach for Community Heat and Electricity (REACHE) program[208] and the Indigenous Forestry Initiative.[209]

Barriers to accessing skills training

Many of the barriers for Indigenous peoples and communities to access skills training in the renewable energy sector are compounded with issues related to access to basic and essential resources. For example, the ability for people to build their technical skills through hands-on work on energy efficiency projects in their own communities is difficult when there aren't enough houses to meet the needs of the residents.[210]

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[205] Natural Resources Canada, "Clean Energy for Rural and Remote Communities (CERRC) Program." (2018). https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/CERRC%20EN%20Webinar%20Mar72018.pdf

[206] Natural Resources Canada, "Generating New Opportunities: Indigenous Off-Diesel Initiative." https://impact.canada.ca/en/challenges/off-diesel

[207] Employment and Social Development Canada, "About the Indigenous Skills and Employment Training Program." https://www.canada.ca/en/employment-social-development/programs/indigenous-skills-employment-training.html

[208] Northern Affairs (Canada) "Northern REACHE Program." https://www.rcaanc-cirnac.gc.ca/eng/1481305379258/1594737453888

[209] Natural Resources Canada. "Indigenous Forestry Initiative." https://www.nrcan.gc.ca/science-and-data/funding-partnerships/funding-opportunities/forest-sector-funding-programs/indigenous-forestry-initiative/13125

[210] Indigenous Clean Energy, *Energy Foundations: The Value Proposition for Financing Energy Efficient Homes in Indigenous Communities Canada-Wide* (2021), 11. https://icenet.work/attachment?file=qrecQf4HdFgB4OHm6gR5yQ%3D%3D

Indigenous Clean Energy's recent research on financing energy-efficient homes for First Nations, Métis, and Inuit communities across Canada has found a multitude of beneficial impacts that could come from investment, including skills development and employment.[211]

Beyond housing issues, Indigenous communities often have minority ownership over the energy projects on their lands, likely limiting the ability to control the type of skill-building opportunities community members can access on those projects. In one recent study, researchers found that only 41 of 194 energy projects in Canada were controlled by the Indigenous community they were in, meaning that they had 51% ownership or more.[212] Barriers to project ownership include a lack of internal capacity, lack of financial capital, lack of progressive policies, and mistrust of government and developers.[213]

While barriers exist for rural and remote Indigenous communities, individuals that live in urban centres also face unique obstacles. Even though urban Indigenous people are more likely to have a university degree, be employed, and experience higher income levels than Indigenous people who do not live in urban centres, the gap between urban Indigenous and non-Indigenous people on these outcomes remains significant. There is evidence that shows that the employment gap between Indigenous and non-Indigenous peoples disappear in urban settings where Indigenous people have a university degree.[214] Yet Indigenous students are underrepresented in STEM fields of study[215], the fields that often set graduates up for higher levels of pay and career advancement in the energy sector.[216]

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[211] *Energy Foundations*, 17-19.

[212] Christina E. Hoicka, Katarina Savic, Alicia Campney, "Reconciliation through renewable energy? A survey of Indigenous communities, involvement, and peoples in Canada," *Energy Research & Social Science* (2021), 12. https://doi.org/10.1016/j.erss.2020.101897

[213] Christina E. Hoicka, Katarina Savic, Alicia Campney, "Reconciliation through renewable energy? A survey of Indigenous communities, involvement, and peoples in Canada," *Energy Research & Social Science,* (2021), 12-13. https://doi.org/10.1016/j.erss.2020.101897.

[214] Indigenous and Northern Affairs Canada, *Evaluation of the Urban Aboriginal Affairs Strategy* (2017), 9. https://www.rcaanc-cirnac.gc.ca/DAM/DAM-CIRNAC-RCAANC/DAM-AEV/STAGING/texte-text/ev_uas17_1520437292422_eng.pdf

[215] Paul Arriagata, *The achievements, experiences and labour market outcomes of First Nations, Métis and Inuit women with bachelor's degrees or higher* (Statistics Canada, 2021), 6. https://www150.statcan.gc.ca/n1/en/pub/75-006-x/2021001/article/00009-eng.pdf?st=PWZsXn7P

[216] *Women in Alberta's Energy Transition*, 9.

Opportunities

As the renewable electricity sector creates jobs in a net-zero economy, it is important that policymakers and educators take a closer look at the lower representation of Indigenous workers in the electric power generation activities (3.3%) compared to other primarily fossil fuel focused industries, of which jobs held by Indigenous workers sit between 6-7% depending on the activity.[217] One potential reason for the high representation in oil and gas extraction and transportation activities, for example, is that these jobs are near or in Indigenous communities, making them somewhat accessible as workplaces.[218] This speaks to the importance of developing sustainable job training and employment opportunities that do not require people to regularly leave their communities to access.

Indigenous leaders and their collaborators are delivering skills development and training to respond to these opportunities and overcome some barriers. Examples include:

- Tradewinds to Success, an Indigenous-led pre-apprenticeship training and shop experience program to develop skills in home building for First Nations, Métis and Inuit people.[219] A Residential Construction program teaches skills to build energy-efficient tiny homes to tackle the housing infrastructure and skill-building barriers at the same time and providing skills for students to access future career training.[220]
- Generation Power, a program of ICE, works with Indigenous youth and provides a step for young people to get into the renewables sector to increase representation of Indigenous workers in renewable energy through "cohort-based instruction, peer-to-peer mentoring and on-the-land education."[221] The program also engages energy providers at the territorial, industrial or provincial level to help them build their capacity to employ and support Indigenous workers.[222]

[217] Canadian Centre for Energy Information. "Industry," *Energy and Employment* (2019). https://energy-information.canada.ca/en/subjects/energy-and-employment.

[218] Geoff Dembicki, "Indigenous workers are escaping 'toxic' fossil fuel jobs," *Vice,* April 20, 2021. https://www.vice.com/en/article/jg8xj3/indigenous-workers-are-escaping-toxic-fossil-fuel-jobs-for-solar

[219] Trade Winds to Success, "Discover Trade Winds." https://www.tradewindstosuccess.ca/

[220] Trade Winds to Success, "Residential Construction Program." https://www.tradewindstosuccess.ca/rcp

[221] Generation Power, "About Generation Power." https://www.generationpower.ca/about

[222] Generation Power, "About Generation Power." https://www.generationpower.ca/about

- Ontario Power Generation (OPG) launched a Reconciliation Action Plan to address the lack of long-term careers for Indigenous workers in electricity, with specific targets to partner with Indigenous communities, businesses, and organizations to advance reconciliation. They have committed to growing economic impact for Indigenous communities to $1 billion over the next ten years by "maximizing opportunities for Indigenous business participation in OPG operations, projects and initiatives."[223]

A 2018 report from the Organization for Economic Co-operation and Development (OECD) offers recommendations for supporting Indigenous people in accessing employment and skills training including:[224]

- "Leverage the role of cities in addressing the needs of urban Indigenous People."
- "Look for opportunities to enhance skills training for Indigenous People through targeted work experience programs."
- "Expand access to higher education opportunities to support Indigenous students."
- "Consider increasing the use of mentorship as a key tool for supporting Indigenous employment."
- "Use social enterprises as a pathway to economic prosperity for Indigenous People."

Beyond technical, energy-specific skillsets, Indigenous communities and peoples already have invaluable skills, intergenerational knowledge, and expertise related to their lands and ecosystems. Indigenous Climate Action indicates that Indigenous "rights, our knowledges, and our approaches to climate change are systematically excluded from the creation and implementation of climate policies and plans."[225] For generations, Indigenous communities and peoples have been experts in creating reciprocal relationships with the land[226] and systems thinking[227], both of which are

[223] Ontario Power Generation, *Reconciliation action plan* (2021), 17. https://www.opg.com/building-strong-and-safe-communities/indigenous-relations/reconciliation-action-plan/

[224] OECD, *Indigenous Employment and Skills Strategies in Canada,* OECD Reviews on Local Job Creation, (OECD Publishing, Paris, 2018), 99-106. http://dx.doi.org/10.1787/9789264300477-en

[225] Indigenous Climate Action, *Decolonizing Climate Policy in Canada* (2021), 8.https://static1.squarespace.com/static/5e8e4b5ae8628564ab4bc44c/t/6061cb5926611066ba64a953/1617021791071/pcf_critique_FINAL.pdf

[226] Kaniela Ing, "The Only Moral Path," in Required Reading: Climate Justice, Adaptation and Investing in Indigenous Power (NDN Collective Climate Justice Campaign 2021), 12.

[227] Jade Begay, "An Indigenous Systems Approach to the Climate Crisis," in *Required Reading: Climate Justice, Adaptation and Investing in Indigenous Power* (NDN Collective Climate Justice Campaign 2021), 94.

central to the energy transition. Honouring and listening to this expertise will be important as net-zero skills educators are identified.

6.2 Gender equity

Over and above the issue of supporting upskilling and training to ready the labour force for a net-zero economy, there is an opportunity for policymakers and decisionmakers to address broader equity concerns, particularly for diverse demographic and population groups that have been historically excluded from the energy industry and improve equity in a net-zero economy. Innovation, Science and Economic Development Canada, in their 50-30 Challenge, highlight the benefits of diversity to workplaces, including broadening the talent pool to overcome skill gaps, tapping into more diverse markets, improving employee satisfaction, engagement and overall performance, promoting innovation, and reducing reputational risk.[228]

In 2019, only 31.3% of all energy jobs in Canada were held by women.[229] In a report on the barriers for women in the energy transition in Alberta, the Pembina Institute found that the renewable energy sector has carried forward many inequities from the traditional energy sector and has only marginally better representation of women, particularly in leadership positions.[230]

Contributing to this low representation are five key barriers: lack of opportunity to access training and jobs, lack of good jobs and supports (in particular, affordable childcare) that accommodate the responsibilities of many women, an income gap in similar jobs and across professions, inability to advance into leadership and into roles with better compensation, and traditionally male-dominated industry cultures. These barriers entwine to disempower women in their roles, make it challenging for them to advance, and can discourage women from joining the energy industry altogether.[231]

The barriers for women in participating in and leading Canada's net-zero transition are not unique to the energy sector — they are the result of a long history of systemic inequities and cultural norms, compounding on other experiences related to race, class,

[228] Innovation, Science and Economic Development Canada. "The 50-30 Challenge: Your Diversity Advantage." https://www.ic.gc.ca/eic/site/icgc.nsf/eng/07706.html

[229] Canadian Centre for Energy Information (Canada). "Energy and employment." https://energy-information.canada.ca/en/subjects/energy-and-employment

[230] *Women in Alberta's Energy Transition*, 2.

[231] *Women in Alberta's Energy Transition.*

ability, gender identity, Indigeneity, language and citizenship to exacerbate the negative experiences of women who live at these intersections. Even if significant steps are taken to address workplace inequities, social and gender norms, while slowly shifting, still impact the way women are perceived, included and supported in the energy sector.[232]

To address these barriers, gender equity must be deliberately included in net-zero transition plans and policies by governments, post-secondary institutions, and industry. Creating safer, gender-specific spaces where women can connect and learn in an environment with fewer gendered power differentials is critical.[233] Several networks and training programs have emerged which aim to create such a space, including Women in Renewable Energy nationally,[234] Young Women in Energy in Alberta,[235] Women in Science and Engineering at the University of Calgary,[236] and Women Building Futures in Edmonton.[237] Early intervention programs that focus on increasing girls' interest in STEM at an early age are also proving to be successful, with programs like Power Girls STEM Program[238] in Vancouver and the Girls Can…[239] program at Brandon University as promising examples.

GBA Plus

"Gender-based Analysis Plus (GBA Plus) is an analytical process used to assess how diverse groups of women, men and non-binary people may experience policies, programs, and initiatives. The "plus" in GBA Plus acknowledges that GBA goes beyond biological (sex) and socio-cultural (gender) differences to consider other identity factors such as ethnicity, age, income level, and mental or physical ability."

[232] *Women in Alberta's Energy Transition*, 5.

[233] Ruth Lewis, Elizabeth Sharp, Jenni Remnant and Rhiannon Redpath, "Safe Spaces: Experiences of Feminist Women-Only Space," *Sociological Research Online,* volume 20, issue 4 (2015). DOI: 10.5153/sro.3781

[234] Women in Renewable Energy (Canada), "The WiRE Mission." https://www.womeninrenewableenergy.ca/

[235] Young Women in Energy (Alberta), "About YWE." https://www.youngwomeninenergy.com/about-us-2/

[236] Women in Science and Engineering, "About Us." https://www.uofcwise.com/about-us

[237] Women Building Futures (Canada), "Transform Your Life. We've Got the Tools to Help." https://womenbuildingfutures.ca/

[238] DIVERSEcity Community Resources Society (British Columbia, Canada), "Power Girls STEM Program." https://www.dcrs.ca/our-services/programs-for-children-and-families/power-girls-stem-program/

[239] Brandon University (Ontario, Canada). "Girls Can…program teaches scientific literacy," February 19, 2021. https://www.brandonu.ca/news/2021/02/19/girls-can-program-teaches-scientific-literacy/

> The Government of Canada has committed to applying GBA Plus to the development of all policies, programs, and legislation. Using the tool allows policymakers and programmers to explore the specific needs of a diverse range of Canadians, to design policies and programs that are responsive and accessible.[240]

Applying a GBA Plus lens would involve collecting, analyzing, and disseminating disaggregated data. In the context of this paper, GBA Plus could be used to analyze the demographics of those who currently have transferable skills, and those who are accessing net-zero initiatives. This will enable evidence-based decisions to ensure that programs are benefiting historically excluded groups. Useful data for this research includes, but is not limited to, experiences where race, gender identity and expression, class, ability, Indigeneity, age, language, sexual orientation, location, and other identities intersect. For example, much of the data on women's experiences of harassment and violence are anecdotal, and prevention and response interventions are not well-documented.[241] Regional and industry-specific data will help to develop relevant solutions for workplaces and training institutes. Furthermore, while there are reports that powerfully detail the violence many Indigenous women and 2SLGBTQQIA+ people experience in connection to the energy sector in Canada, more "accurate, culturally specific, and comprehensive" research is needed to better understand this relationship and best practices in prevention and response and meaningfully implement the learnings.[242]

When applying a gender-based analysis and intersectional lens to creating a more inclusive and equitable labour force, it is important to also consider how families can gain access to affordable social services, care and domestic work, as needed, including childcare, teaching, social work, cleaning and so on. As governments and educators think about preparing the workforce for a net-zero transition, considerations should

[240] Environment and Climate Change Canada. *Annex: Gender-based Analysis Plus from A Healthy Environment and a Healthy Economy (2021)*. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy/annex-gender-based-analysis-plus.html

[241] Kate McInturff, *The Gap in the Gender Gap* (Canadian Centre for Policy Alternatives 2013), 29-30. https://www.policyalternatives.ca/sites/default/files/uploads/publications/National%20Office/2013/07/Gap_in_Gender_Gap_VAW.pdf

[242] *Reclaiming Power and Place,* 86.

also be given to the kinds of social supports to enable training, upskilling, or new employment opportunities.[243]

Proactively addressing these barriers would foster a more equitable workforce, one that supports a diverse range of women and 2SLGBTQQIA+ individuals.

6.3 Creating equitable access to training

There are benefits of broadening the talent pool to overcome skill gaps, tapping into more diverse markets, improving employee satisfaction, engagement, and overall performance, promoting innovation, and reducing reputational risk.[244] To get to these benefits, access to the necessary skills training is key. Consideration should be given to offer equitable, inclusive, and supportive training and skill-building opportunities for current and potential workers to fully participate in Canada's net-zero economy.

Economic injustice disproportionately impacts people who are also facing other types of marginalization[245], making the cost of applying to and attending training programs and other skill-building opportunities a major barrier. Some of the ways that training can be made more accessible include providing low-barrier grants, bursaries and scholarships and offering sliding-fee payment scales based on current income levels. Governments and institutions could also consider providing free training and education to those historically excluded from certain roles in the energy sector, such as Indigenous peoples and women as indicated above. These income supports could be clearly communicated on government and educational institute websites.[246] In addition, utilizing equitable recruitment processes for internships and experiential learning opportunities can help to prioritize students who are underrepresented in the energy industry.

In many cases, newcomers to Canada may already have the necessary training for in-demand jobs but are not able to work in their field for a variety of reasons. One of these barriers is a lack of Canadian work experience. This can result in newcomers working in

[243] Greer Gosnell and Sarah Hastings-Simon, "Biden's climate plan will not address gender and racial inequality," *The Hill,* December 28, 2020. https://thehill.com/opinion/civil-rights/531756-bidens-climate-plan-will-not-address-gender-and-racial-inequality

[244] "The 50-30 Challenge – Your Diversity Advantage."

[245] Citizens for Public Justice, *Poverty Trends 2020: Rights & Realities in Canada (2020). https://cpj.ca/wp-content/uploads/2021/01/Poverty-Trends-2020.pdf*

[246] For example, Women Building Futures includes a section on Financial Aid under the "Services" section of their website: https://womenbuildingfutures.ca/services/financial-aid/

lower-paying jobs or roles that do not fully recognize their experience and skills.[247] A research study indicated that this may be addressed by providing "learning in the context of the Canadian labour market, [and offering] one-to-one job coaching, job customization, and individualized supports."[248] These approaches are useful to consider in addressing the unique needs of newcomers and helping them unlock their fullest employment and economic potential and contributions to Canada's net-zero energy economy.

6.4 Mental health support

Cultivating greater diversity in Canada's energy sector requires a "people-first" approach and meeting individuals where they are at. Programs and workplaces that take a "whole person" approach are able to create more inclusive environments that "allow for different needs or life events to be recognized and supported,"[249] in turn making space for workers with a diversity of identities and experiences.

As well, workers in potentially declining sectors may be coping with a sense of loss or shift in identity as they leave jobs that they have been familiar with for many years and contemplating new jobs and skillsets in new emerging clean energy industries. A recent report from the International Institute for Sustainable Development states that "transitions that conflict with one's identity can cause emotional distress or mental health impacts beyond the material consequences of the disruption." The lack of supports for workers to cope with these shifts may also result in resistance to transitioning.[250] In response, it will become increasingly important for employee assistance or training programs to offer flexible, holistic, trauma-informed support for students and employees.[251] This could include offering free, on-site counselling,

[247]Social Research and Demonstration Corporation, *Barriers to employment and training for equity-seeking groups: Final report.* (2010). 19. https://www.srdc.org/media/553157/training-barriers-for-equity-seeking-groups-final-report.pdf

[248] *Barriers to employment and training for equity-seeking groups,* 25.

[249] *Barriers to employment and training for equity-seeking groups,* 29.

[250] International Institute for Sustainable Development, *Building momentum for a just transition in Canada: Perspectives from civil society* (2021), 13, 24. https://www.iisd.org/system/files/2021-04/building-just-transition-canada-civil-society.pdf.

[251] *Barriers to employment and training for equity-seeking groups,* 29.

National Fund for Workforce Solutions, *A trauma-informed approach to workforce: An introductory guide for employers and workforce development organizations.* (2021). https://nationalfund.org/wp-content/uploads/2021/04/A-Trauma-Informed-Approach-to-Workforce.pdf

partnering with a local mental health organization to provide support, and ensuring programs incorporate flexible attendance and program completion policies.[252]

As Canada transitions to a net-zero economy and aims to support all Canadians, this also means understanding and addressing gender-based harassment and violence that creates barriers for women in the energy sector.[253] Indigenous women and 2SLGBTQQIA people in particular face a specific type of colonial, gender-based violence in a range of settings, including in the workplace. In *Reclaiming Power and Place: The Final Report of the National Inquiry into Missing and Murdered Indigenous Women and Girls*, prioritizing the health and wellness of Indigenous women and 2SLGBTQQIA individuals is a clear call to justice. Policymakers and educators should continue to provide "sustainable, permanent, no-barrier, preventative, accessible, holistic, wraparound services."[254]

Dan Cantiller, "Trauma, healing and learning in the Canadian post-secondary institution," *Medium,* April 29, 2021. https://dancanthinks.medium.com/trauma-healing-and-learning-in-the-canadian-postsecondary-institution-2c5a717032a9

[252] *Barriers to employment and training for equity-seeking groups: Final report,* 29.

[253] *Women in Alberta's Energy Transition,* 22-25.

[254] *Reclaiming Power and Place,* 180.

7. Conclusion and recommendations

As Canada moves towards a net-zero transition there are several labour force considerations that must be addressed by policymakers. It is increasingly important that the Government of Canada work with educators, other governments, both international and within Canada, businesses, labour unions and more to actively plan the transition to clean energy in Canada. It is vital that fossil fuel workers find their place in the globally decarbonizing economy, so that Canadian communities continue to thrive. In addition, sectors need support to evolve and reskill the energy end-use workforce, especially in transportation and buildings.

This research paper has been limited in scope due to information and data gaps. The following is not covered in this study:

- Estimates of the number of workers that could be impacted by the transition due to the decline of certain industries or the growth in others. This study does not estimate the magnitude of displaced workers that may choose to take new jobs in the energy sector or in non-climate or energy sectors, or to retire early.
- Comprehensive discussion and detailed mapping of fossil fuels skills onto skills required in emerging sectors.
- Granular and comprehensive estimates of the timing of when fossil labourers will be displaced, emerging sectors will grow their labour force, and labourers in industries such as construction and EV manufacturing will be faced with necessary upskilling.

This paper has also been limited in terms of the areas it has analyzed. It has focused on the Pembina Institute's traditional areas of expertise, including clean electricity, oil and natural gas, buildings, transportation, nature-based solutions, carbon capture, utilisation and storage, and hydrogen. It has not examined the important roles played by and changes that can be expected in areas such as nuclear, cross-cutting clean technology, biofuels, agriculture, and industry (including steel and cement). It has also not explored the potential for transition of fossil fuel workers into sectors not directly related to climate, which represents another potential avenue of future work. Finally, this paper has been limited by uncertainty as to the nature of, and technologies to be employed in, Canada's transition to net-zero emissions by 2050.

The following five recommendations relate to opportunities for the federal government to provide greater clarity on the net-zero transition, to support research that will help prepare for anticipated changes and overcome information gaps, to support fair outcomes for labourers and historically excluded groups, and to support Indigenous rights and reconciliation.

1. Chart a clear course to net-zero for Canada

Uncertainty surrounding Canada's net-zero transition makes planning for its impacts on the labour force by the public and private sectors — including skills planning — more difficult. While the 2030 Emissions Reduction Plan sets the stage to chart a clear course to net-zero, the federal government should:

- **Continue to advance consultation and work to set Canada's pathway to 2050:** The pathway to 2050 is about making choices. The Net-Zero Advisory Body, established by the federal government, has been tasked with consulting with Canadians to advise the government on most likely pathways to net-zero and reduction milestones leading up to 2050. A successful consultation means Canadians understand and align around the social, economic, and technological choices to be made in this transformation toward a shared vision of the future. This process will be key to making decisions about industrial and economic development in Canada. For example, in this paper, we identify geothermal as having high potential for skills transfer from fossil fuels, but geothermal remains underdeveloped in Canada, due to factors including competition from other forms of power generation and a lack of a policy and regulatory framework.[255]
- **Set sectoral milestone targets for Canada's transition to net-zero:** To provide certainty and transparency in how every sector of the economy will contribute to meeting Canada's national targets, the government should set five-year targets for every sector of the economy. This work should deliver additional milestone targets to shape the journey to 2050. Such milestones provide clear and needed guidance to appropriately plan for skills transition.
- **Support promising technologies, and technological research, that will support a net-zero transition:** Canada's ultimate path to net-zero will be heavily impacted by which "wild card" technologies, as defined by CICC, prove to be scalable and cost-effective. This result will not be fully within Canada's control. Nevertheless, Canada should make decisions on which wild cards are

[255] Clean Energy Canada, "Media Brief: Geothermal energy and its potential in Canada," July 26, 2020. https://cleanenergycanada.org/media-brief-geothermal-energy-and-its-potential-in-canada/

most promising within the Canadian context and provide support thereto, while also scaling up currently available market-ready solutions. Doing so will represent a first step towards addressing a significant source of uncertainty as to Canada's path to net-zero and thereby towards increasing the capacity for relevant actors to engage in net-zero related skills planning.

- **Signal Canada's commitment to a net-zero transition:** One significant barrier to clarity on Canada's path to net-zero is uncertainty whether Canada will go down that path at all. Interviewees noted fossil fuel workers may feel the industry is immutable; they are receiving mixed signals from the federal government on the need to transition. Key to reinforcing the government's commitment to net-zero and encouraging Canada's energy labour force to consider a future in industries aligned with net-zero, will be to 1) develop a 1.5-degree aligned energy demand and supply scenario, 2) implement Canada's oil and gas cap, and 3) meet the new requirements set out under the Canadian Net-Zero Emissions Accountability Act.

2. Fund research to understand labour and skills impacts

There are opportunities to fill knowledge gaps and develop evidence-based net-zero policies and programs. It is clear from this research that more information is needed to plan for the net-zero transition and manage shifts in the labour force. The federal government should support granular net-zero skills modelling that provides in-depth information on the demand for and supply of skills in Canada in any given net-zero pathway, estimates of the magnitude in shifts in demand and the degree to which there is matching supply, and helps to identify requirements to smoothly bridge any gaps, between 2025 to 2050.

3. Support fair outcomes for labourers impacted by the net-zero transition

The federal government should support labourers impacted by the net-zero transition by paving the way towards upskilling for jobs in the energy sector, and also ensure that those workers choosing early retirement are able to do so:

- **Provide financial support for worker upskilling:** Support workers to overcome barriers to upskill such as the cost of training and/or the cost of taking time off work.[256] According to polling of oil, gas, and coal workers conducted by

[256] *Trading Up,* 24.

Abacus Data, 60% would engage in training of up to two years if provided with a full scholarship, as opposed to 37% if payment came out-of-pocket.[257] Canada has a number of programs that provide financial support for training, including the $960 million Sectoral Workforce Solutions Program, the $55 million Community Workforce Development Program, the $298 million Skills for Success Program and the $225 million Future Skills initiative. The Canada Training Credit, a refundable tax credit, can also help cover training costs.[258] These must continue and expand.[259]

- **Support workers as they navigate upskilling and training options:** Canada's upskilling and training landscape has been criticized as being fragmented, lacking standardization and lacking certainty for participants on the degree to which participation can successfully lead to employment opportunities. Granular information on the skillsets required to succeed in the clean economy has been identified as potentially useful to workers and for the standardization of programming, with Singapore's SkillsFuture program identified as an international best practice example.[260] Within Canada, efforts to provide such granular information are already underway, including PetroLMI's Careers in Energy website[261] and Iron & Earth's Climate Career Portal.[262] As Canada transitions to net-zero, the federal government should provide additional and ongoing funding to these and similar resources, prioritize a focus on emerging net-zero aligned industries, encourage exploration of a broader number of net-zero aligned sectors and encourage the information provided thereby be informed, on an ongoing basis, by net-zero skills modelling.
- **Align ongoing federal skills programming with climate change efforts:** Federal skills programming has been criticized for being insufficiently aligned

[257] Abacus Data, *Detailed Results: Climate Emergency Polling & Transition to Renewable Sources with Oil & Gas Sector Workers* (2021), 2, 27. https://www.harriscentreforum.ca/forecast-nl/news_feed/climate-emergency-polling-what-do-the-numbers-tell-us

[258] Government of Canada, *People-Centred Just Transition: Discussion Paper* (2021), 3-4. https://www.rncanengagenrcan.ca/en/collections/just-transition

[259] Additionally, Canada's 2030 ERP outlined commitments for a new Futures Fund for the provinces of Alberta, Newfoundland and Labrador and Saskatchewan, which will assist with economic diversification; as well as a Clean Jobs Training Centre, which will "help workers across sectors upgrade or gain new skills to be on the leading edge of the zero carbon industry". *Source: 2030 Emissions Reduction Plan,* 86.

[260] Beata Caranci and Francis Fong, *Don't Let History Repeat: Canada's Energy Sector Transition and the Potential Impact on Workers* (TD Economics, 2021), 8-9.

[261] Careers in Energy, "About PetroLMI." https://careersinenergy.ca/about-petrolmi/

[262] Iron & Earth, "Climate Career Portal." https://www.climatecareerportal.com/

with Canada's net-zero transition.[263] As Canada charts a clear course to net-zero and funds granular net-zero skills modelling, it will gain an increased understanding of the costs of training and upskilling associated with the transition. The federal government should ensure it is providing sufficient and commensurate financial support, continuing, adjusting, and topping up the aforementioned initiatives as necessary. It should consult closely with relevant labour groups including Blue Green Canada, Unifor and the Canadian Labour Congress, as well as relevant educational bodies and associations, when designing its support programs.

- **Support workers choosing early retirement:** Twenty percent of energy sector workers are currently at or within five years of Canada Pension Plan eligibility. Over 40% are at or within fifteen years of eligibility.[264,265] The federal government should support those looking to retire early. Interviewees have noted the importance of honouring pensions, the potential of early retirement incentives and the importance of unions in negotiating such incentives.

4. Improve outcomes for historically excluded groups

The next 30 years will see growth in jobs in many sectors, as Canada goes through an energy transition. When developing policies, procedures, and investments to ensure the net-zero transition, the Canadian government should prioritize ensuring an equitable workforce and leadership. Taxpayer-funded investments for the just transition should be structured to meet Canada's joint international commitments to climate change action, gender equity, and UNDRIP as well as offer the co-benefits of pay equity and equitable leadership.

To expand access to the benefits of energy, equity should be a key consideration as Canada explores pathways to the skills development a net-zero energy economy will require. The following are recommendations that may help to address barriers for marginalized groups in accessing the opportunities of the energy transition:

- **Continue to apply a GBA Plus lens to all federal transition policies and programs, and publicly report on the impact:** In order to ensure that women and other marginalized groups can benefit from and participate in the energy

[263] *The Prosperous Transition Plan,* 36

[264] Statistics Canada, "Employment Characteristics for Selected Energy Industries," https://www150.statcan.gc.ca/n1/pub/25-26-0003/252600032021001-eng.htm

[265] Government of Canada, "CPP retirement pension: Do you qualify," https://www.canada.ca/en/services/benefits/publicpensions/cpp/cpp-benefit/eligibility.html

transition equally, GBA Plus should be used to assess the potential impact of transition policies on different groups.[266] The impact of using this assessment on decision-making should be publicly available, both as an example for other decision-making bodies and for accountability purposes.

- **Prioritize the collection and transparent, ethical use of disaggregated data:** A diversity, equity and inclusion lens should be applied to data collection, research, and policymaking, that considers intersectionality and different lived experiences of Canadians. Research on the impact of Canada's energy transition should include a deeper exploration of the connections between violence against Indigenous women and the energy sector.[267]
- **Address mental health as part of skills training:** Programs should be encouraged and resourced to create trauma-informed environments that recognize and respond to emotional distress and mental health issues that may arise as the work force changes over time. Policymakers and educators should strive to create environments that prevent and address the impacts of violence and harassment.[268]

5. Support Indigenous rights and reconciliation

The energy transition offers an opportunity to support the self-determination, sovereignty, and economic security of Indigenous groups. Indigenous leaders have highlighted the United Nations Declaration on the Rights of Indigenous Peoples as a framework for developing renewable energy projects.[269]

- **Invest in and scale up Indigenous-led training, employment, and mentorship programs:** Remote and rural settings should be prioritized, and programs should be led by Indigenous organizations and experts, with flexibility to recognize and incorporate regional knowledge and practices.[270] There are good examples where public, private and post-secondary institutions co-create Indigenous-specific programs to support reconciliation and UNDRIP commitments.

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[266] Women and Gender Equality Canada, "Take the Gender-based Analysis Plus course," April 14, 2021. https://women-gender-equality.canada.ca/en/gender-based-analysis-plus/take-course.html

[267] *Women in Alberta's Energy Transition,* 26.

[268] *Reclaiming Power and Place,* 180.

[269] Rochelle Baker, "Indigenous-led clean energy projects can fuel reconciliation," *Canada's National Observer,* November 4, 2021. https://www.nationalobserver.com/2021/11/04/news/indigenous-led-clean-energy-projects-can-fuel-reconciliation

[270] *Indigenous Employment and Skills Strategies in Canada,* 99-106.

- **Invest in Indigenous-led renewable energy and energy efficiency projects** in rural and remote communities[271] to support economic development and skill-building opportunities. This would respect Articles 21 and 32 of UNDRIP, and allow for Indigenous peoples and communities to create culturally appropriate and hands-on skill-building opportunities directly in remote communities where training might be otherwise inaccessible.[272,273]

[271] Christina E. Hoicka, Katarina Savic, Alicia Campney, "Reconciliation through renewable energy? A survey of Indigenous communities, involvement, and peoples in Canada," *Energy Research & Social Science,* 74 (2021). https://doi.org/10.1016/j.erss.2020.101897

[272] *Energy Foundations*, 17-19.

[273] It should be noted that the 2030 ERP dedicated $180 million to an Indigenous Leadership fund. *2030 Emissions Reduction Plan; Clean Air, Strong Economy,* 101.

Appendix A. Transferability pathways for renewables

Occupation	Skills Upgrading	Transferability Pathway	Geothermal Subsector	Solar Subsector	Wind Subsector
Business and Operations Support					
Administrative Assistant	None	Direct	Yes	Yes	Yes
Asset Integrity Officer	None	Direct	Yes		
Business and Operations Analyst	Minor	Refocus	Yes	Yes	Yes
Business Development Manager	Minor	Refocus	Yes	Yes	Yes
Contract Manager and Negotiation Specialist	Minor	Refocus	Yes	Yes	Yes
Energy Trading Scheduler	Minor	Refocus	Yes	Yes	Yes
Government Relations Analyst	Minor	Refocus	Yes	Yes	Yes
Human Resources Advisor	None	Direct	Yes	Yes	Yes
Human Resources Analyst	None	Direct	Yes	Yes	Yes
Logistics Coordinator	Minor	Refocus	Yes	Yes	Yes
Logistics Manager	Minor	Refocus	Yes	Yes	Yes
Market Analyst	Minor	Refocus	Yes	Yes	Yes
Operations and Production Accounting Professional	Minor	Refocus	Yes		
Project Manager	Minor	Refocus	Yes	Yes	Yes
Purchasing Agent	Minor	Refocus	Yes	Yes	Yes
Purchasing Manager	Minor	Refocus	Yes	Yes	Yes
Supply Chain Analyst	Minor	Refocus	Yes	Yes	Yes
Warehouse Technician	None	Direct	Yes	Yes	Yes
Engineers					
Automation Engineer	None	Direct	Yes		Yes

Occupation	Skills Upgrading	Transferability Pathway	Geothermal Subsector	Solar Subsector	Wind Subsector
Chemical Engineer	Minor	Refocus	Yes		
Chemical Process Engineer	Minor	Refocus	Yes		
Civil Engineer	Minor	Refocus		Yes	Yes
Cost Engineer	Minor	Refocus	Yes	Yes	Yes
Electrical Engineer	None	Direct	Yes	Yes	Yes
Engineering Manager	None	Direct	Yes	Yes	Yes
Environmental Engineer	None	Refocus	Yes		Yes
Instrumentation Engineer	None	Direct	Yes	Yes	Yes
Maintenance/Reliability Engineer	None	Direct	Yes		Yes
Mechanical Engineer	None	Direct	Yes		Yes
Petroleum Engineer	Minor	Refocus	Yes		
Environmental, Regulatory and Stakeholder Engagement					
Communications Professional	None	Direct	Yes	Yes	Yes
Environmental Advisor	None	Direct	Yes	Yes	Yes
Environmental Manager	None	Direct	Yes	Yes	Yes
Environmental Technician	None	Direct	Yes		
Health and Safety Professional	None	Direct	Yes	Yes	Yes
Hydrologist	Minor	Refocus	Yes		
Indigenous Relations Specialist	None	Direct	Yes	Yes	Yes
Investor Relations Professional	Minor	Refocus	Yes	Yes	Yes
Joint Venture Representative	Minor	Refocus	Yes	Yes	Yes
Mineral Land Professional	None	Direct	Yes		
Permitting Coordinator	None	Direct	Yes	Yes	Yes
Policy Analyst	Minor	Refocus	Yes	Yes	Yes
Quality Control and Inspection Professional	Minor	Refocus	Yes	Yes	Yes

Occupation	Skills Upgrading	Transferability Pathway	Geothermal Subsector	Solar Subsector	Wind Subsector
Regulatory Affairs Professional	Minor	Refocus	Yes	Yes	Yes
Stakeholder Relations Professional	None	Direct	Yes	Yes	Yes
Surface Land Professional	None	Direct	Yes	Yes	Yes
Geoscience Professionals					
Geologist	Minor	Refocus	Yes		
Geophysicist	Minor	Refocus	Yes		
Wellsite Geologist	Minor	Refocus	Yes		
Information Technology Roles					
Automated Systems Technician and Technologist	None	Direct	Yes	Yes	Yes
Operators					
Completions Superintendent	Minor	Refocus	Yes		
Control Room Operator	None	Direct	Yes		
Field Operator	None	Direct	Yes		
Heavy Equipment Operator	None	Direct	Yes	Yes	Yes
Production Coordinator	None	Direct	Yes		
Rig Manager	Minor	Refocus	Yes		
Technicians and Technologists					
Drafting Technologist	None	Direct	Yes	Yes	Yes
Electrical Technician and Technologist	Minor	Refocus		Yes	Yes
Instrumentation Engineering Technologist	None	Direct	Yes	Yes	Yes
Mechanical Technician	Minor	Refocus		Yes	Yes
Petroleum Engineering Technologist	Minor	Refocus	Yes		
Surveying and Geomatics Technologist	None	Direct		Yes	Yes
Trades					
Construction Manager	Minor	Refocus	Yes	Yes	Yes

Occupation	Skills Upgrading	Transferability Pathway	Geothermal Subsector	Solar Subsector	Wind Subsector
Crane Operator	None	Direct			Yes
Facility Operations and Maintenance Manager	None	Direct	Yes	Yes	Yes
Industrial Electrician	None	Direct	Yes	Yes	Yes
Instrumentation Technician	None	Direct	Yes	Yes	Yes
Maintenance Planner	None	Direct	Yes	Yes	Yes
Millwright and Industrial Mechanic	None	Direct	Yes		Yes

Source: PetroLMI[274]

[274] PetroLMI, "Assess Your Career Change." https://careersinenergy.ca/assess-your-career-change/