THINKING GREEN

BUILDING A SUSTAINABLE DIGITAL ECONOMY FOR CANADA

ICTC CTIC

Research by

The Information and Communications Technology Council

With support from Evergreen Canada

Preface

The Information and Communications Technology Council (ICTC) is a not-for-profit, national centre of expertise for strengthening Canada's digital advantage in a global economy. Through trusted research, practical policy advice, and creative capacity-building programs, ICTC fosters globally competitive Canadian industries enabled by innovative and diverse digital talent. In partnership with an expansive network of industry leaders, academic partners, and policy makers from across Canada, ICTC has empowered a robust and inclusive digital economy for 30 years.

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Executive Summary

The relationship between the green economy and digital economy is complex. Climate change, deforestation, and environmental damage are threatening the stability of our economies, food systems, and human life; without clear and decisive action across the board, harms may become irreversible. Technology solutions, such as cleantech and clean energy, play a key role in limiting such harms. At the same time, the digital economy is experiencing rapid growth, and with it the industry's carbon emissions and material needs grow. While the digital economy is not a core driver of environmental damage, meeting key targets like the United Nations Framework Convention on Climate Change (UNFCC) Paris Agreement requires all industries to curb their environmental footprints. Embedding green economy practices that are low carbon, resource efficient, and socially inclusive is one way for the digital economy to balance growth needs without sacrificing environmental wellbeing.

While not an exclusive list, this paper discusses five key areas where the green and digital economies interact:

Foundations for a Digital Economy: To keep up with a rapidly evolving digital economy, "digital infrastructure" is needed now more than ever. Digital infrastructure raises two distinct issues. First, talent needs in the green economy and digital economy increasingly overlap, creating a need for both environment-related domain knowledge in core tech roles and new digital skills in core environment roles. Second, the production of digital infrastructure (notably hardware, data warehouses, and network infrastructure) is growing, resulting in greater carbon emissions and natural resource exploitation. Improving the digital economy's environmental footprint will require supporting green tech production and adoption, and initiatives to reduce emissions.

The Future of Work: Jobs and the broader labour market have been influenced dramatically by technology for hundreds of years. Increasingly, sustainability and the green economy are impacting the evolving nature of work as well. A thriving digital economy (and policy for it) will capitalize on developments in both technology and the green economy, driving a future of work that is both equitable and sustainable.

The Human Side of Tech: The digital economy is increasingly attuned to its social impacts. Often, these are heavily interconnected with environmental impacts. Quality measurement and data collection, technology transfers, and technology built for social and environmental good will all be key in developing a socially and environmentally just digital economy.

Smart Communities: While the impacts of environmental degradation are felt around the world, the impacts of environmental degradation on people are experienced largely within communities. This means that communities are an important starting place from which to approach sustainability. The concept of "open smart cities" provides an important framework for communities to navigate the green economy and boost local innovation capacity. Combined, this is critical to ensure that intelligent communities are inherently green communities.

Trade and Investment: The environment is a key consideration in trade and investment decisions. Governments, investors, and consumers want to invest in solutions that are both sustainable and climate ready; as a result, environmental impact is increasingly factored into many regional and international trade agreements, which influences investments. While many regions already have a price on pollution, such as emissions taxes, the future of such pricing mechanisms will require global action. Additionally, business and consumer incentives, and cross-border collaboration is needed to support and entrench environmentally sound business models, standards, and practices going forward. Greening Canada's trade and investment activity is a long-term commitment that is key to economic growth and social wellbeing.

Background

The Information Communications Technology Council (ICTC) held its inaugural Horizon Digital Future Summit on February 1 and 2, 2022. This paper builds on the conversations held during the summit and explores the relationship between the green and digital economies. In closing the summit, ICTC signed the CIO Strategy Council's Sustainable IT Pledge, the first-ever commitment by Canadian organizations to cut rapidly rising emissions from digital technologies.[1] This builds on ICTC's existing collaboration with the CIO Strategy Council on the advancement of standards, trust, and resiliency of the Canadian digital economy. Sustainability is central to a successful digital economy, and ICTC looks forward to continuing its work with the CIO Strategy Council and other key partners like Evergreen to ensure a sustainable digital economy for Canada.

The economy is changing rapidly. Work and labour look different now than they did 10 years ago, and the importance of the digital economy is growing. Tech ethics fields are maturing, and global trade and investment patterns are in constant flux. At the same time, it is abundantly clear that our collective wellbeing hinges on tackling climate change, making the global transition to a green economy the most urgent of these changes. Meeting the UNFCC Paris Agreement requires that all industries curb their impact on the environment.

1 "A Connected World Shouldn't Cost the Earth," 2021, CIO Strategy Council, https://ciostrategycouncil.com/sustainable/

In recent years, internet use and data have dramatically increased energy demand.[2] Tech hardware requires significant rare earth mineral extraction, and cloud computing, AI, and cryptocurrencies are increasingly dependent on electricity, often generated by coal.[3] The digital economy has an important role to play in building a more sustainable economic system, both by minimizing these harms and by capitalizing on its ingenuity, creativity, and potential.

This report opens the discussion on the intricate relationship between the green and digital economies. The digital economy must play a more active role in advancing a sustainable future. To facilitate change in this area, ICTC and the CIO Strategy Council have joined forces to launch roundtables that investigate the deepening green and digital connection and propose actionable measures to boost sustainability in Canada's digital ecosystem. This paper sets the foundation for that work. Beginning with an introduction to the green economy and the urgency of the green transition, this paper explores the relationship between the green economy and five key areas: digital foundations, the future of work, tech ethics, intelligent communities, and trade and investment.

2 Cummings, M., "Surge in digital activity has hidden environmental costs," January 27, 2021, YaleNews, https://news.yale.edu/2021/01/27/surge-digital-activity-has-hidden-environmental-costs

3 "Digital economy's environmental footprint is threatening the planet," September 9, 2019, Queen's Gazette, https://www.queensu.ca/gazette/stories/digital-economy-s-environmental-footprint-threatening-planet

Introduction to Green Economy

Defining Green Economy

Most definitions for green economy centre on equity, wellbeing, and the earth's ecological limits. For the United Nations (UN), green economy "results in improved human wellbeing and social equity," "[reduces] environmental risks and ecological scarcities," and "is low carbon, resource efficient, and socially inclusive." For the Green Economy Coalition, green economy is "a resilient economy that provides a better quality of life for all within the ecological limits of the planet."[4]

Calls to transition to a green economy are rooted in decades of work by the UN and European Union.[5] Following the 2008 financial crisis, the UN encouraged countries to use large-scale public investment to foster a green economy and provided policy support to those investing in green sectors or making environmentally unfriendly sectors "greener."[6] Recommendations published by the UN in 2009 solidified its goal to stimulate economic recovery while making the global economy more sustainable.[7] Since then, sustainable development, green economy, and green growth have become core pillars of economic growth strategies in regions like Europe, Canada, China, and the United States. In 2020, governments and international organizations began taking steps toward a green global economic recovery from COVID-19.

Green economy, also referred to as green growth or "decoupling," is driven by the desire to decouple population and economic performance from environmental and ecological damage. Over the last 70 years, human activity has accelerated at an incredible rate, putting immense pressure on the earth's ecological systems.

4 "Green Economy," 2021, United Nations, https://sustainabledevelopment.un.org/index.php?menu=1446
5 "Green Economy," 2021, United Nations, https://sustainabledevelopment.un.org/index.php?menu=1446
6 "Green Economy," 2021, United Nations, https://sustainabledevelopment.un.org/index.php?menu=1446
7 "Green Economy," 2021, United Nations, https://sustainabledevelopment.un.org/index.php?menu=1446

Figure 1 shows the staggering trajectory of 24 socioeconomic and earth system indicators from 1950 to 2010, including population, gross domestic product (GDP), GHG emissions, fertilizer consumption, water use, ocean acidification, tropical forest loss, and many others.[8] As noted by the European Environment Agency, "economic growth is closely linked to increases in production, consumption, and resource use, and has detrimental effects on the natural environment and human health."[9]

The Great Acceleration

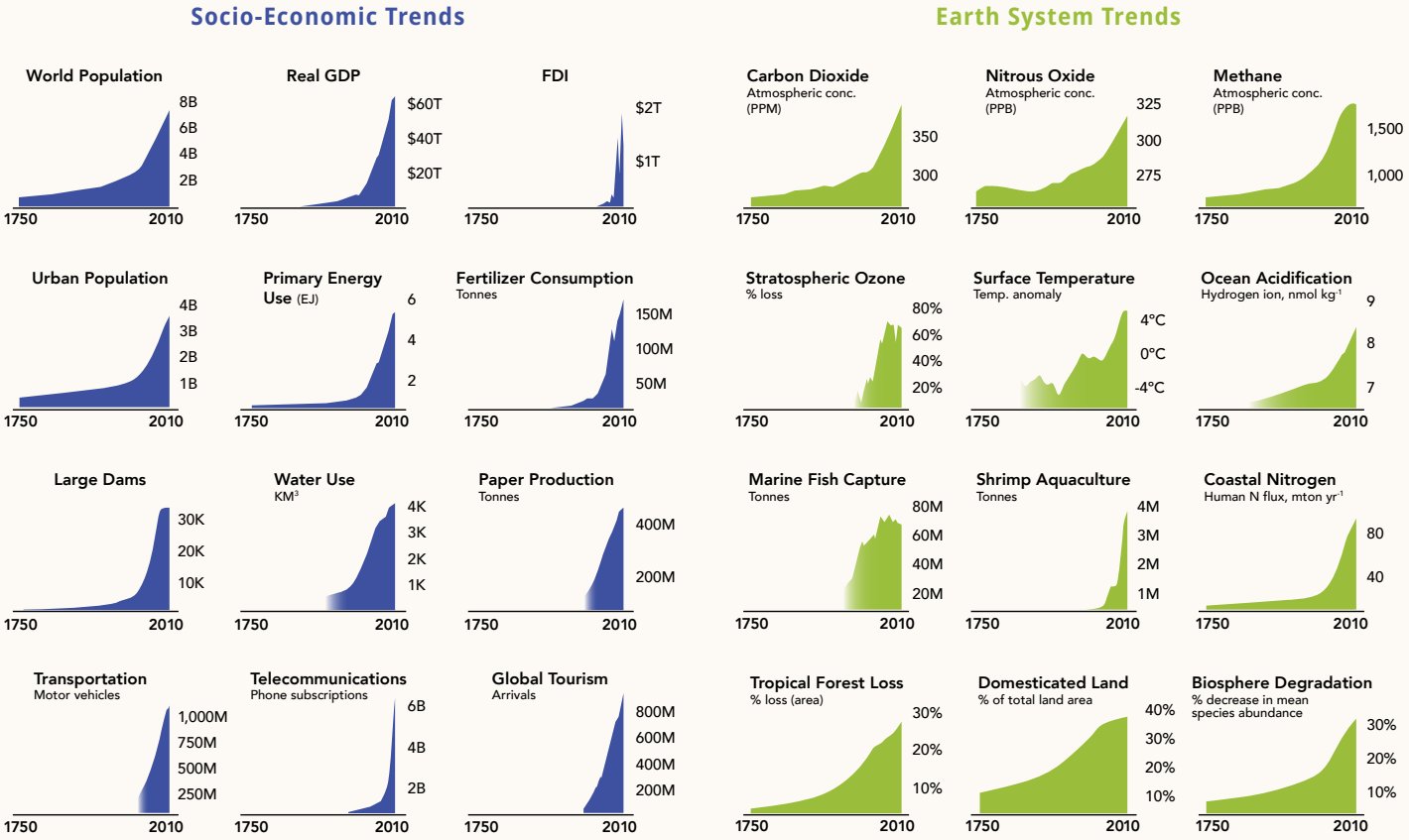


Figure 1. The Great Acceleration. **Source:** Adapted from Steffen et al., Global Change and the Earth System, 2004. See: "Great Acceleration," 2021, International Geosphere Biosphere Programme, http://www.igbp.net/ images/18.950c2fa1495db7081ebd1/1421396650502/GreatAcceleration2015igbpsrclowres.jpg

In 2015, researchers at Stockholm University outlined nine "planetary boundaries," including biosphere integrity, biogeological flows, land system change, ocean acidification, and climate change. In 2022, a tenth planetary boundary related to environmental pollutants was added: "novel entities"[10] (chemical pollution such as plastics, heavy metals, and persistent organic compounds).

8 Steffen, W., et al., "The trajectory of the Anthropocene: The Great Acceleration," January 16, 2015, Stockholm University, the Australia National University, and International Geosphere-Biosphere Programme, https://journals.sagepub.com/doi/ abs/10.1177/2053019614564785?journalCode=anra

9 "Growth without economic growth," 2021, European Environment Agency, https://www.eea.europa.eu/publications/growth-without-economic-growth

10 "Planetary Boundaries," 2021, Stockholm Resilience Centre, https://www.stockholmresilience.org/research/planetary-boundaries.html

Each boundary crossed represents a significant threat to the stability of human life on earth. Today, the earth has already transgressed five of the boundaries and is dangerously close to transgressing three more (the remaining two have not been quantified: see Figure 2).[11] Already, changes in the frequency and severity of extreme weather events are making large regions of the world unhabitable. Since the development of the planetary boundaries, the Stockholm Resilience Centre has worked with organizations like the European Environment Agency, Swedish Environmental Protection Agency, World Business Council on Sustainable Development, and Ellen McArthur Foundation to operationalize the planetary boundaries concept and integrate it into public policy frameworks. The Stockholm Resilience Centre's response to the planetary boundaries focuses on resilience thinking, which is "the capacity of a system to deal with change and continue to develop." At a high level, the Centre contends that "the innovative capacity that has put us in the current environmental predicament can also be used to push us out of it." But to do so, "economic and technological solutions must become more ecologically literate."

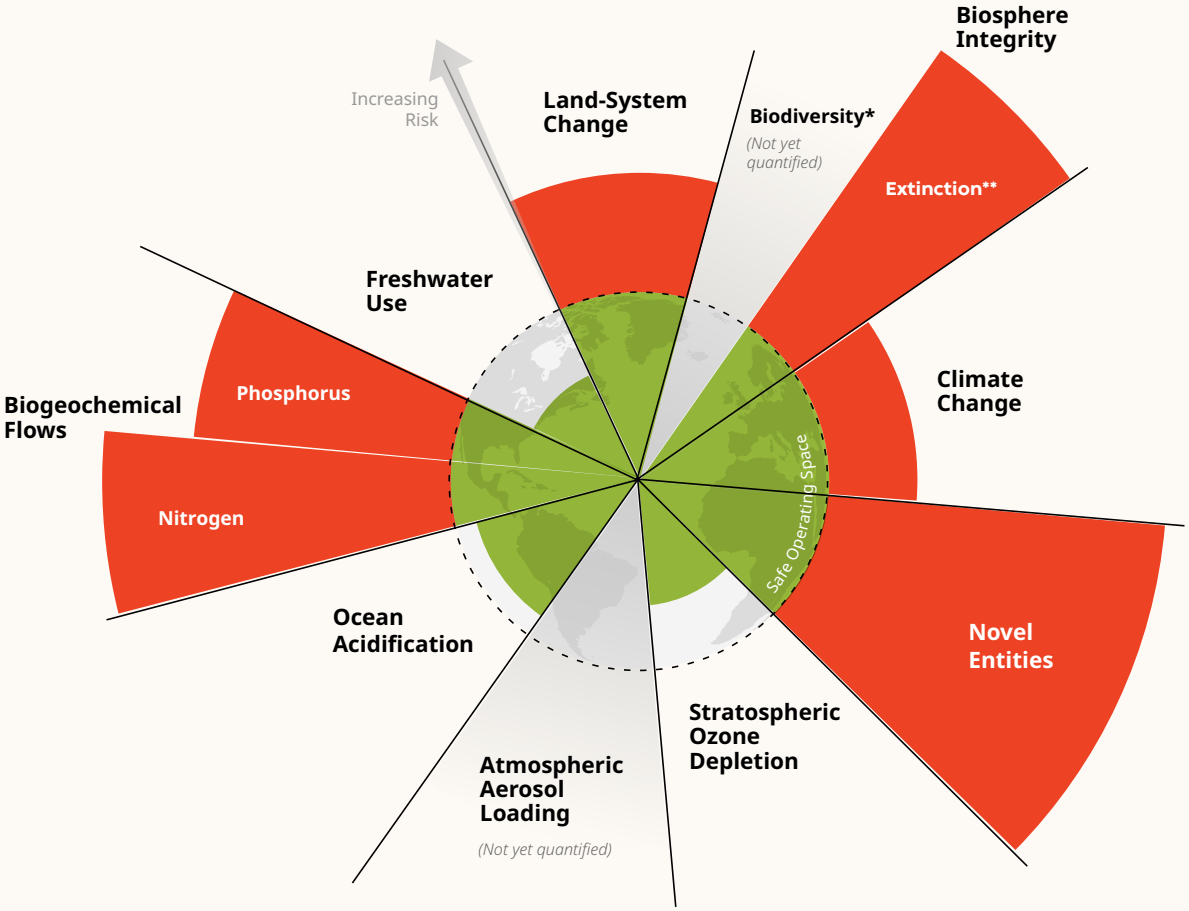


Figure 2. The Ten Planetary Boundaries. **Source:** J. Lokrantz/Azote based on Steffen et al. 2015 and Persson et al. 2022. See: "Planetary Boundaries," 2022, Stockholm Resilience Centre, https://www.stockholmresilience.org/research/planetary-boundaries.html

*Biodiversity Intactness Index **Extinctions per million species-years

11 "Planetary Boundaries," 2021, Stockholm Resilience Centre, https://www.stockholmresilience.org/research/planetary-boundaries.html

Despite this unsettling reality, continued economic growth, in many cases, relies on continued pollution and resource use. GDP remains the central mechanism to measure growth. Its continued upward trajectory is seen as necessary for improving quality of life, reducing poverty, upholding government funds, and maintaining political and economy stability.[13] Green economy responds to this dilemma by focusing on methods to continue production and some consumption but more efficiently and equitably, "reducing resource consumption, waste generation, and emissions across the full life cycle of processes and products."[14]

According to Blue Green Canada[15] and the Organisation for Economic Co-operation and Development (OECD),[16] green economy policies include:

- Creating good green jobs that pay a living wage
- Enhancing productivity, making energy and resource use more efficient
- Allocating resources to the highest value use
- Putting a price on carbon and other pollution
- Boosting investor confidence through governance predictability
- Encouraging greater use of renewable resources
- Making manufacturing greener
- Assigning a proper value to natural environments and ecosystems
- Investing in green technologies and solutions, and stimulating demand for these solutions
- Establishing a robust recycling and reuse industry or circular economy

13 Cummings, M., "Surge in digital activity has hidden environmental costs," January 27, 2021, YaleNews, https://news.yale.edu/2021/01/27/surge-digital-activity-has-hidden-environmental-costs

14 "Digital economy's environmental footprint is threatening the planet," September 9, 2019, Queen's Gazette, https://www.queensu.ca/gazette/stories/digital-economy-s-environmental-footprint-threatening-planet

15 What is the Green Economy?"2021, Blue Green Canada, https://bluegreencanada.ca/green-economy-101/what-is-the-green-economy

16 "What is green growth and how can it help deliver sustainable development?" 2018, OECD, https://www.oecd.org/greengrowth/whatisgreengrowthandhowcanithelpdeliversustainabledevelopment.htm;

The Green Growth-No Growth Debate

Whether it is possible to achieve economic growth *and* environmental sustainability has been debated heavily. On one side of the debate lies green economy, green growth, and sustainable development advocates. On the other are those advocating for degrowth, sufficiency, and doughnut economics.[17]

Arguments that green growth is limited in its ability to combat environmental harms are as follows:

- → Economic growth is ultimately tied to finite energy and resources[18]
- → The green economy relies on mineral and resource extraction, which may result in further carbon emissions and ecological damage[19]
- → Green growth requires decoupling that is absolute, permanent, and global, but to date no such evidence exists[20]
- → Green growth cannot prevent the transgressing of planetary boundaries on its own, and therefore it needs to be accompanied by sufficiency strategies[21]
- → Circular economy, which is often provided as a solution to the limits of green growth, is also restricted in its ability to reduce environmental pressures[22]

17 "About Doughnut Economics," 2021, Doughnut Economics Action Lab, https://doughnuteconomics.org/about-doughnut-economics; Stratford, B., "Green growth vs degrowth: are we missing the point?" 2020, Open Democracy, https://www.opendemocracy.net/en/oureconomy/green-growth-vs-degrowth-are-we-missing-point/

Parrique, T. et al., "Decoupling Debunked," 2019, European Environmental Bureau," https://mk0eeborgicuypctuf7e.kinstacdn.com/wp-content/uploads/2019/07/Decoupling-Debunked.pdf; Hickel, J., "Why Growth Can't be Green," 2018, Foreign Policy, https://foreignpolicy.com/2018/09/12/why-growth-cant-be-green/

Young, D. et al., "The Green Economy has a Resource-Scarcity Problem," 2021, Harvard Business Review, https://hbr.org/2021/07/the-green-economy-has-a-resource-scarcity-problem

Parrique, T. et al., "Decoupling Debunked," 2019, European Environmental Bureau," https://mk0eeborgicuypctuf7e.kinstacdn.com/wp-content/uploads/2019/07/Decoupling-Debunked.pdf; Vaden, T. et al., "Decoupling for ecological sustainability: A categorisation and review of research literature," 2020, Elsevier, https://www.sciencedirect.com/science/article/pii/S1462901120304342?via%3Dihub; "A systematic review of the evidence on decoupling of GDP, resource use and GHG emissions, part II: synthesizing the insights," Haber, H. et al., 2020, IOP Science, https://iopscience.iop.org/article/10.1088/1748-9326/ab842a; Hickel, J. and Kallis, G., "Is Green Growth Possible?" 2019, Taylor and Francis Online, https://www.tandfonline.com/doi/abs/10.1080/13563467.2019.1598964?journalCode=cnpe20; Vaden, T. et al., "Raising the bar: on the type, size and timeline of a 'successful' decoupling," 2020, Taylor and Francis Online, https://www.tandfonline.com/doi/abs/10.1080/09644016.2020.1783951?journalCode=fenp20; "Growth without economic growth," 2021, European Environment Agency, https://www.eea.europa.eu/publications/growth-without-economic-growth

Parrique, T. et al., "Decoupling Debunked," 2019, European Environmental Bureau," https://mk0eeborgicuypctuf7e.kinstacdn.com/wp-content/uploads/2019/07/Decoupling-Debunked.pdf; https://iopscience.iop.org/article/10.1088/1748-9326/ab842a; Wiedmann, T., "Scientist's Warning on Affluence," 2020, Nature, https://www.nature.com/articles/s41467-020-16941-y; Hoffmann, U., "Can green growth really work and what are the true (socio-)economics of climate change?" 2015, United Nations, https://unctad.org/system/files/official-document/osgdp2015d4_en.pdf

"Growth without economic growth," 2021, European Environment Agency, https://www.eea.europa.eu/publications/growth-without-economic-growth; https://hbr.org/2021/06/the-limits-of-the-sustainable-economy?ab=at_art_art_1x1; Parrique, T. et al., "Decoupling Debunked," 2019, European Environmental Bureau," https://mk0eeborgicuypctuf7e.kinstacdn.com/wp-content/uploads/2019/07/Decoupling-Debunked.pdf

Proponents of degrowth acknowledge that it has significant implementation barriers (e.g., consumption culture,[23] political backlash,[24] and technical feasibility[25]), yet certain degrowth policies may still be attainable (for example, policies that reduce global dependance on economic growth, recognize the risks associated with relying on decoupling alone, establish tough environmental protections, and acknowledge the impact of growth dependence on policymakers).[26] A 2019 report by the European Environmental Bureau further suggests that green growth and degrowth strategies can exist simultaneously:

> *The fact that decoupling on its own…will not be sufficient to reduce environmental pressures…is not a reason to oppose decoupling…or the measures that achieve decoupling… It is a reason to have major concerns about the predominant focus of policymakers on green growth… We advocate complementing efficiency-oriented policies with sufficiency policies, with a shift in priority and emphasis from the former to the latter, even though both have a role to play.*[27]

Progress Toward Green Economy

Measuring progress toward green economy is difficult, particularly when international comparison is involved. Green economy indicators can capture many different themes, but the relevance of these themes varies by country, regional context, priorities, and needs.[28] An indicator that captures built-up areas[29] as a percentage of total land is less relevant for Canada than, say, Singapore, which is more population dense and has much less available land. Green economy indicators could also focus on how emissions-intense or natural resource efficient a country's economy is; how resilient a country is to environmental or ecological risks; what opportunities are available in industries and sectors related to the environment; or how inclusive the country's environmental policies are.[30]

23 Wiedmann, T., "Scientist's Warning on Affluence," 2020, Nature, https://www.nature.com/articles/s41467-020-16941-y; "The global transition to green and fair economies: Global Green Economy Barometer," 2020, Green Economy Coalition, https://www.greeneconomycoalition.org/assets/reports/GEC-Reports/1037-GEC-Barometer-Phase2-A4-V8j-WEB.pdf

24 Keyßer, L. and Lenzenm, M., "1.5 °C degrowth scenarios suggest the need for new mitigation pathways," 2021, Nature Comunications, https://www.nature.com/articles/s41467-021-22884-9

25 Lenaerts, K. et al., "Can climate change be tackled without ditching economic growth?" 2021, Bruegel, https://www.bruegel.org/2021/09/can-climate-change-be-tackled-without-ditching-economic-growth/

26 Stratford, B., "Green growth vs degrowth: are we missing the point?" 2020, Open Democracy, https://www.opendemocracy.net/en/oureconomy/green-growth-vs-degrowth-are-we-missing-point/

27 Parrique, T. et al., "Decoupling Debunked," 2019, European Environmental Bureau," https://mk0eeborgicuypctuf7e.kinstacdn.com/wp-content/uploads/2019/07/Decoupling-Debunked.pdf

28 Narloch, U. et al., "Measuring Inclusive Green Growth at the Country Level," 2016, Green Growth Knowledge Platform, https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/Measuring_Inclusive_Green_Growth_at_the_Country_Level.pdf

29 "Built-up" is defined as the presence of buildings (roofed structures). See: "Built-up area and built-up area change in countries and regions," 2021, OECD.STAT, https://stats.oecd.org/Index.aspx?DataSetCode=BUILT_UP

30 "Green Growth Indicators 2017," 2017, OECD, https://www.oecd.org/environment/green-growth-indicators-2017-9789264268586-en.htm; Narloch, U. et al., "Measuring Inclusive Green Growth at the Country Level," 2016, Green Growth Knowledge Platform, https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/Measuring_Inclusive_Green_Growth_at_the_Country_Level.pdf

Three prominent measurements for green economy are the OECD's Green Growth Indicators,[31] the Global Green Growth Institute's Green Growth Index,[32] and the Green Economy Coalition's Global Green Economy Barometer.[33] The former two assess the progress of different countries or regions, while the third focuses on progress at a global scale. According to these indicators:

Among OECD countries, environmental productivity has improved (less carbon is emitted and less energy and materials are used per unit of GDP) **and relative decoupling has taken place** (CO_2 emissions have increased at a lower rate than real GDP).[34] That said, OECD progress in these areas is limited by indirect carbon and material flows, which are encapsulated in international trade (most OECD countries are net importers of CO_2, including Canada).[35] Moreover, while an increasing number of countries are pledging net-zero economies by 2050, global carbon emissions continue to grow.

Public and private actors are reimagining finance to account for environmental impact. Some countries are moving beyond traditional measures like GDP and job growth, establishing mandatory climate-related financial disclosures, and tying budget outcomes to wellbeing and environmental impact. Additionally, more than 450 financial institutions in 45 countries around the world have committed to net-zero emissions by 2050.[36] Nonetheless, in many sectors, it remains easier to buy or invest in harmful products and services than green ones. For example, in some industries, sustainable practices require additional resources while harmful alternatives drive operational efficiencies. In addition, in comparison to deeply entrenched polluting industries, the market for green alternatives may be small.

Fossil fuels, such as coal, oil, and natural gas, dominate the global energy mix, with renewables playing only a limited role. Stronger efforts are necessary to successfully transform the global energy system and expand renewable energy sources like solar photovoltaics (PV) and wind.[37]

31 "Green Growth Indicators," 2021, OECD.STAT, https://stats.oecd.org/Index.aspx?DataSetCode=GREEN_GROWTH#

32 "Green Growth Index 2020," 2020, Global Green Growth Institute, https://greengrowthindex.gggi.org/wp-content/uploads/2021/01/2020-Green-Growth-Index.pdf

33 "The global transition to green and fair economies: Global Green Economy Barometer," 2020, Green Economy Coalition, https://www.greeneconomycoalition.org/assets/reports/GEC-Reports/1037-GEC-Barometer-Phase2-A4-V8j-WEB.pdf

34 "Most countries have achieved only a relative decoupling between emissions and economic growth, although some managed to reduce emission levels in absolute terms... Half of OECD countries have decreased emissions in absolute terms (absolute decoupling)... Yet... Most reporting is based on the production perspective. This includes emissions generated on the national territory without taking trade flows into account. Countries may thus show absolute decoupling from a production perspective, but not in terms of their final demand. This is due both to changing trade patterns and to the shift of polluting industries to lower-cost locations, often with more lax environmental regulations." See; "Green Growth Indicators 2017," 2017, OECD, https://www.oecd.org/environment/green-growth-indicators-2017-9789264268586-en.htm

35 "Green Growth Indicators 2017," 2017, OECD, https://www.oecd.org/environment/green-growth-indicators-2017-9789264268586-en.htm

36 "Amount of finance committed to achieving 1.5°C now at scale needed to deliver the transition," 2021, Glasgow Financial Alliance for Net Zero, https://www.gfanzero.com/press/amount-of-finance-committed-to-achieving-1-5c-now-at-scale-needed-to-deliver-the-transition/

37 'Net Zero by 2050 A Roadmap for the Global Energy Sector," 2021, International Energy Agency, https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

Optimistically, in 2020, a new sales record was set for electric vehicles,[38] China surpassed its wind, solar, and hydropower targets,[39] and renewable energy sources grew rapidly.[40] Governments around the world have made substantial commitments to green growth (notably, the European Green Deal[41] and China's pledge to be carbon neutral by 2060[42]). In March 2021, countries with net-zero targets represented 61% of global emissions, 68% of GDP, and 52% of the world population.[43]

At the same time, governments currently spend more than US $5 trillion annually subsidizing fossil fuels, nearly the same amount as would be necessary to achieve the global SDGs (sustainability development goals).[44] Motor vehicles are generally not taxed at a rate proportional to their external costs (e.g., pollution), and environmental taxes like carbon pricing are underused, while government R&D spending on environment and energy objectives in OECD countries has remained stagnant, and inventions related to the environment have slowed down.[45]

There is continued high pressure on natural resources and ecosystems. Wild animal populations and biodiversity are threatened by population growth, infrastructure development, and land degradation and fragmentation, and the existing stock of protected land and water is insufficient to address these threats.[46] The economy relies heavily on material consumption to support economic growth,[47] but only 9% of the global economy can currently be considered circular.[48] Even the green economy brings with it a swath of new material needs: battery inputs (such as lithium, nickel, cobalt, manganese, and graphite), renewable energy inputs (such as copper, selenium, and platinum), recycled plastics, and sustainable cotton.[49]

38 "World Energy Outlook," 2021, International Energy Agency, https://iea.blob.core.windows.net/assets/888004cf-1a38-4716-9e0c-3b0e3fdbf609/WorldEnergyOutlook2021.pdf

39 Lewis, J. and Edwards, L., "Assessing China's Energy and Climate Goals," 2021, CAP, https://americanprogress.org/article/assessing-chinas-energy-climate-goals/

40 https://iea.blob.core.windows.net/assets/888004cf-1a38-4716-9e0c-3b0e3fdbf609/WorldEnergyOutlook2021.pdf

41 "A European Green Deal," 2021, European Council, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

42 "China's Achievements, New Goals and New Measures for Nationally Determined Contributions," October 2021, UNFCCC, https://www4.unfccc.int/sites/ndcstaging/Pages/Party.aspx?party=CHN&prototype=1

43 Black, R. et al., "Taking Stock: A global assessment of net zero targets," 2021, The Energy & Climate Intelligence Unit and Oxford Net Zero, https://ca1-eci.edcdn.com/reports/ECIU-Oxford_Taking_Stock.pdf?mtime=20210323005817&focal=none

44 "The global transition to green and fair economies: Global Green Economy Barometer," 2020, Green Economy Coalition, https://www.greeneconomycoalition.org/assets/reports/GEC-Reports/1037-GEC-Barometer-Phase2-A4-V8j-WEB.pdf

45 "Green Growth Indicators 2017," 2017, OECD, https://www.oecd.org/environment/green-growth-indicators-2017-9789264268586-en.htm

46 "Green Growth Indicators 2017," 2017, OECD, https://www.oecd.org/environment/green-growth-indicators-2017-9789264268586-en.htm

47 "Most countries have achieved only a relative decoupling between emissions and economic growth, although some managed to reduce emission levels in absolute terms... Half of OECD countries have decreased emissions in absolute terms (absolute decoupling)... Yet... Most reporting is based on the production perspective. This includes emissions generated on the national territory without taking trade flows into account. Countries may thus show absolute decoupling from a production perspective, but not in terms of their final demand. This is due both to changing trade patterns and to the shift of polluting industries to lower-cost locations, often with more lax environmental regulations." See; "Green Growth Indicators 2017," 2017, OECD, https://www.oecd.org/environment/green-growth-indicators-2017-9789264268586-en.htm

48 "The global transition to green and fair economies: Global Green Economy Barometer," 2020, Green Economy Coalition, https://www.greeneconomycoalition.org/assets/reports/GEC-Reports/1037-GEC-Barometer-Phase2-A4-V8j-WEB.pdf

49 Young, D. et al., "The Green Economy has a Resource-Scarcity Problem," 2021, Harvard Business Review, https://hbr.org/2021/07/the-green-economy-has-a-resource-scarcity-problem

Canada's Progress Toward Green Economy

Canada's progress toward green economy is mixed. Despite some improvement over the past 20 years, Canada lags OECD peers in many categories. The OECD's Green Growth Indicators, published in 2015, rank Canada lowest overall out of 46 OECD, EU, and BRICS countries (Brazil, Russia, India, China, and South Africa), and second lowest for progress toward green growth from 2000 to 2015. According to this data, the Canadian economy is emissions and material intensive (see Table 1), with environment-related products making up a low percentage of Canada's exports, particularly in comparison to high-emitting exports like crude oil and cars. Canada also has the second highest water extractions per capita and seventh highest emissions per capita in the world.[50] Municipal waste is growing at a faster rate than material recovery (e.g., recycling). Finally, a comparatively low percentage of Canada's terrestrial and marine lands are protected.

Environmental and resource productivity indicators	Canada	World	OECD	OECD EU	G20	G7
Production-Based CO_2 Productivity (2020, USD)[53]	3.13	3.78	5.17	7.37	3.83	4.97
Demand-Based CO_2 Productivity (2018, USD)[54]	3.20	3.68	4.19	5.39	3.57	3.94
Non-energy material productivity (2017, USD)	1.97	–	3.92	3.95	–	–

Table 1. OECD Green Growth Indicators

Many areas require immediate attention, but there are some green growth indicators for which Canada fares well: a very low percentage of Canada's population is exposed to outdoor particulate matter (e.g., air pollution); and environment-focused international development assistance accounts for a significant portion of Canada's development assistance spending.[51] Moreover, in comparison to most other OECD countries, a higher portion of Canada's publicly-funded R&D goes toward environment-focused R&D.[52]

50 "Green Growth Indicators 2017," 2017, OECD, https://www.oecd.org/environment/green-growth-indicators-2017-9789264268586-en.htm

51 "Green Growth Indicators 2017," 2017, OECD, https://www.oecd.org/environment/green-growth-indicators-2017-9789264268586-en.htm

52 "Green Growth Indicators 2017," 2017, OECD, https://www.oecd.org/environment/green-growth-indicators-2017-9789264268586-en.htm

53 USD of GDP for each kg of CO_2 emitted on the national territory. Production-based productivity accounts for CO_2 emissions generated on the national territory, without taking trade flows into account.

54 USD of GDP for each kg of CO_2 emitted anywhere to satisfy domestic final demand. Demand-based CO_2 productivity shows the economic value generated per unit of CO_2 emitted to satisfy domestic final demand, irrespective of where production occurred.

The Global Green Growth Institute's Green Growth Index (GGI) meanwhile places Canada 33rd out of 117 countries (see Table 2). The GGI ranks countries on four dimensions and 16 sub-indices. Canada ranks notably well for social inclusion, but not as well for efficient and sustainable resource use, natural capital protection (apart from environmental quality), and green economic opportunities. As with the OECD indicators, Canada's worst rankings are for efficient and sustainable energy use, GHG emissions, green trade, and green innovation.

Sub-Indicators	Canada	UK	Germany	France	US	Dimension
Efficient & Sustainable Energy Use	48.57	53.26	55.89	53.36	44.82	Efficient And Sustainable Resource Use
Efficient & Sustainable Water Use	58.20	100.00	66.08	65.98	55.10	
Sustainable Land Use	56.78	58.89	76.69	70.93	51.35	
Material Use Efficiency	76.36	87.01	86.55	87.70	79.22	
Environmental Quality	83.62	88.59	84.76	87.71	81.21	Natural Capital Protection
GHG Emissions Reductions	36.38	78.79	76.21	79.12	49.96	
Biodiversity & Ecosystem Protection	50.81	62.45	73.78	71.36	56.77	
Cultural and Social Value	64.74	77.01	96.58	81.11	72.62	
Green Investment	62.77	59.27	72.57	66.16	62.31	Green Economic Opportunities
Green Trade	22.54	42.67	68.72	31.45	42.33	
Green Employment	68.54	62.88	89.98	52.14	71.98	
Green Innovation	31.28	16.68	36.77	42.02	18.23	
Access to Basic Services & Resources	83.31	90.98	93.13	88.65	90.49	Social Inclusion
Gender Balance	84.77	88.08	79.13	92.84	71.51	
Social Equity	88.94	89.89	94.12	90.49	91.15	
Social Protection	95.11	91.35	92.47	85.42	89.37	

Table 2. Global Green Growth Institute's Green Growth Index

The global transition to a green economy will reshape the face of many industries, as will digital transformation. At the same time, the digital economy has an important role to play in building a more sustainable economic system. There is significant room for Canada to become more sustainable and progress in green growth. The following sections discuss five areas at the intersection of the green and digital economies where such progress can be made, and Canada can become a key contributor to the global shift toward green prosperity.

Digital Economy Foundations

The digital economy is built on a foundation of data, software, hardware, telecommunications infrastructure, and talent. Data powers analytics and AI, enabling us to better understand real world processes and make more informed decisions. Hardware connects data and software to the physical world through sensors, microchips, batteries, and integrated circuits, and telecommunications infrastructure connects each of these. Finally, digitally skilled workers drive innovation—building new products and services, cleaning and analyzing data, perfecting user interfaces, and implementing security systems and protocols. Each of these components is necessary for a digital economy to thrive.

The digital economy remained strong throughout the COVID-19 pandemic and economic crisis. While other sectors, such as accommodation and food services, experienced a severe decline in employment and GDP, employment and output in the digital economy remained stable and at times grew.[55] When international lockdowns threatened local businesses, digital economy firms helped those businesses transition online and did the same for governments, students, and legal and medical professionals. Coming out of the pandemic, the world is more digital and technology-enabled than ever before, and digital economy firms are well positioned to capitalize on these trends.

Interestingly, interviewees in this study noted similarities between the digital and green economies. Just as early adopters of digitization and remote work were less severely impacted by lockdowns, environmentally friendly businesses and investors are more prepared for the transition to a green economy. As one interviewee noted:

> *Circular economy practices are seen favourably by investors because they are fit for the future... [unlike] companies that rely on very linear production models... The negative externalities [of products] may not be priced in at the moment, but everybody knows they're a big problem, and if you're an investor, you want to be one step ahead of the game.* 99
>
> – Interviewee

55 Hamoni, R. et al., "Building Canada's Future AI Workforce: In the Brave New (Post-Pandemic) World," March 2021, Information and Communications Technology Council, https://www.ictc-ctic.ca/wp-content/uploads/2021/03/ICTC_Report_Building_ENG.pdf

In addition to these similarities, the digital and green economies intertwine in two important ways. For one, as the green economy becomes more digital, its digital infrastructure needs increase. Second, the digital economy has direct material and energy needs, which in turn impact the environment and invoke the need for green economy practices. These connections and their policy implications are explored in more detail in the sections below.

Green Economy and Digital Infrastructure

Green economy and digital transformation are changing the face of many organizations. Organizations have many motives to become more sustainable: to stay competitive, become more efficient, satisfy customers, and keep up with regulatory requirements. Technology is also central to many organizations' sustainability plans. For example, organizations might employ sensors and other IoT (internet of things) technologies to improve energy and material resource efficiency. They could also reduce their environmental footprint by transitioning to renewable energy sources, enabling more employees to work remotely, or adopting augmented and virtual reality into design and prototyping processes. While specific digital infrastructure needs vary depending on the technology in question, broadly speaking, the green economy requires:

- Sensors, metres, and other IoT devices to gather and transmit data
- Data analysis to assess progress toward green economy and guide decision making
- Broadband infrastructure to enable technology adoption in rural and remote areas
- Cleantech solutions such as remote collaboration tools, virtual prototyping tools, etc.
- Digitally skilled talent with relevant domain knowledge

Digital Talent Needs

Digital and green economy occupations are growing at a faster rate than the rest of the economy.[56] In Canada, environmental workers most commonly occupy roles in the professional, scientific, and technical services, followed by utilities, management of companies and enterprises, mining, quarrying, and oil and gas extraction, and agriculture, forestry, fishing, and hunting.[57]

56 "A Green Economic Recovery: Trends, Developments, and Opportunities for the Environmental Workforce," 2021, Eco Canada, https://info.eco.ca/acton/attachment/42902/f-f2dd8b7e-ef71-4dcd-bb18-ca890753598b/1/-/-/-/-/Trends%20Report%20March%202021.pdf; Cutean, A. et al., "Canada's Growth Currency Digital Talent Outlook 2023," 2019, Information and Communications Technology Council, https://www.ictc-ctic.ca/wp-content/uploads/2019/11/canada-growth-currency-2019-FINAL-ENG.pdf

57 "From Recession to Recovery: Environmental Workforce Needs, Trends and Challenges," 2021, Eco Canada, https://info.eco.ca/acton/attachment/42902/f-e71451d5-61a8-4207-9712-b0c2641a7877/1/-/-/-/-/Outlook%20Report%20to%202025.pdf

According to the Environmental Careers Organization of Canada (ECO Canada), environmental workers are workers "that drive or support the goals of environmental protection, resource management, and sustainability."[58] They fall into two distinct categories:

- Core environmental workers, which, regardless of industry, support environmental protection, resource management, and sustainability through environmental competencies; and
- Environmental goods and services sector workers, which, regardless of occupation, work for environmental goods and services firms, such as cleantech companies.[59]

A similar trend is observed in the digital economy, where there are two distinct labour groups: core tech workers, which regardless of industry, directly support the development, adoption, or use of digital technologies; and tech sector workers, which, regardless of occupation, work for a tech firm. As shown in Figure 3, these trends converge in different ways throughout the Canadian economy, creating a spectrum of tech and environmental skills combinations.

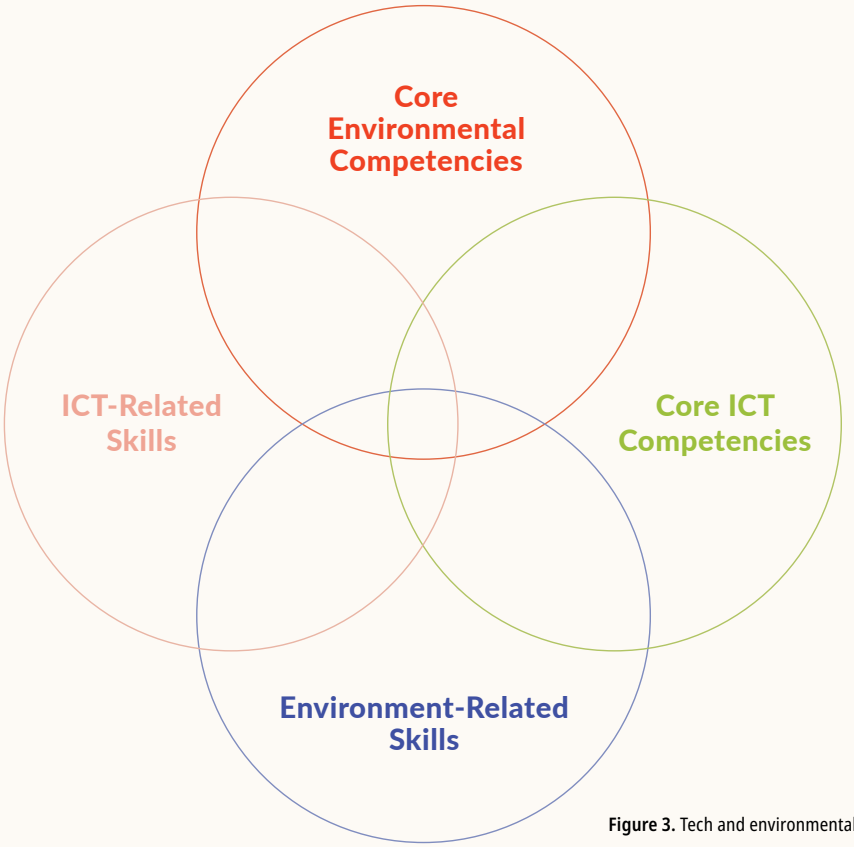


Figure 3. Tech and environmental skills combinations.

58 "From Recession to Recovery: Environmental Workforce Needs, Trends and Challenges," 2021, Eco Canada, https://info.eco.ca/acton/attachment/42902/f-e71451d5-61a8-4207-9712-b0c2641a7877/1/-/-/-/-/Outlook%20Report%20to%202025.pdf

59 "From Recession to Recovery: Environmental Workforce Needs, Trends and Challenges," 2021, Eco Canada, https://info.eco.ca/acton/attachment/42902/f-e71451d5-61a8-4207-9712-b0c2641a7877/1/-/-/-/-/Outlook%20Report%20to%202025.pdf

60 "From Recession to Recovery: Environmental Workforce Needs, Trends and Challenges," 2021, Eco Canada, https://info.eco.ca/acton/attachment/42902/f-e71451d5-61a8-4207-9712-b0c2641a7877/1/-/-/-/-/Outlook%20Report%20to%202025.pdf

One area where these two trends are converging is the building sector. As more building projects incorporate energy efficiency into their design, such as with smart buildings, there is a greater need to measure efficiency outcomes.[61] Government policy and financial incentives, such as are in place in Canada and the EU,[62] are also driving demand for energy efficient buildings and retrofits. For instance, the federal government's most recent ministerial mandate letters established plans to publish a net-zero-emissions building code and model retrofit code by 2024.[63] Policies like these create subsequent demand not only for IoT devices, building control systems, automation, and data, but for digital skills and literacy across the workforce. In terms of core ICT workers, ECO Canada forecasts increased demand for the following roles in the energy efficient building sector: web/application developers, software developers, cybersecurity specialists, data analysts, data engineers, data operations engineers, integration specialists, and business intelligence developers.[64] Additionally, new and emerging digital skills needs were identified for seven of the building sector's core occupations.[65] Other labour market needs related to green economy are discussed in more detail in The Future of Work section.

Digital Economy and the Environment

Energy and material inputs are needed to produce, transport, and use ICT devices, operate data centres and networks, and deliver technology services. Through their impact on climate change and the environment, technology products and services invoke a need for green economy practices. This section discusses the digital economy's impact on climate change through energy consumption and carbon emissions, and on the natural environment through mining and extraction.

Technology, Energy Use, and Carbon Emissions

There is currently no standardized practice in Canada to report and track emissions data from the technology sector; this makes it difficult to assess and compare the sector's impact on the environment.

61 "Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Buildings Workforce," 2021, Eco Canada, https://info.eco.ca/acton/attachment/42902/f-00111b67-483c-42e6-8060-fc13be56709f/1/-/-/-/-/Energy%20Efficiency%20in%20Buildings%202021.pdf

62 "Renovating buildings for greener lifestyles," 2021, European Commission, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en#renovating-buildings-for-greener-lifestyles

63 "Minister of Innovation, Science and Industry Mandate Letter," December 16, 2021, Office of the Prime Minister of Canada, https://pm.gc.ca/en/mandate-letters/2021/12/16/minister-innovation-science-and-industry-mandate-letter

64 "Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Buildings Workforce," 2021, Eco Canada, https://info.eco.ca/acton/attachment/42902/f-00111b67-483c-42e6-8060-fc13be56709f/1/-/-/-/-/Energy%20Efficiency%20in%20Buildings%202021.pdf

65 "Assessment of Occupational and Skills Needs and Gaps for the Energy Efficient Buildings Workforce," 2021, Eco Canada, https://info.eco.ca/acton/attachment/42902/f-00111b67-483c-42e6-8060-fc13be56709f/1/-/-/-/-/Energy%20Efficiency%20in%20Buildings%202021.pdf

Based on international data, however, it is likely that the tech sector contributes less to Canada's total carbon emissions than high-emitting industries[66] like oil and gas, transport, heavy industry, buildings, and agriculture. At the global level, technology is estimated to account for approximately 1.8 to 3.9% of total carbon emissions.[67] Estimates of technology emissions vary because determining its carbon footprint is challenging. Technology transcends traditional sector boundaries, meaning its emissions may be baked into those of other sectors such as mining or manufacturing. Notably, approximately one-quarter of technology's total carbon footprint is from "embodied emissions," e.g., emissions throughout the manufacturing process, from raw material extraction to shipping.[68] Similarly, technology transcends national borders and relies heavily on imported goods,[69] meaning domestic emissions may be intertwined those of other countries.

Researchers generally agree that technology emissions have increased over time, alongside data traffic, data centres, and communication networks, and these emissions have increased at a faster rate than emissions generally.[70] In 2020, nearly three-quarters of technology emissions stemmed from data centres and communication networks, which are energy intensive.[71] In response to growing energy demand, organizations like the UN International Telecommunication Union (ITU) and ICTFOOTPRINT.eu have established and promoted standards to help tech companies reduce their emissions in line with the UNFCCC Paris Agreement.[72] For example, ITU Standard ITU L. 1470 puts forward emissions-reduction trajectories for network operators and data centres.[73] While numerous standards for measuring and reducing technology emissions exist, many companies face barriers to implementing them.[74] For example, companies may have difficulty implementing standards due to:

- Different standards employing overlapping or conflicting methodologies
- Difficulty implementing lifecycle methodologies and/or interpreting and using the results
- A dearth of data and/or knowledge about technology's environmental impact
- Limited understanding of the benefits of implementing the standard
- A lack of resources or incentives

66 Freitag, C. et al., "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations," 2021, ScienceDirect, https://www.sciencedirect.com/science/article/pii/S2666389921001884#

67 Freitag, C. et al., "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations," 2021, ScienceDirect, https://www.sciencedirect.com/science/article/pii/S2666389921001884#

68 Freitag, C. et al., "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations," 2021, ScienceDirect, https://www.sciencedirect.com/science/article/pii/S2666389921001884#

69 Canada imported USD $33 276 million worth of ICT goods in 2020, while exporting $8 236 million.

70 Freitag, C. et al., "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations," 2021, ScienceDirect, https://www.sciencedirect.com/science/article/pii/S2666389921001884#

71 "Greenhouse gas emissions in the ICT sector: Trends and methodologies," March 2020, UNEP and DTU, https://c2e2.unepdtu.org/wp-content/uploads/sites/3/2020/03/greenhouse-gas-emissions-in-the-ict-sector.pdf

72 "ICT industry to reduce greenhouse gas emissions by 45 per cent by 2030," February 2020, UN ITU, https://www.itu.int/en/mediacentre/Pages/PR04-2020-ICT-industry-to-reduce-greenhouse-gas-emissions-by-45-percent-by-2030.aspx; "D2.1 – Results of the Interpretation and Selection of the Methodologies," October 2017, ICTFOOTPRINT.EU, https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14084

73 "D2.1 – Results of the Interpretation and Selection of the Methodologies," October 2017, ICTFOOTPRINT.EU, https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14084

74 "D3.2 – Recommendations and Uptake by SMEs," October 2017, ICTFOOTPRINT.EU, https://ictfootprint.eu/sites/default/files/ICTFOOTPRINT.eu_D3.2-Recommendations%20and%20uptake%20by%20SMEs%20-v1.1.pdf

There is less agreement among researchers on future emissions trends—e.g., whether energy efficiency gains will continue to reduce technology's carbon footprint, whether renewable energy adoption will decarbonize technology, or emissions will stabilize due to technology saturation, or broad tech adoption will reduce emissions in other sectors.[75] Some researchers believe broad technology adoption can help reduce emissions in other sectors, such as through the introduction of smart grids to the utilities sector; however, they urge that this will only happen under certain policy and market conditions and that it will not happen by default.[76] For reductions to take place, government and industry will need to ensure that technology products and services aimed at reducing emissions are available on the market, affordable, and that other sectors are willing and able to adopt them. This will require supporting cleantech research and development, incentivizing cleantech adoption, and promoting the development of universal standards for tracking outcomes that can be tied to government incentives. In sectors where a market for sustainable products and services exists, standards can establish trust between consumers and industry to spur demand. In the agri-food sector, for example, it is already possible to measure the impact of precision agriculture technologies on the environment through reduced fertilizer use. Yet due to a lack of universal standards, it remains unclear to industry and consumers whether that justifies marketing a product as "sustainable."[77]

Action is also needed to ensure emissions savings realized through technology adoption do not result in rebound effects, whereby increased carbon efficiency leads to greater consumption of other carbon emitting products and services.[78] A concrete example of a rebound effect would be an individual using their dishwasher more often to clean dishes after buying an energy efficient dishwasher: each load of dishes may use less energy, but overall energy consumption increases. A strong rebound effect could threaten technology's ability to lower emissions in other sectors. According to experts in the field, governments can help reduce rebound effects by shifting their economies to greener consumption patterns (e.g., expanding renewable energy to as many sectors as possible) and downsizing consumption (achieved either voluntarily by consumers and industry, or involuntarily via carbon caps or pricing).[79] While Canada and many other countries have implemented a carbon tax or other carbon pricing mechanism, many have not. This discrepancy creates an uneven playing field in the global economy, whereby only some trading partners are subject to a price on carbon. It also increases the risk of "carbon leakage," whereby carbon pricing causes companies or investors to move their production processes to jurisdictions with lower or no carbon costs. These challenges and possible solutions are discussed further in the Trade and Investment section.

75 Freitag, C. et al., "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations," 2021, ScienceDirect, https://www.sciencedirect.com/science/article/pii/S2666389921001884#

76 Freitag, C. et al., "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations," 2021, ScienceDirect, https://www.sciencedirect.com/science/article/pii/S2666389921001884#

77 Ivus, M. et al., "Sowing the Seeds for Tomorrow," 2021, Information and Communications Technology Council, https://www.ictc-ctic.ca/wp-content/uploads/2021/11/canadian-agrifood-tech-2021.pdf

78 Freitag, C. et al., "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations," 2021, ScienceDirect, https://www.sciencedirect.com/science/article/pii/S2666389921001884#

79 Vivanco, D. et al., "How to deal with the rebound effect? A policy-oriented approach," 2016, Science Direct, https://www.sciencedirect.com/science/article/pii/S0301421516301586#; "Aligning Policies for a Low-carbon Economy," 2015, OECD, https://www.oecd.org/environment/Aligning-Policies-for-a-Low-carbon-Economy.pdf

80 "Exploring Border Carbon Adjustments for Canada," August 2021, Government of Canada, https://www.canada.ca/en/department-finance/programs/consultations/2021/border-carbon-adjustments/exploring-border-carbon-adjustments-canada.html

Technology and Material Resource Needs

Technology products can require an intricate supply of material resources for the production of semiconductors, integrated circuits, microelectrical components, displays, LEDs, electrical connections, rechargeable batteries, and more.[81] Smartphone screens alone are made up of at least 14 elements, demonstrating the material complexity of technology hardware. The United Nations Conference on Trade and Development provides a list of 24 elements that are considered important for digital economy and identifies their usage. Of these elements, gallium, germanium, indium, rare earth elements (REEs), selenium, tantalum, and tellurium are "essential raw materials for the building blocks of all tech hardware, such as microchips and integrated circuits." [82]

The cleantech and clean energy industries, too, need minerals and other material resources to produce solar panels, wind turbines, and batteries. As countries around the world pursue ambitious climate action and the demand for cleantech and clean energy minerals rises, it will be important for mineral-rich countries to manage the environmental impact of domestic mining activities.[83] Today, up to 11% of global energy use is accounted for by the mining industry, and many mining projects take place in water stressed regions. These environmental pressures will increase without effective environment policies.[84] Nonetheless, despite being more mineral intensive than fossil fuel technologies, renewable energy emissions are substantially lower than fossil fuel emissions, which is essential to meeting the UNFCCC Paris Agreement.[85]

Key Issues and Policy Considerations

While there are many low-tech environmental solutions—such as reforestation, wetland restoration, pollinator parks, and regenerative farming—climate solutions are increasingly technology-based, driving green economy's digital infrastructure needs. This part of the green transition relies on the development and deployment of innovative technology products and services, reliable telecommunications infrastructure, and talent. This will require Canada to support cleantech innovation and encourage adoption via procurement, tax credits, and other policy tools.

81 "Exploring Border Carbon Adjustments for Canada," August 2021, Government of Canada, https://www.canada.ca/en/department-finance/programs/consultations/2021/border-carbon-adjustments/exploring-border-carbon-adjustments-canada.html

82 "Digital Economy Growth and Mineral Resources: Implications for Developing Countries," December 2020 UNCTAD, https://unctad.org/system/files/official-document/tn_unctad_ict4d16_en.pdf

83 "Digital Economy Growth and Mineral Resources: Implications for Developing Countries," December 2020 UNCTAD, https://unctad.org/system/files/official-document/tn_unctad_ict4d16_en.pdf

84 Hund, K. et al., "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition," 2020, International Bank for Reconstruction and Development/ The World Bank, https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf

85 Hund, K. et al., "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition," 2020, International Bank for Reconstruction and Development/ The World Bank, https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf

86 Hund, K. et al., "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition," 2020, International Bank for Reconstruction and Development/ The World Bank, https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf

Helping SMEs become early adopters of digital transformation and green economy practices can increase their efficiency while helping them stay competitive in the global marketplace and in line with consumer and regulatory trends. At the same time, it will be important for Canada to continue deploying broadband infrastructure in rural and remote areas so that industries concentrated in these areas (such as agriculture, mining, and forestry) can readily adopt cleantech solutions. Finally, there is a growing need for environment-related domain knowledge in core technology roles and new digital skills in core environment roles, making it necessary to advance labour development programs at the intersection of the digital and green economies.

It is important to ensure that emissions savings realized through technology adoption does not result in rebound effects, the latter threatening technology's ability to lower emissions in other sectors. Canada can help prevent rebound effects by shifting the economy to greener consumption patterns, expanding renewable energy to as many sectors in the economy as possible, and encouraging consumers and industry to downsize harmful consumption.

Combatting climate change requires an absolute reduction in total global carbon emissions, including that of the technology sector. Despite efficiency gains and investment in renewable energy, many emerging technologies like AI, IoT, blockchain, and digital twins have not yet reached mainstream adoption, suggesting possible further growth of technology emissions.[86] Possible solutions to this challenge include deploying renewable energy throughout the technology supply chain (such as using hydro-electric energy for data warehouses[87]), expanding energy efficiency standards for tech infrastructure, and encouraging sustainable technology design for devices and software.[88] At the same time, it may also be necessary to educate the public and industry about responsible technology procurement, use, and disposal, and give consumers clearer and more accurate information about the environmental footprint of technology products and services.[89] Notably, the latter solution would require—among other things—better and more transparent data on technology-related emissions and increased use of standardized carbon assessments[90] by tech industry players.[91]

86 "The ICT industry dominates corporate agreements to purchase renewable energy." See: "Greenhouse Gas Emissions in the ICT Sector," March 2020, UNEPD, https://c2e2.unepdtu.org/wp-content/uploads/sites/3/2020/03/greenhouse-gas-emissions-in-the-ict-sector.pdf

87 Freitag, C. et al., "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations," 2021, ScienceDirect, https://www.sciencedirect.com/science/article/pii/S2666389921001884#

88 "Greenhouse gas emissions in the ICT sector," March 2020, UNEP and DTU, https://c2e2.unepdtu.org/wp-content/uploads/sites/3/2020/03/greenhouse-gas-emissions-in-the-ict-sector.pdf

89 Freitag, C. et al., "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations," 2021, ScienceDirect, https://www.sciencedirect.com/science/article/pii/S2666389921001884#

90 "Built on GHG Protocol," 2022, Greenhouse Gas Protocol, https://ghgprotocol.org/guidance-built-ghg-protocol; "ICT Standards," 2022, ICTFOOTPRINT.EU, https://www.ictfootprint.eu/en/methodologies; https://ictfootprint.eu/en/system/files/ICTFOO~1.PDF

91 Freitag, C. et al., "The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations," 2021, ScienceDirect, https://www.sciencedirect.com/science/article/pii/S2666389921001884#

The technology, cleantech, and clean energy industries require minerals and other material resources to produce hardware and devices. Amid growing demand, governments will need to balance the threat of new or exacerbated environmental pressures with potential bottlenecks in the supply of material inputs. Canada is a significant producer of the minerals and metals required for solar panels, smart grids, wind turbines, LED light bulbs, and electric cars, and can position itself as sustainable, international leader.[92]

> *In a lot of cases, we downcycle things; we end up with mixed materials or things that can't be processed because they've been designed in such a way that taking them apart doesn't work. A lot of electronics are like that: you can only shred them and recuperate about 10 percent of their value. Whereas if you had the right design in the first place, and disassembly and repurposing centres, you could enable the materials and components to stay in the economy, as opposed to leak in the environment. When they do leak into the environment, they not only pollute but also increase our need to extract more virgin resources in order to replace them.* 99
>
> – Interviewee

Another possible solution to material needs is circularity. A circular economy promotes resource efficiency by designing waste out of production processes and keeps materials in the economy for as long as possible. In a circular economy, products and materials are made to last longer and be more easily repaired, reused, and recycled. The extent to which a circular economy can reduce environmental pressures will depend on how well the technology, cleantech, and clean energy industries can design and market recycled materials in production processes and establish recycling infrastructure. In some cases, transforming waste into reusable inputs has a greater impact on the environment than using virgin resources, which limits circular economy solutions.[93] Recycling rates for many materials are also low, limited by consumer willingness to separate waste and the ability of waste service providers to collect, store, and transport waste at a reasonable cost.[94] Finally, materials degrade over time and can only be recycled a limited number of times.[95]

92 "From Mineral Exploratio not Advanced Manufacturing: Developing Value Chains for Critical Minerals in Canada," June 2021, Parliament of Canada, https://www.ourcommons.ca/Content/Committee/432/RNNR/Reports/RP11412677/rnnrrp06/rnnrrp06-e.pdf

93 Meyers, k. et al., "The Limits of the "Sustainable" Economy," June 2021, Harvard Business Review, https://hbr.org/2021/06/the-limits-of-the-sustainable-economy?ab=at_art_art_1x1

94 Meyers, k. et al., "The Limits of the "Sustainable" Economy," June 2021, Harvard Business Review, https://hbr.org/2021/06/the-limits-of-the-sustainable-economy?ab=at_art_art_1x1

95 "Growth Without Economic Growth," January 2021, European Environment Agency, https://www.eea.europa.eu/publications/growth-without-economic-growth/file

Despite the above challenges, circular economy practices can, at least partially, help address growing material needs. Canada can support this work by incentivizing companies to engage in circular design and make it easier for consumers to repair broken devices, or when repair is not possible, disassemble and recycle device parts. Interviewees in this study noted that a successful circular economy requires the right incentive system. At the front, recycling and repairing devices will have to become more practical and cost effective than polluting. Companies can also be encouraged to embed more product information so that, at each state of a product's lifecycle, it is possible to know what the product is made of, how it can be repaired, and how it can be recycled or disposed safely. Finally, consumers and industry can be incentivized to use technology devices for longer, purchase second-hand devices, and reduce rapid the turnover of devices where possible.

The Future of Work

What is the Future of Work?

Driven by social, political, and technological developments, work has evolved throughout history. Yet when, where, how, and why people work has undergone significant change in recent years, leading to the term the "future of work." In a 21st Century context, discussion regarding the future of work often centres on technological development and includes a focus on:

- **The role of education and training:** determining how education and training can best prepare workers for the future and understanding skill development, upskilling, and reskilling in an evolving and increasingly tech-oriented job market.
- **The quality of work:** understanding how factors such as job satisfaction, security, pay, autonomy, and risk influence an individual's working experience now and in the future.
- **Evolving roles, tasks, and responsibilities:** as technologies and industries change, so do the specific tasks that workers perform. Predicting and preparing for the future of work on a task-based level has become a central component of understanding the future of work.[96] At the same time, work is becoming less long term and more task-based, a phenomenon called the "unbundling" of work.[97]
- **The influence of automation and AI:** recent estimates suggest that nearly a third of Canadian workers are at risk of "automation-related job transformation". This could have disproportionate outcomes for some workers and brings up significant questions about leisure time, social safety nets, and the purpose of work.[98]
- **Equity, inequality, and precarity:** as working conditions, norms, and relationships have changed in recent years, issues of inequality have taken centre stage, whether in terms of the concentration of capital, class stratification, or attention to demographic-based inequity.
- **Decentralization and digitization:** people work remotely and asynchronously, communicate by chat, work fewer standard hours, and generally have less defined boundaries to their work.

96 Beer, P. and Mulder, R., "The Effects of Technologyical Developments on Work and Their Implications for Continuous Vocational Education and Training," May 8, 2020, Frontiers in Psychology, https://www.frontiersin.org/articles/10.3389/fpsyg.2020.00918/full

97 "The Changing Nature of Work," June 1, 2016, Policy Horizons, https://horizons.gc.ca/en/2016/06/01/the-changing-nature-of-work/

98 Frenette, M. and Frank, K., "Automation and Job Transformation in Canada: Who's at Risk?" June 29, 2020, Statistics Canada, https://www150.statcan.gc.ca/n1/pub/11f0019m/11f0019m2020011-eng.htm

99 Marshall, T., "Wicked Problems," 2008, Birkhauser Basel, https://link.springer.com/referenceworkentry/10.1007%2F978-3-7643-8140-0_304

The Future of Work and the Green Economy: Complex Problems, Similar Solutions

The future of work and the green economy share several similarities. Both are attempts to solve wicked problems—problems that defy "any standard attempt to find a solution because [they are] a symptom or result of multiple, contingent, and conflicting issues."[99] Additionally, the future of work and the green economy are global concepts that influence a vast range of individuals and institutions, and yet regional or local considerations are critical for both. Policy to influence the green and digital economies can sometimes be interconnected: some initiatives simultaneously support investments in the future of workers and investments in the green economy. For example, Blue Green Canada notes that "investing in Canadian mass-timber manufacturing [wood has long been used in the construction of single-family homes, but it hasn't been a go-to construction material for other building types, such as commercial buildings and high-rises] would support local workers and could potentially create an export market using Canadian timber."[100] Blue Green Canada also recommends designing and constructing zero-emissions vehicles in Canada.[101] The merging of employment policy with environmental policy has gained widespread public attention in the US, in the form of the Green New Deal, which "calls on the [United States] federal government to dramatically reduce greenhouse gas emissions, create high-paying jobs, ensure that clean air, clean water, and healthy food are basic human rights, and end all forms of oppression."[102]

Developments in the green economy influence the future of work. This is partly because jobs are increasingly being directly impacted by climate change. The International Labour Organization (ILO) writes that "we may soon reach the point in which the jobs created or improved by economic development risk being destroyed or worsened by the resulting environmental degradation. The world of work needs environmental sustainability." While transitioning to a green economy will create jobs, it will simultaneously cause some displacement. As one interviewee noted:

> *There probably is a little bit of displacement that's going to happen, right? Especially with industries like oil and gas where, the goal is to reduce emissions. And so you're going to see workers potentially having that industry knowledge, but not necessarily having the environmental or the innovation part of their skill sets.*

99 Marshall, T., "Wicked Problems," 2008, Birkhauser Basel, https://link.springer.com/referenceworkentry/10.1007%2F978-3-7643-8140-0_304

100 "Buy Clean: How Public Construction Dollars Can Create Jobs and Cut Pollution," January 2021, Blue Green Canada, https://bluegreencanada.ca/wp-content/uploads/sites/19/2021/01/Buy-Clean-How-Public-Construction-Dollars-Can-Create-Jobs-and-Cut-Pollution-Eng-2-1.pdf

101 "Let's Talk Budget 2021," February 19, 2021, Blue Green Canada, https://bluegreencanada.ca/2021/02/19/lets-talk-budget-2021/

102 Friedman, L., "What is the Green New Deal? A Climate Proposal, Explained," February 21, 2019, The New York Times, https://www.nytimes.com/2019/02/21/climate/green-new-deal-questions-answers.html

Research on the future of work has focused largely on the potential job-loss risks associated with automation, but Michael Osborne et al. suggest that other factors, including labour market changes caused by the green economy, are equally noteworthy.[104]

Many core aspects of the future of work influence the green economy as well. For example, a just transition to a green economy entails providing decent work. As the ILO states, "in order to ensure a just transition, efforts to promote the green economy must be accompanied by policies that facilitate the reallocation of workers, advance decent work, offer local solutions and support displaced workers."[105] In short, an inclusive green economy cannot exist without a fair future of work.

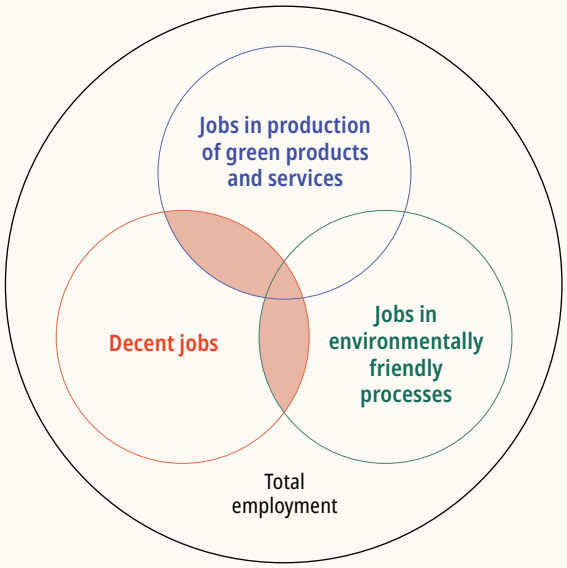


Figure 4,[106] shows the intersection of green jobs and services, and decent jobs—justice must be a core component to both job creation and environmental preservation.

Figure 4. What is a green job? **Source:** International Labour Organization

If a green economy is to succeed, the workforce supporting it must also succeed. Some impacts of the green economy on work and labour policy relate to:

- labour market implications (the green economy will change the number and type of available jobs)
- education and skills (the green economy will change what training and skills people need)
- enabling a just transition (equity and inclusion are needed to ensure that the green economy develops fairly)
- decentralization and the "unbundling" of work (core aspects of the future of work will influence the green economy)

104 Bakhshi, H. et al., "The Future of Skills Employment in 2030," 2017, Nesta, https://media.nesta.org.uk/documents/the_future_of_skills_employment_in_2030_0.pdf

105 "Greening with jobs: World Employment Social Outlook 2018," 2018, International Labour Organization, https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_628654.pdf

106 "What is a green job?" April 13, 2016, International Labour Organization, https://www.ilo.org/global/topics/green-jobs/news/WCMS_220248/lang--en/index.htm

Labour Market Implications

The green economy has substantial potential to impact the labour market in the future. While COVID-19 contracted the Canadian labour force in 2020, the environmental workforce weathered the storm, growing by 5%.[107] ECO Canada estimates that "as many as 233,500 net job openings are expected by 2029,"[108] while Clean Energy Canada suggests that the sector is set to grow by more than half a million by 2030.[109] Figure 5 estimates the breakdown of various clean industries.

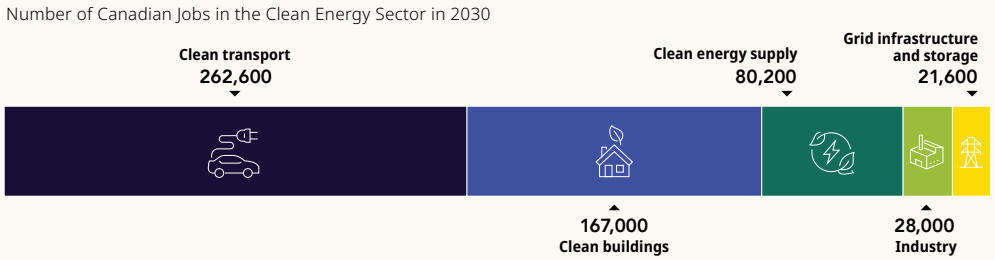


Figure 5. Number of Canadian jobs in the clean energy sector in 2030. **Source:** Clean Energy Canada

ECO Canada adds that nearly a third of the current environmental workforce will retire in the next 10 years, describing a labour force demand that "is impacting every province and territory, and every industry."[110] Entire job boards now exist specifically for jobs in the Canadian green economy (e.g., the ECO Canada Job Board[111] and GoodWork[112]). On a global scale, the green economy is expected to grow significantly as well. Figure 6[113] displays how employment growth in renewables is projected to vastly outpace growth in other industries.

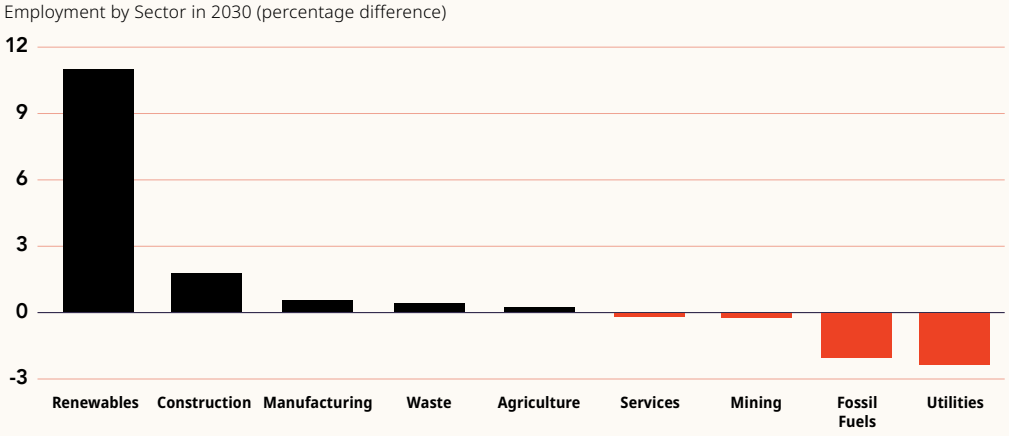


Figure 6. Energy sustainability and employment in 2030. **Source:** International Labour Organization

107 "Updated Labour Market Outlook 2025," March 2021, ECO Canada, https://eco.ca/new-reports/updated-environmental-labour-outlook-to-2025/

108 "Canada's Environmental Workforce," 2021, ECO Canada, https://eco.ca/environmental-students/environmental-workforce-101/

109 "The Fast Lane: With smart policy, Canada's clean energy sector is poised for rapid growth as fossil fuels slow down," October 2019, Clean Energy Canada, https://cleanenergycanada.org/wp-content/uploads/2019/10/Report_TER2019_CleanJobsFuture_20191001_FINAL.pdf

110 "Canada's Environmental Workforce," 2021, ECO Canada, https://eco.ca/environmental-students/environmental-workforce-101/

111 "Job Board," 2021, ECO Canada, https://www.eco.ca/JobBoard/

112 "Good Work," 2022, People and Planet, https://www.goodwork.ca/jobs

113 "World Employment and Social Outlook 2018: Chapter 2. Employment and the role of workers and employers in a green economy," 2018, International Labour Organization, https://www.ilo.org/weso-greening/documents/WESO_Greening_EN_chap2_web.pdf

There is undeniable optimism surrounding the potential job creation caused by a green economy. Additionally, Canada fares well relative to many other countries in terms of green employment opportunities in the Green Growth Index. Nonetheless, Osborne et al. note that "evidence for the broader jobs potential of the green economy is... ambiguous,"[115] while "structural changes associated with the green economy are fundamentally dependent on government policy."[116] The OECD also sets tempered expectations, predicting that "green policies can achieve job creation in a number of 'green' economic sectors and through a transition of the economy toward more labour-intensive services sectors, while job destruction especially occurs in 'brown' sectors whose activities get replaced by green sectors."[117] Further, the OECD suggests that "the size of the overall job turnover created by green growth is likely to be relatively small compared to overall labour market movements."[118] In other words, a green transition is only one factor influencing large, complex labour markets.

Education and Skills

The OECD notes that "education and training systems that prepare workers for future labour demand needs are especially important to smooth the [green] transition."[119] They add that transferable skills and dynamic, flexible labour markets will be key to easing the green growth labour force transition[120] Because transferable skills will be highly important, skill development programs that enable skill transfers, upskilling, and career pivots will be critical. Education systems will need to adapt to changing labour markets and skills demand. In fact, some educational institutions are already doing so: for example, the University of Calgary's oil and gas engineering bachelor program was suspended in 2021 due to decreasing demand for such roles.[121] Understanding the need to transition the existing workforce, the University of Calgary and other institutions have also joined forces with community organizations via the EDGE UP program, which trains the city's displaced energy workers for in-demand jobs in tech. In the words of one interviewee, employers may need to support skill transitions and training:

66 *The question becomes for [energy] companies, is there a natural shift that could take place where you can transform those workers and do those roles and stay within the industry?... So it's a choice for these companies to upskill or reskill these workers and maintain them within the industry because of their wealth of knowledge and experience in their own sectors.* 99

114 "Green Growth Index 2020," December 2020, GGGI, https://greengrowthindex.gggi.org/wp-content/uploads/2021/01/2020-Green-Growth-Index.pdf

115 Bakhshi, H. et al., "The Future of Skills Employment in 2030," 2017, Nesta, https://media.nesta.org.uk/documents/the_future_of_skills_employment_in_2030_0.pdf

116 Bakhshi, H. et al., "The Future of Skills Employment in 2030," 2017, Nesta, https://media.nesta.org.uk/documents/the_future_of_skills_employment_in_2030_0.pdf

117 "Employment Implications of Green Growth," June 2017, OECD, https://www.oecd.org/environment/Employment-Implications-of-Green-Growth-OECD-Report-G7-Environment-Ministers.pdf

118 "Employment Implications of Green Growth," June 2017, OECD, https://www.oecd.org/environment/Employment-Implications-of-Green-Growth-OECD-Report-G7-Environment-Ministers.pdf

119 "Employment Implications of Green Growth," June 2017, OECD, https://www.oecd.org/environment/Employment-Implications-of-Green-Growth-OECD-Report-G7-Environment-Ministers.pdf

120 "Employment Implications of Green Growth," June 2017, OECD, https://www.oecd.org/environment/Employment-Implications-of-Green-Growth-OECD-Report-G7-Environment-Ministers.pdf

121 Villani, M., "University of Calgary suspends admission for oil and gas engineering program," July 8, 2021, CTV News, https://calgary.ctvnews.ca/university-of-calgary-suspends-admission-for-oil-and-gas-engineering-program-1.5502133

Equity and Fairness as Jobs Change

A transition to a green economy will not happen overnight. There will be winners and losers throughout the process, and it is important that the transition does not exacerbate existing inequalities. Losses will need to be mitigated and success distributed equitably. The Mowat Centre suggests that "any negative impacts associated with [the green] transition need to be identified, mitigated, and managed."[122] Ensuring that career changes are possible and that new jobs are created is necessary, but it is also important that these jobs are high quality. According to Innovating Canada, "Canadian cleantech jobs have an average annual salary of between $80–$90,000. These are good jobs and pivoting to a cleantech-driven economy will create more of them."[123]

Workers' rights and environmentalism go hand-in-hand, in many cases. Arif Jetha et al. write that "climate change and related extreme weather events (e.g., wildfires, droughts) are anticipated to contribute to the forced migration of workers, damage to workplaces, lost productivity, and impact worker health and safety,"[124] and add that "certain groups of workers may be most affected by climate change, including those from racialized or Indigenous communities, youth and young adults, older adults, and those with low socioeconomic status."[125] A just transition to a green economy will thus entail a future of work that protects labour interests and vulnerable groups.

Decentralization and the "Unbundling" of Work

Offices are spreading out—notably by way of remote work but also due to the increasing reliance on contractors and consultants. The vast majority of working documents are now stored on the "cloud" rather than in filing cabinets. At the same time, work is "unbundling"—becoming increasingly task-based, shifting away from long-term arrangements[126] and less standard hours[127] These are major themes in the future of work with subtle yet growing influences on the green economy. Remote work has potential to limit greenhouse gas emissions by reducing travel,[128] yet the emissions of remote work depend on a variety of factors,[129] including less efficient energy use in homes.

122 Thirgood, J. et al., "Decent Work in the Green Economy," 2017, Mowat Centre and Smart Prosperity Institute, https://munkschool.utoronto.ca/mowatcentre/wp-content/uploads/publications/156_decent_work_in_the_green_economy.pdf

123 Jackson, J. and Switzer, J., "Thinking of a New Career? Think Cleantech," 2020, Innovating Canada, https://www.innovatingcanada.ca/environment/thinking-of-a-new-career-think-cleantech/#

124 Jetha, A. et al., "Fragmentation in the future of work: A horizon scan examining the impact of the changing nature of work on workers experiencing vulnerability," March 2021, Wiley, https://onlinelibrary.wiley.com/doi/epdf/10.1002/ajim.23262

125 Jetha, A. et al., "Fragmentation in the future of work: A horizon scan examining the impact of the changing nature of work on workers experiencing vulnerability," March 2021, Wiley, https://onlinelibrary.wiley.com/doi/epdf/10.1002/ajim.23262

126 May, K., "Five game changers that could shape the future of work," December 2019, Policy Options, https://policyoptions.irpp.org/magazines/december-2019/five-game-changers-that-could-shape-the-future-of-work/

127 Messenger, J., "Working time and the future of work," 2018, International Labour Organization, https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms_649131.pdf

128 Morisette, R. et al., "Working from home: Potential implications for public transit and greenhouse gas emissions," April 2021, Statistics Canada, https://www150.statcan.gc.ca/n1/pub/36-28-0001/2021004/article/00005-eng.htm

129 Guerin, T., "Policies to minimize environmental and rebound effects from teleworks: A study for Australia," June 2021, Science Direct, https://www.sciencedirect.com/science/article/abs/pii/S2210422421000034

Urban transformations caused by fewer people working in central business districts have potential to influence emissions and land use as well, though these impacts are not yet clear. Similarly, digitization has lessened the need for paper and storage of documents—yet also increased energy demand.[130] One version of "unbundled" work is the platform economy. A successfully functioning platform economy has potential to allocate resources more effectively and sustainably (for example, by simplifying car-sharing). At the same time, the platform economy can also drive additional consumption.[131]

Key Issues and Policy Considerations

There are a range of policy considerations that influence the green economy and the future of work—in some cases independently, in some cases simultaneously. The ILO advocates for policies that benefit green growth alongside jobs and a healthy economy, supporting "a policy mix comprising cash transfers, stronger social insurance, and limits on the use of fossil fuels,"[132] adding that such policies "could lead to faster economic growth, stronger employment creation and a fairer income distribution, as well as lower greenhouse gas emissions."[133] The OECD, meanwhile, targets three policy areas to support labour markets and a green transition:[134]

Several policies that support a green economy while creating jobs are already in place in Canada. Canada's Clean Fuel Standard is expected to "create up to 31,000 jobs in clean fuels by 2030 and eliminate 30 megatons of pollution." Another is British Columbia's Carbon Tax. The OECD cites this as an example of an environmental tax that simultaneously reduces carbon emissions and increases employment, noting that between 2008 and 2011 (the three years after the implementation of the tax), per capita GHG emissions declined by 10% in BC, which represented a 19% reduction in emissions when compared to the per capita fossil fuel consumption in the rest of Canada.[136] Of course, green policies that are able to support job creation are better than ones that cannot, but the ILO suggests that green jobs themselves can also be drivers of change: "jobs, and particularly green jobs, can act as a catalyst for the transition to a green economy, and can be considered a policy objective in themselves."[137]

130 "The growing footprint of digitalization," November 2021, UN Environment Programme, https://wedocs.unep.org/bitstream/handle/20.500.11822/37439/FB027.pdf

131 Pouri, M. and Hilty, L., "The Relevance of Digital Sharing Business Models for Sustainability," 2020, https://www.ifi.uzh.ch/dam/jcr:4abc7924-4c3f-4bf3-9302-ba6abaae01f0/2020_Pouri_Hilty_Relevance_of_Digital_Sharing_Busiess_Models_for_Sustainability.pdf

132 "Greening with jobs: World Employment Social Outlook 2018," 2018, International Labour Organization, https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_628654.pdf

133 "Greening with jobs: World Employment Social Outlook 2018," 2018, International Labour Organization, https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_628654.pdf

134 "Greening Jobs and Skills," 2021, OECD, https://www.oecd.org/greengrowth/greening-jobs-skills/greeningjobsandskills.htm

135 "The Fast Lane: With smart policy, Canada's clean energy sector is poised for rapid growth as fossil fuels slow down," October 2019, Clean Energy Canada, https://cleanenergycanada.org/wp-content/uploads/2019/10/Report_TER2019_CleanJobsFuture_20191001_FINAL.pdf

136 "Employment Implications of Green Growth," June 2017, OECD, https://www.oecd.org/environment/Employment-Implications-of-Green-Growth-OECD-Report-G7-Environment-Ministers.pdf

137 "World Employment and Social Outlook 2018: Chapter 2. Employment and the role of workers and employers in a green economy," 2018, International Labour Organization, https://www.ilo.org/weso-greening/documents/WESO_Greening_EN_chap2_web.pdf

Education diffusion and the reallocation of workers from declining to growing jobs. Qualified workers are necessary to fill roles in the green economy, and workplace training programs are one way to build an appropriately skilled workforce while also building strong industry-education partnerships. The government of Canada offers work-integrated learning funding for green jobs across five unique training and employment subsidy programs.[138,139] Other possible educational policies that could develop a strong green workforce include increased funding for green economy programs at traditional educational institutions, supporting an adaptive workforce with upskilling and reskilling (particularly for displaced workers), and supporting lifelong learning (for example through subsidies for employers). Interviewees noted that nearly all industries are demonstrating increased demand for soft skills—often also called transferable skills—which may facilitate career switching. Finally, training programs must be responsive to evolving industry and labour demands.

Support green tech innovation and diffusion through investments and innovation incentives. The idea that sustainability and good jobs are at odds with each other is a false dilemma. Policies that support both simultaneously are not only possible, they are necessary. Further, there is growing appetite for investment in Canada's green economy, and green jobs. Such investments are more popular in Canada than any other G20 country except for the UK.[140] In May 2021, the federal government announced "investments of $44.3 million in 11 Canadian cleantech companies that are leading breakthrough Canadian cleantech innovations,"[141] noting that "Canadian cleantech innovation will be the driving force behind our green economic recovery. It will not only create thousands of good jobs but also help build a sustainable future."[142]

138 "Green jobs in natural resources," 2022, Natural Resources Canada, https://www.nrcan.gc.ca/climate-change/canadas-green-future/green-jobs/87

139 "ECO Employment Programs," 2021, ECO Canada, https://eco.ca/environmental-professionals/employment-funding-and-job-board/apply-for-job-funding/

140 Jaganmohan, M., "Support for investment in the green economy among G20 countries 2020," October 29, 2021, Statista, https://www.statista.com/statistics/1201304/popularity-more-investment-green-economy-jobs-g20-countries/

141 "Government of Canada supports cleantech innovation and jobs growth across the country," May 27, 2021, Government of Canada, https://www.canada.ca/en/innovation-science-economic-development/news/2021/05/government-of-canada-supports-cleantech-innovation-and-jobs-growth-across-the-country.html

142 "Government of Canada supports cleantech innovation and jobs growth across the country," May 27, 2021, Government of Canada, https://www.canada.ca/en/innovation-science-economic-development/news/2021/05/government-of-canada-supports-cleantech-innovation-and-jobs-growth-across-the-country.html

The Human Side of Tech

What is the Human Side of Tech?

Technology is increasingly pervasive and influences our day-to-day lives in myriad ways. As a result, it is held accountable for harms such as the erosion of democracy but also societal breakthroughs such as vaccine development, space exploration, and global communication. Whether technological determinism—the idea that technological development determines a society's social and cultural outcomes—is true or not, it is clear that the "human" dimensions of technology matter. When considering the relationship between tech and more social or cultural phenomena, a few topics are key:

- **Creating tech responsibly:** technological innovation for the sake of innovation has potentially harmful ramifications. The recent the "tech backlash" also highlights the growing public dissatisfaction with the prioritization of profit or growth at the expense of people.
- **Limiting tech harms:** recently, technology's negative consequences on the environment, privacy, democracy, equity, and social belonging have surfaced. Yet, these issues stem partly from inappropriate or unhealthy use of technology, and like other advances that carry potential harms, regulations, standards, and incentives can help to prevent or mitigate adverse consequences.
- **Capitalizing on tech benefits:** technology has many positive externalities and can be designed to improve the world—green economy examples range from technology for carbon capture, use, and storage to apps that educate users about their carbon footprint. Encouraging technological development that benefits humans and the environment is crucial.
- **Public engagement and user-centred design:** individual technological inventions can have significant social impacts. To ensure that these impacts are societally beneficial, public engagement and consultation is needed. Similarly, user-centred design—meaning design that focuses on the needs and experiences of those using a technology—has become a core aspect of technological innovation.
- **Equity, Diversity, and Inclusion (EDI):** some technologies are accessible only to certain people (for example expensive electric cars), while others can disproportionately harm distinct segments of the population (for example facial recognition). Technologies should be built with the end user in mind and advance and uphold the principles of EDI.

How Does the Human Side of Tech Relate to the Green Economy?

Key considerations for the green economy are ecological, but they are also human. Research by the Green Economy Coalition suggests that "policymakers continue to put forward technocentric green economy solutions centred on the provision of green technology and finance, without deeper engagement with the social dimensions of a green economy transition."[143] A healthy environment—and society—requires technology and technology policy that is ethically created with attention to users and social impact at its core.

Public Input and Democratization

In the early 2000's, techno-optimists readily claimed that "Web 2.0" would spur user-generated content and advance participation and democratization. The appeal of enhanced democracy supported by new technology platforms is now stronger, particularly as environmental degradation becomes more pressing. Public input will be necessary in the green economy. The OECD writes that "vulnerable groups may have a considerable stake in the success of green polices as direct beneficiaries since they bear a disproportionate share of the health costs of air pollution and climate change,"[144] while citizen-led dialogues have been described as an "effective way to mainstream inclusion through all stages of the policy cycle."[145] Ideally, technology can serve to promote, rather than inhibit democratic processes, allowing "the adoption of smart solutions by public administrations that involves citizens in local planning [and] facilitates a democratic and collaborative process."[146]

Operating at the Local Level

Technological development can occur on a global scale—including via multinational tech companies and international research partnerships. Similarly, climate change is a global problem. Yet many of the immediate challenges associated with it are experienced at the local level. For example, extreme weather in British Columbia (including excessive wildfires and floods accelerated and intensified by climate change) forced thousands of people from their homes twice in 2021. This is a clear reminder that global actions can have very specific local consequences. At the same time, potential solutions can occur locally as well.

143 Mohamed, N., "Inclusion Matters: Policy insights and Lessons from the Green Economy Coalition's national dialogues," July 2020, Green Economy Coalition, https://www.greeneconomycoalition.org/assets/reports/GEC-Reports/GEC-Inclusion-Paper-Najma-July-2020-WEB-Final.pdf

144 "OECD Green Growth Papers," March 2021, OECD, https://www.oecd-ilibrary.org/docserver/ca9d8479-en.pdf

145 Mohamed, N., "Inclusion Matters: Policy insights and Lessons from the Green Economy Coalition's national dialogues," July 2020, Green Economy Coalition, https://www.greeneconomycoalition.org/assets/reports/GEC-Reports/GEC-Inclusion-Paper-Najma-July-2020-WEB-Final.pdf

146 "SDGs, the green economy and open source tech: bringing sustainability to the forefront of business," March 10, 2021, 17 Global Goals, https://17globalgoals.com/sdgs-the-green-economy-and-open-source-tech-bringing-sustainability-to-the-forefront-of-business/

The Green Economy Coalition notes that "transformative green economy policy agendas are often incubated at local and state levels rather than always starting in central government."[147] Further, the unique attributes of certain areas or communities mean that local solutions are sometimes necessary even for global challenges.

Global Inequality and Development Considerations

Despite the importance of local solutions in technology development and the green economy, international considerations matter as well. Developing countries disproportionately face the consequences of climate change, are less able to reap the benefits of technological development, and often have little say in either matter. The International Institute for Environment and Development writes that "the green economy (particularly a technology-led one) potentially risks ignoring the poor, for example, those in informal sectors and developing countries."[148] In the words of one interviewee:

> *The extremes in our society of both education and economic wherewithal are unnecessary and impede our ability to get to a green economy.*

The case of e-waste is a powerful example of the need to remain attuned to the social impacts of technology and the green economy: in e-waste dumps, located largely in developing countries, informal workers extract "precious metals such as gold from computer chips and copper from cables by burning the devices or using toxic chemical baths."[149] Doing so leads to exposure to "dangerous chemicals such as mercury, lead, dioxins, and flame retardants."[150] E-waste has grown by 21% in the last five years, and is expected to continue to grow, while it continues to be transported from high to low-income countries.[151] Similarly, many precious metals are critical components of technology,[152] yet mining for these metals has been associated with human rights abuses, largely in developing countries.[153,154]

147 Mohamed, N., "Inclusion Matters: Policy insights and Lessons from the Green Economy Coalition's national dialogues," July 2020, Green Economy Coalition, https://www.greeneconomycoalition.org/assets/reports/GEC-Reports/GEC-Inclusion-Paper-Najma-July-2020-WEB-Final.pdf

148 Benson, E. et al., "Informal and Green? The forgotten voice in the transition to a green economy," March 2014, https://pubs.iied.org/16566iied

149 "Children and digital dumpsites: E-waste exposure and child health," 2021, World Health Organization, https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/9789240023901-eng.pdf

150 "Children and digital dumpsites: E-waste exposure and child health," 2021, World Health Organization, https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/9789240023901-eng.pdf

151 "Children and digital dumpsites: E-waste exposure and child health," 2021, World Health Organization, https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/9789240023901-eng.pdf

152 Dennehy, K., "Study: Metals Used in High-Tech Products Face Future Supply Risks," March 2015, Yale School of the Environment, https://environment.yale.edu/news/article/metals-used-in-hightech-products-face-future-supply-risks

One interviewee highlighted the need to keep track of the materials and production history of products to avoid issues like these:

> *It's important to know how stuff is produced, if it comes from a source that, for instance, doesn't accept socially damaging practices, child labor, or deforestation. So the transparency on the origins of the product [is necessary].*

– Interviewee

Identity

Factors such as race, gender, and income status can influence how people experience technology, environment degradation, and access to the green economy and its benefits. It is also necessary to consider the role of intersectionality—the understanding that "everyone has their own unique experiences of discrimination."[155] Income can influence experiences of climate change and access to technology. For example, the use of air conditioners in Canada varies according to household income.[156] Worldwide, women are often excluded from green economy leadership and high-growth occupations. The OECD notes that "barriers to female entrepreneurship may constrain women's participation in the renewable energy sector, an area that is expected to expand considerably in the green transition."[157] Women account for less than a quarter of the renewable energy sector and occupy roles that are "mostly lower-paid non-technical, administrative, and public relations positions."[158] Perceptions of tech and the green economy may differ according to identity as well.

Key Issues and Policy Considerations

Policies that consider the green economy, technology, and a range of social factors simultaneously are considered by many to be a good response to the COVID-19 pandemic. The OECD writes that "recovery efforts to 'build back better' [from COVID-19] must be both green and people-centred, and consistent with the objectives of the Paris Agreement and the 2030 Agenda for Sustainable Development."[159] Aspects of policy that are likely to influence both people-centred technology and green growth include data and measurement, immigration policy, a focus on "just transitions," and technology transfers.

155 Taylor, B., "Intersectionality 101: what is it and why is it important?" November 2019, Womankind Worldwide, https://www.womankind.org.uk/intersectionality-101-what-is-it-and-why-is-it-important/

156 "Summertime control of temperature in Canadian homes: How Canadians keep their cool," November 2015, Statistics Canada, https://www150.statcan.gc.ca/n1/pub/16-002-x/2011002/part-partie3-eng.htm

157 "The inequalities-environment nexus: Towards a people-centred green transition," 2021, OECD, https://www.oecd-ilibrary.org/docserver/ca9d8479-en.pdf

158 Baruah, B. and Gaudet, C., "Creating and Optimizing Employment Opportunities for Women in the Clean Energy Sector in Canada," May 2018, Smart Prosperity Institute, https://institute.smartprosperity.ca/sites/default/files/baruahksgfinalreportmay2018-kss.pdf

159 "The inequalities-environment nexus: Towards a people-centred green transition," 2021, OECD, https://www.oecd-ilibrary.org/docserver/ca9d8479-en.pdf

New Indicators, Measurements, and Incentivizing Data Collection

An effective green transition and long-term green economy requires quality data and measurement. Data collection, evaluation, and comparison ensures that policies are evidence-based and their impacts can be measured across time. The OECD writes that "indicators that capture the intersectionality of environmental and social challenges are needed, such as more accurate and timely information on how different demographic groups, workers and territories are affected by the environmental degradation."[160] As one interviewee noted:

> *"[a lack of available data] really limits our ability on the public policy side to help identify problems or gaps and respond more immediately to them, and because changes are happening quite quickly globally. You need to have that data availability to really be best informed and make decisions on it.*
>
> – Interviewee

The OECD Wellbeing, Inclusion, Sustainability, and Equal Opportunity (WISE) Centre is responding to the need for more intersectional indicators by creating new ways to measure and improve people's wellbeing beyond GDP:

> *Using innovative methodologies and new data, WISE is investigating what drives [people's] wellbeing beyond GDP. Improved statistical measures at more granular levels are being used to fill the gap between standard macroeconomic statistics and indicators that have a more direct bearing for people's lives. Building on the pioneering OECD Wellbeing Framework and other OECD tools, WISE is developing guidelines and improving the metrics used to assess more accurately the inclusiveness and quality of workplaces and jobs, environmental quality, subjective wellbeing, trust, safety, and many other important aspects of our lives.*[161]
>
> – Interviewee

A Focus on Just Transitions

The "Just Transition," in the words of the European Commission, is "a key tool to ensure that the transition toward a climate-neutral economy happens in a fair way, leaving no one behind."[162] At its core, policies for a just transition give consideration to communities and individuals that face disproportionate harms from climate change, and also to those who face potential losses amid transitions to a green economy.

160 "The inequalities-environment nexus: Towards a people-centred green transition," 2021, OECD, https://www.oecd-ilibrary.org/docserver/ca9d8479-en.pdf

161 "Centre on Wellbeing, Inclusion, Sustainability and Equal Opportunity (WISE)," Accessed February 2022, OECD, https://www.oecd.org/wise/

162 "The Just Transition Mechanism: making sure no one is left behind," 2022, European Commission, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism_en

One component of this, discussed in detail in the Future of Work section, entails a focus on workers, providing them with resources (such as upskilling opportunities), a say over how green economy transitions occur, efforts to minimize hiring barriers, and quality job opportunities.[163] Additionally, industrial policy must aim to support a equitable green transition. As Tamara Krawchenko and Megan Gordon write for the IRPP, "efforts to reinvent industries must build in resiliency and consider longevity and sustainability in every sense of the word."[164] Such efforts must entail industrial policy that considers long-term impacts and avoids short-term political motivations.

Global Technology Transfer

Numerous technologies exist that enhance efficiency and reduce harm to the environment. Blockchain, for example, has potential to certify green energy production by small independent producers who want to sell that energy (i.e., owners of solar power). Open-source software can integrate multiple energy sources for greater efficiency, and smart technologies can use data to "nudge" citizens to make environmentally responsible choices. The green economy cannot benefit from technology research and development without technology diffusion. Unfortunately, just because a technology exists does not necessarily mean that it will be adopted. Further, research suggests that "the effectiveness of different climate policies depends on the type and strength of [technological] diffusion barriers."[165] In the words of one interviewee, "the main issue isn't about the development of those technologies; it's more about the deployment.

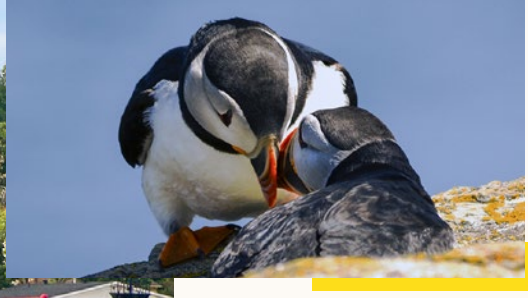
Technology diffusion is also an issue of international coordination. So long as more technologies are developed and used in wealthy countries, global inequalities will persist in the green (and digital) economy. This raises the challenge of ensuring that green economy benefits are realized by all countries. As David Popp writes for the World Bank, "Many of the fixed costs of technology development have already been paid by developed countries. Thus, in many cases, it is the transfer of these technologies to developing countries that is important."[166] Methods to enable successful technology transfers could entail international agreements (for example, as part of climate accords), or direct investment in technology development in poorer countries.

163 Markova, A., "Want to know what a just transition to a green economy looks like? Ask the workers," October 18, 2021, The Guardian, https://www.theguardian.com/commentisfree/2021/oct/18/just-transition-green-economy-workers-resources-empowerment

164 Krawchenko, T. and Gordon, M., "Five lessons for managing a just transition from environmentally destructive industries," August 25, 2021, https://policyoptions.irpp.org/magazines/august-2021/five-lessons-for-managing-a-just-transition-from-environmentally-destructive-industries/

165 Hotte, K., "How to accelerate green technology diffusion? Directed technological change in the presence of coevolving absorptive capacity," November 2019, Energy Economics, https://www.oxfordmartin.ox.ac.uk/downloads/GreenTechDiffusionKH.pdf

166 Popp, D., "The Role of Technological Change in Green Growth," October 2012, The World Bank, https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/Role_of_technological_change%20in%20gg_Ggkp.pdf



Intelligent Communities

Defining “Smart Cities” and “Intelligent Communities”

Data and technology are increasingly central to public sector solutions, a domain of market activity often referred to as “smart cities.” While there are numerous definitions for the term smart cities, many involve an inherent bias toward large, urban contexts, and an emphasis on the commercial aspects of technology. Growing interest in technology-based solutions among smaller communities signals the need to transition to a broader and more inclusive term such as “intelligent communities.”

Through an administrative lens, municipalities represent practical services that matter in our everyday lives: water and wastewater, garbage collection, transit, roads, and public health. But the concept of a municipality deserves broadening to understand how to reduce market friction and maximize utility and value. Municipalities include communities and local neighbourhoods. They include sports and recreation centres, parks, barbecues, and friends and families. Often, communities exist outside typical municipal corporate structures and include residents not just citizens. Furthermore, they include Indigenous representation defined by geographic boundaries but that also transcend geography. Over decades, communities have developed sophisticated approaches and social norms for protecting Indigenous data sovereignty. The economic and social patterns within municipalities and communities are not simplifying over time but rather becoming layered and more complex.

Some aspects of commercial strategy influence policy decisions at all levels of government, however, the current paradigm is being challenged by communities and residents, confusing commercial markets. Accordingly, Canadian firms face a number of new questions: How do public sector markets work? How do public markets and commercial innovation collide in clean technology and environmental domains? What does a “city as platform” mean, what is data governance, and how do these systems influence product development cycles in the new green economy? The global speed of commercial innovation is bumping up against the glacial nature of “community time” and the natural capacity limits of local governments and communities. Smart cities approaches can no longer be purely commercial solutions based on large urban markets.

With inherent local connections, communities often express individual and group identity with greater strength than other types of political identification or geographic boundary. Only when the concept of open smart cities is advanced—or the definition of "smart cities" is broadened to include municipalities of all sizes, and inextricably linked to community—can policy makers and innovators unlock the full opportunity and impact of "smart." The made-in-Canada, open smart city approach provides a new understanding of how shared value can be unlocked along a redefined, smart cities and green economy innovation value chain.

Communities and policy makers are rethinking and redefining "smart cities" through the lens of shared value and the concept of "openness" in public sector markets. Increasingly, national and regional markets have placed a greater emphasis on combining ICT with social innovation at the community level. "Open smart cities" is a Canadian-born concept and framework that emerged from multi-sectoral collaboration and codesigned solutions, which allow for language, concepts, and place-based approaches to bridge sectoral divides and influence new forms of shared value creation inside and outside Canada's green economy.[167]

Intelligent Communities and the Green Economy

Considering open and shared value, how do intelligent communities relate to the green economy? Historically, limited effort has been made to gather empirical evidence about smart cities trends or practical methodological barriers, including a clear lack of sectoral and/or policy alignment on the definition and operationalization of the smart cities concept. It is relatively easy, however, to conclude that communities will continue to play an essential role in tackling the wicked problem of climate change and environmental degradation. Furthermore, communities will increasingly employ smart cities or data and technology approaches to maximize impact in numerous environmental and innovation domains, across tech-related sectors, as well as many others.

Since early 2019, Evergreen Canada[168] and Open North[169] have collaboratively developed and delivered several pan-Canadian municipal advisory services and capacity supports. These activities were designed to run in alignment with the Government of Canada's Smart Cities Challenge but were also created to advance broad capacity gains across community sectors. They are focused on accelerating place-based solutions and social and ICT innovation and impact. Together, intake data from Evergreen's *Future Cities Canada*[170] and Community Solutions program, and application data from the Government of Canada's Smart Cities Challenge provide tentative insight into possible national "smart cities" trends.

167 Open Smart Cities Guide, Open North, Version 1.0, 2018.

168 For information about Evergreen Canada see www.evergreen.ca

169 For information about Open North see www.opennorth.ca

170 Future Cities Canada is a sub-brand identity of Evergreen Canada, capturing a nation suite of urban innovation programs. For information about Future Cities Canada see www.futurecitiescanada.ca

Evergreen Canada's Innovation Library is a collection of smart city solutions implemented by communities across Canada from 2019 to 2021. These solutions are displayed in Table 7 as either "data and technology solutions," which mostly constitute tech-related smart cities projects and approaches, or "administrative solutions," which are defined as government or community innovations, such as data literacy labs or new and effective forms of governance. Currently, Evergreen's Innovation Library has documented over 190 community solutions and covers a wide variety of sectors. Of these, approximately 16% focus specifically on environmental areas and solutions. A cautious extrapolation based on the tables above provides a couple of general considerations that may warrant further research or discussion (discussed further in the Key Issues and Policy Considerations section below).

Smart Cities Challenge, Competition One, April 2018: Focus Areas Identified by Applicants

Empowerment and Inclusion	**31%**
Economic Opportunity	**23%**
Environmental Quality	**13%**
Healthy Living and Recreation	**13%**
Mobility	**12%**
Safety and Security	**8%**
Total	**100%**

N.B. This data can be found in a (one page) Smart Cities Challenge document that was distributed publicly during 2018-2019. The descriptions were based on 225 participating communities and 130 eligible applications. Twenty-five of the applications represent Indigenous communities or are focused on Indigenous populations.

Table 7. Smart Cities Challenge applications by focus areas. **Source:** "Smart Cities Challenge," April 2018, Government of Canada, publicly distributed leaflet accessed in April 2018.

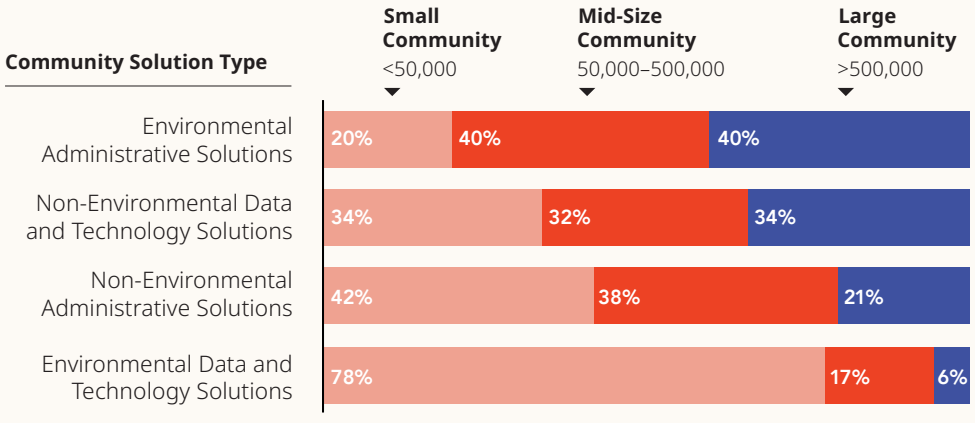


Figure 7. A summary of Evergreen Canada's Innovation Library's smart cities focus areas. **Source:** Evergreen Canada's Innovation Library, Environmental & Non-Environmental Solutions by Community Size, 2019-2021.

Key Issues and Policy Considerations

In the context of both the national challenge program and Evergreen Canada's innovation capacity support services, communities tend not to prioritize the environment when approaching innovation priorities and smart cities solutions. The environment is indeed a focus area of significance but not of prominence, registering at 13 percent in Table 3, and 16 percent in Evergreen Canada's Innovation Library. While there are numerous other factors and methodological considerations that can contribute to understanding this data, there are few comparable data sets in Canada: the current description provides a provisional snapshot for practitioners and policy makers to weigh, given other qualitative and quantitative research that may emerge in the future. Further, in Table 4, one interesting trend is apparent and further substantiated by Evergreen Canada's matchmaking and event-based program activities: **smaller communities across Canada are looking to data and technology solutions more to help solve environmental challenges.**

Future work in the intelligent communities space could seek to clarify why communities prioritize other outcomes, such as empowerment and inclusion or economic opportunity over environmental quality when undertaking smart cities projects. Is it a matter of competing priorities or do budget constraints, jurisdictional conflicts, or other barriers prevent communities from pursuing environment-focused initiatives? Similarly, future work could clarify why smaller communities are more likely to use data and technology for environmental outcomes. While a large portion of smart cities research to date has focused on the impact of technology on municipalities and large urban cores, communities of all sizes are using technology to achieve policy outcomes. Importantly, smaller or more rural communities may be financed differently, have different priorities, or face different types of policy challenges.

According to Evergreen Canada's impact and performance data, there has been an increase in the number of communities participating in place-based innovation programs since the onset of the COVID-19 pandemic. Evergreen Canada's working theory explaining the increase of participation in its place-based innovation programs relates to a potentially heightened, mission-critical demand by local governments and Indigenous communities to increase their capacity and broad competencies required for virtual and online service delivery during this time of ongoing crisis. The implications for Canada's green economy may mean greater attention to custom, place-based considerations when tailoring commercial or public sector solutions to climate change and environmental problems.

However, to advance such solutions, Canada will need to address any capacity and skills bottlenecks that exists between national priorities and local capacity. Further, participation in place-based, green economy solutions cannot be exclusive to large urban centres. Communities of all sizes need to be included in this work. One way to support skills development and grow capacity in local governments would be establishing a centre of excellence to mobilize research, development, and talent related to place-based solutions, including those directed at the environment and climate change. Key to this effort is answering fundamental questions at the intersection of smart communities and the environment: how do you design, build, and maintain climate-ready assets and infrastructure, and how do you best apply smart cities solutions?

Trade and Investment

66

It's important for investors, especially those who oversee long-term pension funds, to try and find alternatives to fossil fuel investments because there's a big movement toward the divestment of those. The money that is being freed up needs to go somewhere else, and a circular economy seems like a very attractive proposition at the moment. 99

– Interviewee

The Importance of Trade

Trade is the process of buying and selling goods and services, within the construct of imports and exports. For years, Canada has been one of the world's foremost trading nations. Canadian trade takes place within its borders—interprovincial and territorial trade—and internationally. Canada has numerous global trading partners, but most trade focuses on 20 key countries and regions. The United States represents Canada's foremost trading partner, followed by the European Union, China, Mexico, and Japan.

International trade and collaboration is cornerstone to Canadian economic policy. Despite recent global complications accentuated by the pandemic, trade plays a pivotal role in the Canadian economy, representing approximately one-third of GDP.[172]

By and large, Canada has benefited from making trade and investment foundational pillars of the economy and has benefited from some of the most influential free trade agreements (FTAs) in the world. While not without its challenges, NAFTA for example, lasted for more than 20 years, and produced benefits for Canada not previously possible: it opened new markets, enhanced labour mobility and access to skilled talent, and was instrumental in growing the economy. According to Global Affairs Canada, trilateral trade of merchandise (between Canada, the US, and Mexico) increased more than three-fold since 1993.[173] Another key FTA, the Comprehensive Economic and Trade Agreement (CETA) offers preferential access to the European Union's $17 trillion market.

172 "Canadian international merchandise trade, December 2020," February 5th, 2021, Statistics Canada, https://www150.statcan.gc.ca/n1/daily-quotidien/210205/dq210205b-eng.htm

173 "North American free trade agreement (NAFTA) – Resources," March 4th, 2021, Government of Canada, https://www.international.gc.ca/trade-commerce/consultations/nafta-alena/toolkit-outils.aspx?lang=eng

The benefits of FTAs do not end with economies of scale and a broader market for imports and exports. According to the OECD, trade and FDI are inherently linked, and mutually influential: until the mid-1980s, increased trade was found to influence and boost investment; 1985-onward, this relationship flipped, and a growth in investment was found to be a key pillar of growth in trade. According to a study by the OECD on this matter, data from 14 different countries identified that "each dollar of outward FDI [from investing countries] produces about two dollars' worth of additional exports."[174]

The Importance of Investment

Investment can and does take on numerous forms in Canada. It includes investments made by Canadians in the free market (via purchasing, trading, selling stocks and other equity); venture capital investments, often made by larger firms and institutions into smaller companies (helping with aspects like R&D, commercialization, and market penetration); angel investments, made by individuals who provide capital for small businesses in exchange for equity; and FDI. Although all types of investments are important to the Canadian economy, FDI is the most significant contributor. As one of the world's top destinations for this type of investment, Canada relies on FDI to boost economic performance and offer high-quality labour opportunities to Canadians. While just 1% of companies in Canada are foreign multinational corporations, they support 12% of employment, 15% of GDP, and 60% of trade in goods and services.[175] Moreover, this investment goes far beyond purely economic and labour market output; it boosts free market activity and plays a central role in the exchange of ideas that spur innovation.

Greenfield and brownfield are distinct types of FDI. Greenfield FDI is tied to the building of new infrastructure to support an investment activity. For example, in 2021, Sanofi announced that it would build a new vaccine facility in Toronto, boosting the country's production of influenza vaccines.[176] Brownfield FDI, by comparison, involves leveraging existing infrastructure to support investment activity. For example, in 2019, Amazon announced that it would take over 18 floors in the existing Canada Post building in Vancouver to house 3,000 workers.[177]

174 "Foreign Direct Investment and International Trade: Complements or Substitutes?" October 14, 1999, OECD, https://www.oecd-ilibrary.org/docserver/788565713012.pdf?expires=1642951126&id=id&accname=guest&checksum=D9916A6C4121AFAC0593A03A7BA41DC3

175 "State of Trade 2021 - A Closer Look at Foreign Direct Investment (FDI)," June 30, 2021, Government of Canada, https://www.international.gc.ca/transparency-transparence/state-trade-commerce-international/2021.aspx?lang=eng

176 "Sanofi to build new facility in Canada to increase global availability of high-dose influenza vaccine," March 31, 2021, Sanofi, https://www.sanofi.com/en/media-room/press-releases/2021/2021-03-31-16-05-00-2202566

177 Evan Duggan, "Amazon to take over entire former Canada Post building in downtown Vancouver," December 10, 2019, Vancouver Sun, https://vancouversun.com/business/commercial-real-estate/commercial-real-estate-amazon-to-take-over-entire-former-canada-post-building

Trade and Investment in the Green Economy

Understanding the interconnected relationship between trade and investment is key to sound economic strategy and policies that maximize it. As a result, countries around the world are increasingly thinking beyond traditional aspirations of GDP growth at all costs. Many are crafting and implementing "green transition" economic policies, including new priorities for trade and investment. Canada's closest allies and partners are no different. The European Green Deal,[178] the US Climate Action Plan,[179] and the Japanese Green Growth Strategy[180] are just a few examples of how Canada's most significant trade partners and investors are rooting future prosperity in environmental wellbeing. Although Canada has successfully positioned itself as one of the world's foremost trading nations and a top investment destination, it must now refine this reputation by boosting the export of green products and services and becoming a top destination for green investment.

With international trade representing roughly one-third of the Canadian economy, FTAs are a clear area of focus. Similarly, although FDI to Canada shrank significantly in 2020 during the pandemic, the previous year (2019) saw the biggest boost in FDI in years, with more than $67 billion invested into the Canadian economy (up nearly 20% year-over-year) across more than 350 projects spanning nine provinces.[181] Together, this accounted for nearly 3% of Canadian GDP.[182] FDI is a central contributor to economic output and jobs in Canada, and boosting investment is essential to recharge the Canadian economy as it eases out of the pandemic. Canada's overarching green transition strategy must blend the need for economic stimulus via trade and investment, environmental wellbeing and a steady commitment to tackle climate change.

From Catastrophe to Opportunity: Greening the Fiscal Future

The COVID-19 pandemic caused the deepest economic recession in modern times,[183] surpassing that of the 2008-09 recession. Global GDP sank by 3.5%, and Canada followed suit, dropping by 5%.[184]

178 "A European Green Deal," 2022, European Commission, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

179 "FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies," April 22, 2021, The White House, https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/

180 "Japan's Green Growth Strategy Will Accelerate Innovation," September 16, 2021, Government of Japan, https://www.japan.go.jp/kizuna/2021/09/green_growth_strategy.html

181 "By the numbers: FDI in Canada," 2019, Invest in Canada, https://fdi2019.investcanada.ca/by-the-numbers

182 "Foreign direct investment: Inward and outward flows and stock, annual Table," 2022, United Nations Conference on Trade and Development, https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=96740

183 "COVID-19 to Plunge Global Economy into Worst Recession since World War II," June 8, 2021, World Bank, https://www.worldbank.org/en/news/press-release/2020/06/08/covid-19-to-plunge-global-economy-into-worst-recession-since-world-war-ii

184 "GDP Growth (annual %) – Canada," 2022, World Bank, https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=CA

Industries	2008-2009	2014-2015	2019-2020
All industries	-3.2%	0.8%	-5.2%
Agriculture, forestry, fishing and hunting	-5.1%	4.4%	5.6%
Mining, quarrying, and oil and gas extraction	-10.5%	-2.8%	-8.5%
Utilities	-4.8%	0.5%	-2.4%
Construction	-6.1%	-2.3%	-3.3%
Manufacturing	-13.8%	0.6%	-10.0%
Wholesale trade	-6.8%	-3.3%	-2.4%
Retail trade	-2.4%	-0.1%	-3.3%
Transportation and warehousing	-3.6%	2.6%	-19.8%
Information and cultural industries	-1.3%	2.1%	-1.9%
Finance and insurance	-1.0%	4.9%	4.9%
Real estate and rental and leasing	2.8%	3.0%	1.5%
Professional, scientific and technical services	-2.5%	-0.3%	-2.7%
Management of companies and enterprises	-0.2%	4.1%	-14.0%
Administrative and support, waste management and remediation services	-4.4%	1.9%	-12.6%
Educational services	1.5%	1.2%	-5.4%
Health care and social assistance	2.3%	1.4%	-5.8%
Arts, entertainment and recreation	-0.5%	1.8%	-42.6%
Accommodation and food services	0.7%	2.6%	-33.7%
Other services (except public administration)	-1.0%	0.4%	-15.6%
Public administration	5.4%	0.6%	-1.5%

Table 8. Industry performance during economic downturns, (GDP percentage changes). **Source:** Statistics Canada, calculations by ICTC.

With these dramatic changes, the famous Winston Churchill quote *"Never let a good crisis go to waste"* became a popular mantra in 2020 as the world's leaders planned their recovery. Many took this as an opportunity to "build back better," with a key element being a greener future. The European Union released its NextGenerationEU recovery plan fall 2020, including a EUR 806.9 billion package to make the Union "greener, more digital, and more resilient" over a period of six years. Environmental protection and sustainability are core tenets of this plan.

Six key areas claim 50% of the funding, three are directly related to environmental wellbeing, and all are predicted to have spillover effects for trade and investment attraction. R&D funding, for example, is key to business scale up and new market penetration,[185] and public funding for these and other activities (when coupled with a clear and measurable strategy) signals opportunity to investors.[186]

1. Research and innovation, via Horizon Europe
2. Fair climate and digital transitions, via the Just Transition Fund and the Digital Europe Programme
3. Preparedness, recovery, and resilience, via the Recovery and Resilience Facility, rescEU, and a new health program, EU4Health
4. Biodiversity protection and gender equality
5. Fighting climate change, with 30% of the EU fund package, the highest share ever of the European budget
6. Modernizing traditional policies such as cohesion and the common agricultural policy, to maximize their contribution to the Union's priorities

Playing to Our Strengths and Greening Trade & Investment

Although total Canadian exports fall into numerous categories and across sectors, historically a significant portion can be attributed to two areas: energy and manufactured goods. In 2019, Canada's largest source of exports were energy and minerals, and vehicles and vehicle parts. Most exports were bound for the US (73%), followed by China (4.3%), the UK (3.2%), and Japan (2.3%).

185 Thomson, J. et al., "Navigating Canada's scale-up landscape," December 10, 2021, Brookfield Institute, https://brookfieldinstitute.ca/navigating-scale-ups/

186 Cutean, A. et al., "Betting on Red and White: International Investment in Canadian AI," July 2020, ICTC, https://medium.com/digitalthinktankictc/betting-on-red-and-white-89551f0ea2da

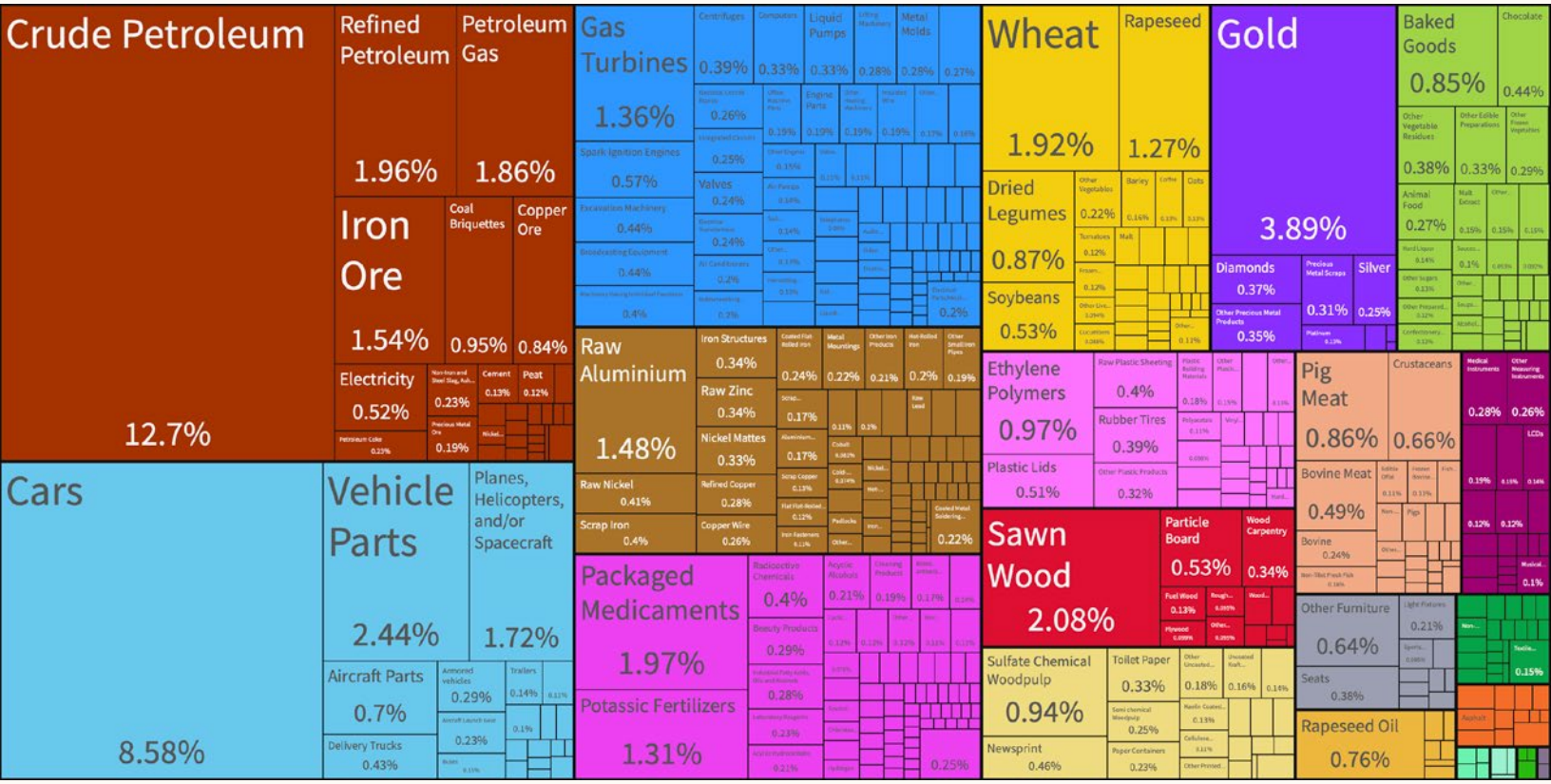


Figure 8. Exports, Canada (2019): $431B[187] . **Source:** OEC[188]

The pandemic upset the balance of existing trade dynamics. In April 2020, Canadian exports decreased by more than 28%, the biggest decline since 2009.[189] Simultaneously, FDI saw severe and unprecedented declines: after a record year in 2019, in 2020, Canadian FDI contracted by nearly 50%.[190]

These changes also caused significant disruption to the types of goods that flowed across borders. Energy products (petroleum, coal, etc.), for example, contracted by 37% in 2020, followed by motor vehicle parts and other transportation equipment and parts. Within the first few months of the pandemic, activities like commuting and travelling were heavily impacted by lockdowns and other restrictions, leading to an immediate and sharp drop to both imports and exports of energy products.[191] Crude oil, one of Canada's most significant exports, saw substantial drops in 2020 (over 80% decrease at the lowest point) and had not recovered to pre-pandemic levels by end of the year. In December 2020, exports of crude oil were still down 26.8% compared with December 2019.[192]

187 "Historical Data," Accessed January 2022, Observatory of Economic Complexity, https://oec.world/en/profile/country/can#historical-data

188 "Historical Data," Accessed January 2022, Observatory of Economic Complexity, https://oec.world/en/profile/country/can#historical-data

189 "Canadian international trade in 2020: A year without precedent," April 14, 2021, Statistics Canada, https://www150.statcan.gc.ca/n1/daily-quotidien/210414/dq210414a-eng.htm

190 Ibid. Canadian foreign investment abroad also contracted in 2020, but less severely than FDI inflows; CDIA saw a decline of 41% during the same period.

191 "Canadian international trade in 2020: A year without precedent," April 14, 2021, Statistics Canada, https://www150.statcan.gc.ca/n1/daily-quotidien/210414/dq210414a-eng.htm

192 Ibid.

While economically damaging in the immediate term, an opportunity emerged. Coupled with new global commitments from regions like Europe to reshape economic activity by anchoring them in sustainable outcomes, building back better quickly became synonymous to building back greener. Changing lifestyles, conservative consumer spending, and intermittent closures of manufacturing plants, led to large drops in the export of vehicles and parts, alongside energy products. In 2020, exports of these goods were 20.3% lower than the year previous.[193] Yet, at the same time, the demand for environmentally friendly alternatives to internal combustion engines (ICE) began to grow. According to Statistics Canada, more Canadians were purchasing and using electric vehicles or hybrids in 2021 than ever before. In Q1, EV adoption grew to 4.5% (up 1% from the year prior), and hybrid sales doubled.[194]

Change in Canadian Goods by Sector (2020)

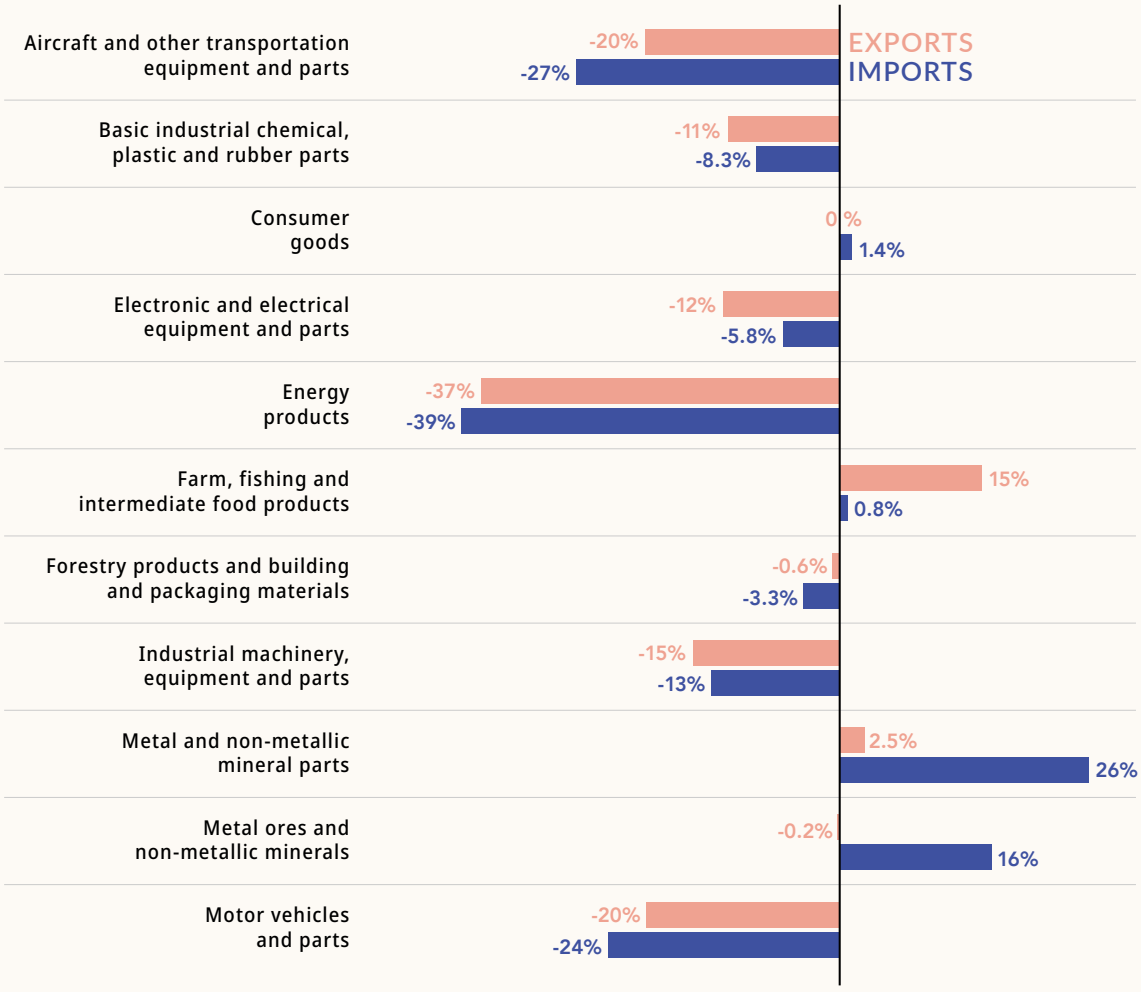


Figure 9. Value of Canadian goods trade in 2020 by product sector.
Source: Statistics Canada, Table 12-10-0122-01, retrieved May 31, 2021. Calculation of the OCE

193 Ibid.

194 "New motor vehicle registrations, quarterly," January 26, 2022, Statistics Canada, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002401

The Canadian government has made major investments to support the growth of the green economy, including the 2021 budget commitment of $1 billion for large-scale clean technology projects.[195] To better elaborate on this opportunity, ICTC consulted with two subject-matter experts on cleantech investment. Both highlight clean technology as an area of opportunity for Canada, stressing natural advantages and scalability potential in renewable energy (wind, solar, thermal), energy storage, electric vehicles, and battery recycling.

> *There's great potential to try and replace some of our current exports in fossil energy with [clean technology like hydroelectric, solar, wind, etc.]... We've got incredible amounts of renewable energy potential.*
>
> – Interviewee

Upskilling to Clean Energy

Beyond economic output, clean energy poses significant labour market growth potential in Canada. Rooted in a deeply entrenched and mature energy sector, Canada has an existing natural competitive advantage the in global race to produce and export clean energy: skilled talent. Significant energy-exporting provinces already possess a wealth of skilled talent that can transition with relative ease (e.g., with short-duration training/upskilling) to key roles that will propel the production and advancement of clean energy products and exports while attracting investment to further expand the industry. Alberta, for example, is home to over 28,000 skilled and highly experienced chemical, petroleum, and electrical engineers, and geoscientists, many that can be transitioned into key roles to support the clean and renewable energy sector.[196]

ICTC's Outlook 2025 report highlights clean technology (environmentally friendly goods with cross-sectoral uses) and clean resources (the greening of the natural resources and energy sector, to develop energy without harming the environment), as key innovation areas. Combined, they are forecasted to create more than 50,000 new jobs by 2025.[197]

195 "Minister Ng highlights Budget 2021 investments in clean technology," April 27, 2021, Government of Canada, https://www.canada.ca/en/innovation-science-economic-development/news/2021/04/minister-ng-highlights-budget-2021-investments-in-clean-technology.html

196 ICTC analysis using Statistics Canada Labour Force Data. Includes NOC (National Occupational Classification) codes 2113, 2133, 2134, 2143, 2144, and 2145.

197 Ivus, M. and Kotak, A., "Onwards and Upwards Digital Talent Outlook 2025," August 2021, ICTC, https://www.ictc-ctic.ca/wp-content/uploads/2021/08/digital-talent-outlook-for-2025.pdf

The CETA Opportunity

Energy is one of Canada's largest income generators and exporting sectors. Transitioning to renewable energy will be a key source of revenue to reboot the economy. Domestic support is needed to expand Canada's clean technology ecosystem, but leveraging agreements like CETA can supercharge this growth path by expanding international market access. The EU is currently Canada's second largest market for clean technology products and services, and bilateral trade of environmental goods and services have continued to grow over the years. Despite a small downturn during 2020, trade levels for most environmental goods and services largely remained above 2016—pre-CETA—levels. Yet, according to previous ICTC research, many SMEs are not well aware of the benefits of CETA or how to leverage it to expand their business.[198] Active knowledge mobilization on this matter is key to helping Canada unlock the multi-trillion-dollar procurement market of the EU and compete for key funding opportunities to boost SME scale up and exports.

	Pipes and tubes for recycling purposes	Prefabricated building structures	Energy efficient machinery	Measuring equipment for pollution levels
2016	413	287	4,311	1,046
2017	CETA IS RATIFIED			
2018	526	442	4,940	1,243
2019	486	398	4,108	1,128

Table 9. Canada-EU Trade in Environmental Goods, EUR Million.[199] **Source:** Statistics Canada.

Turning Brown to Go Green: FDI

Greenfield FDI is a common form of foreign direct investment, oftentimes producing significant economic and labour market impacts in a host country. With greenfield FDI, a home company sets up a subsidiary business in a host country, usually by building a new facility. With this direct investment comes direct economic benefits such as increased revenue, new products and services, direct employment, as well as other indirect benefits like new infrastructure development and jobs in areas like construction. Canada is one of the world's largest FDI receiving countries, and greenfield FDI plays a substantial role in this.

199 "CETA promotes green trade between Canada and the EU," November 25, 2021, Government of Canada, https://www.tradecommissioner.gc.ca/canadexport/0006392.aspx?lang=eng

Historically, FDI, like trade, has been concentrated in a small number of key sectors, including energy and manufacturing. Like trade, this all changed during the pandemic. Between 2019 and 2020, FDI inflows contracted substantially, and the energy and mining sector (previously among the most significant investment attractors) saw the deepest declines, contracting by 136%.

Industries	2020	2019-2020	2019-2020
All industries	32,321	-49%	-31,149
Energy and mining	-7,285	-136%	-27,710
Manufacturing	6,429	-66%	-12,676
Trade and transportation	9,629	3.4%	9,358
Finance and insurance	5,061	-33%	-2,449
Management of companies and enterprises	5,628	-27%	-2,102
Other industries	12,857	53%	4,429

Table 10. The impact of FDI flows amid the pandemic (FDI, percentage and $ millions). **Source:** Statistics Canada, calculations by ICTC.

Although economically challenging in the short term, these changes present an opportunity to change FDI inflow trends and propel a robust FDI strategy that is at once economically beneficial and environmentally friendly.

Enforceable domestic environmental regulations and policy can boost Canada's ability to attract high quality and sustainable FDI, including in "hot" industry areas like cleantech, and agtech. Attracting investment also further influences domestic policy in areas like business and consumer incentives, market size, and commodity pricing. To date, the Government of Canada has introduced some key measures designed to encourage cleantech adoption and development domestically (e.g., $287 million toward Incentives for Zero-Emissions Vehicles,[200] $8 billion toward the Net Zero Accelerator[201]), but a broader and clear green FDI strategy is needed to ensure that all future investment in Canada is economically and environmentally beneficial.

The 2021 IPCC (Intergovernmental Panel on Climate Change) report confirmed a real and immediate need to sharply reduce emissions, and effective FDI policy plays a role. One key consideration of this transition includes developing parameters for "browning" greenfield FDI where reasonable and possible. While building new facilities creates jobs and increases overall spend, it also leads to further development on "vacant" sites. Depending on the size and scale of operations, these sites may be in areas that interfere with natural habitat and community life. Brownfield FDI, by contrast, leverages existing sites, which can keep cost down and encourage good environmental practices (e.g., preventing sprawl).

199 Ibid.

200 "Net Zero Accelerator Initiative," accessed August 18, 2021, Government of Canada, https://www.ic.gc.ca/eic/site/125.nsf/eng/00039.html

Supporting the Demand for Green Consumer Goods and Services

Increasingly, consumers around the world are rethinking consumption models and how they procure and use products. More and more, the take-make-waste linear economic model of consumption is being challenged, especially among younger consumers.[202] These sentiments have been further embedded during the pandemic, with more young people—namely millennials and Gen Z—committing to more sustainable and environmentally friendly consumer habits. Research by PwC on Canadian consumer trends found that 50% of respondents described themselves as being more "eco-friendly" in spring 2021 than in fall 2020. Although the desire for sustainable consumption grows, access and cost remain a challenge. According to the same PwC survey, one-third of respondents cite a lack of availability of sustainable products as a core barrier, and 40% highlight that even when products are available, the high price point is a deterrent.[203]

Helping SMEs Upgrade Business Models

Environmentally conscious consumers require access to cost-effective products and services. Yet, small and medium sized businesses currently struggle with the economic uncertainty brought on by COVID-19 and its numerous waves of infection. According to a recent survey by Statistics Canada, small businesses were more likely to expect insufficient demand for goods or services and were also less likely to report optimism for future economic outlook. Nearly 30% of businesses with fewer than 20 employees expected profitability to decrease in the future.[204] This can cause companies to focus on "staying afloat", trumping the desire to change business models and adapt to new consumer needs.

Resources like those offered through the Circular Economy Innovation Network[205] are essential to help businesses on this journey. The Network is a national forum that seeks to embed circularity in existing supply chains and engages SMEs across Canada and across sectors to build new business models with circularity at the core. Such resources not only fill a current need but help SMEs meet their own longer-term organizational goals. According to 2018 research by the University of Waterloo, even then, sustainability was top of mind for Canadian SMEs. About 86% believed that sustainability was important, and more than half were taking steps to produce favourable environmental outputs.[206] SMEs have the will to make this transition, and many are dedicated to contributing toward a greener and more sustainable future for Canada. But, having to contend with basic survival as the pandemic drags on, resources and supports to prioritize sustainability are essential.

202 "Study Finds People Want to Make Healthy and Sustainable Living Choices but Do Not Know Where to Start," October 2020, Globe Scan, https://globescan.com/2020/10/07/people-want-healthy-sustainable-living-choices-2020/

203 "The global consumer: Changed for good," June 2021, PwC, https://www.pwc.com/gx/en/consumer-markets/consumer-insights-survey/2021/gcis-june-2021.pdf

204 Tam, S. et al., "Impact of COVID-19 on small businesses in Canada, third quarter of 2021," September 2, 2021, Statistics Canada, https://www150.statcan.gc.ca/n1/pub/45-28-0001/2021001/article/00034-eng.htm

205 "Scaling Circular Economy Innovation in Canada," 2022, Circular Economy Leadership Canada, https://circulareconomyleaders.ca/ce-innovation-network/

206 "GATE Survey Report," Accessed January 2022, University of Waterloo, https://uwaterloo.ca/environment/sites/ca.environment/files/uploads/files/sme_study_final.pdf

Once new sustainable business models are built, scale up and commercialization is the next step. This is key to new market expansion and revenue generation. One component of this journey is the development and maintenance of IP. Yet, according to the most recent statistics from the Canadian Intellectual Property Office (CIPO), total patent applications grew by only 1% from 2018 to 2019. Moreover, domestic filings have seen an accelerating downward trend in recent years, decreasing by 3% from 2018 to 2019 and 7% since 2009.[207]

Although Canadian patent filings alone cannot be used as a sole indicator of IP awareness or development among Canadian companies,[208] a renewed focus is needed on turning research innovations into marketable products and services (both in the Canadian and international marketplace). As one interviewee put it:

> *Companies need to understand how IP can be used to protect our free market and create options for commercialization and exports.* 99
>
> – Interviewee

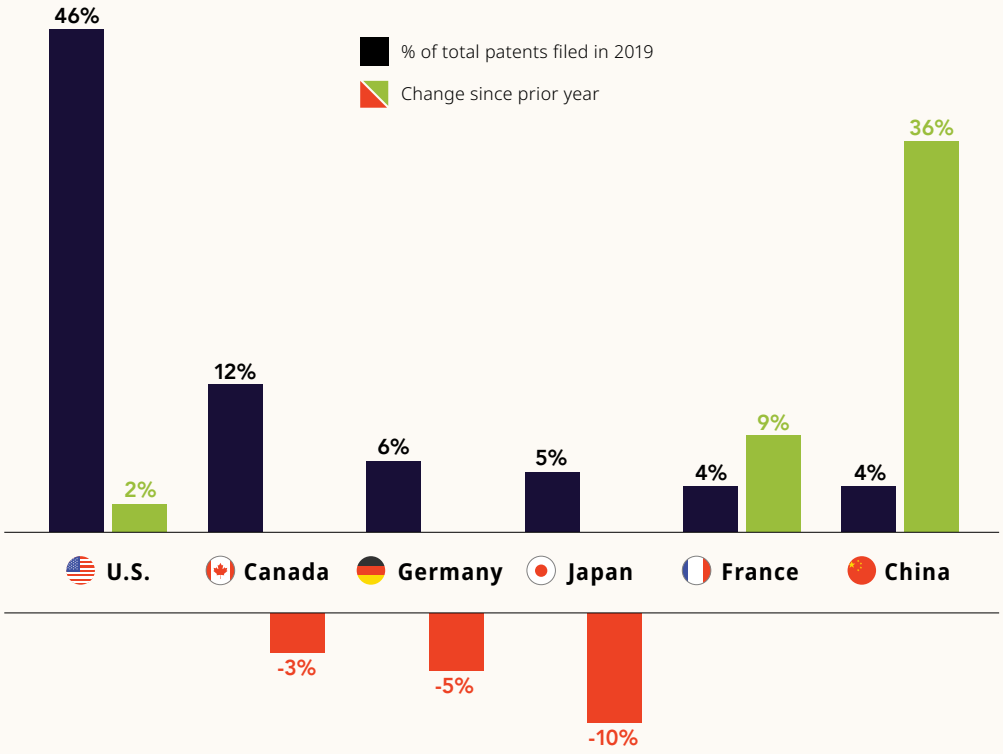


Figure 10. Top counties filing for patents in Canada, 2019.[209] **Source:** Canadian Intellectual Property Office

207 Collette, E. et al., "IP Canada Report 2020," August 26, 2021, Government of Canada, https://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/h_wr04873.html

208 Some argue that is it more beneficial to file patents in larger markets such as the Europe of the United States; others maintain that avoiding filing patents and keeping inventions as trade secrets is a better strategy for innovation yet.

209 Collette, E. et al., "IP Canada Report 2020," August 26, 2021, Government of Canada, https://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/h_wr04873.html

Building Sustainable Economies of Scale with Consumer Incentives

Provincial tax schemes have been proven to create positive incentivizes for larger consumer changes, such as electric vehicle purchases[210] or energy efficient home upgrades.[211] However, an overall green economy requires consumers to make "green choices" as a part of their everyday lives. With cost being a key consideration, economies of scale are necessary to make everyday lifestyle habits "sticky." Although the pandemic and resulting restrictions caused a sharp decline in brick-and-mortar retail, research by McKinsey & Co. identified that within just eight weeks, online consumption reached levels that were expected to take at least a decade to materialize.[212] While much of this was tied to individual comfort levels and convenience at the time of the study—in summer 2020, 70% of the study's survey respondents noted being uncomfortable with the idea of resuming their in-person activities—the surge in ecommerce is expected to continue, as the pandemic has pushed more shoppers online. Of course, an associated consideration is the impact on sustainability. Including heighted "impulse buying," excessive packaging, and returns that oftentimes end up in landfills rather than the resale market, online shopping can be at odds with sustainability. Consumers are increasingly looking for options that address their needs without sacrificing the environment.

Incentives that alleviate financial burdens of sustainable shopping can range in complexity and are often tailored to specific habits in regions or even neighbourhoods. One example of an easily implemented (low-tech) and often widely used green consumer incentive mechanism are deposit-refund schemes (DRS). These mechanisms work by charging the consumer an additional fee as a "deposit" on products that come in recyclable containers, for example glass, plastic, or other materials that can be reused and reprocessed many times. The point of a DRS is to create "closed material loops" or support recycling for other products.[213] Other mechanisms to incentivize sustainable shopping at the consumer level include tax rebates offered to shoppers that buy second-hand products, or to repair existing ones. For example, in 2016, Sweden introduced tax breaks (reducing VAT from 25% to 12%) on items that are repaired (including things like bikes, clothes, even washing machines). For larger items, like washing machines, consumers are also able to claim half of their labour cost (for repairs) on their income tax return.[214] Alternatively, like carbon taxes, sustainable consumer behaviour can—in theory—be incentivized with the use of negative conditionality (the proverbial "stick").

211 "Go Electric Passenger Vehicle Rebates," Accessed January 2022, Government of British Columbia, https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/clean-transportation-policies-programs/clean-energy-vehicle-program/passenger-vehicles

212 "Income Tax Folio S3-F8-C2, Tax Incentives for Clean Energy Equipment," August 2, 2019, Government of Canada, https://www.canada.ca/en/revenue-agency/services/tax/technical-information/income-tax/income-tax-folios-index/series-3-property-investments-savings-plans/series-3-property-investments-savings-plan-folio-8-resource-properties/income-tax-folio-s3-f8-c2-tax-incentives-clean-energy-equipment.html

213 "Perspectives on retail and consumer goods Number 8," August 2020, McKinsey & Company, https://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/perspectives%20on%20retail%20and%20consumer%20goods%20number%208/perspectives-on-retail-and-consumer-goods_issue-8.pdf

214 Watkins, E. et al., "Pollution Deposit refund schemes," 2019, OECD, https://www.oecd.org/stories/ocean/deposit-refund-schemes-58baff8c

215 "Swedish government tax break programme for repair," October 1, 2021, https://knowledge-hub.circle-lab.com/article/3624?n=Government-tax-break-program-for-repair

With the example of online shopping, additional fees could be attached to consumer choices that produce added or unnecessary harm to the environment. For example, consumers could be charged additional shipping fees when purchasing multiple items from an online store but refuse to bundle the delivery (i.e., choosing the fastest, but most wasteful option).

> *The real focus is to think about driving Canadian markets as well as exports and other policy drivers...I think public education is critically important [along with] incentives for consumers.* 99
>
> – Interviewee

Carbon Pricing and Enforcement

A simple way to curtail circulation of a product in the market is to make it more expensive. The overall tobacco control policy leverages taxes—and public education—to steer change. Over the years, many studies have concluded that raising cigarette prices through increased taxes has proven effective at reducing rates of smoking among the general population.[215] The concept of a carbon tax is similar: it acts as an incentive for businesses and individuals to reduce emissions and curtail carbon production; the lower emissions, the less tax, and at the same time, renewable energy producers gain a competitive advantage.

Yet, in 2019, the first year of Canada's national carbon pricing mechanism, emissions increased by 0.2%.[216] Some attribute this to the higher-than-expected economic growth in 2019—leading to more emissions—while affirming that 2020 onward, emissions would begin to drop, which they did on the coattails of the pandemic—temporarily. In early 2020, emissions declined amid lockdown measures, with an overall 7% decrease recorded globally.[217] However, as the year rounded out and lockdowns were lifted, global emissions rose again. By December 2020, they were 2% higher than the previous year.[218]

There are benefits and drawbacks to carbon taxes. Emissions reduction is a clear benefit, but broad enforcement can be challenging and incentives and actual impacts can be unclear. Especially on the heels of an economic crisis like COVID-19, businesses (and countries) may choose to put off emissions reduction in favour of short-term economic recovery. That is, if reducing emissions further negatively impacts GDP growth, targets may be foregone or delayed until more "stable" economic conditions emerge (and environmental conditions worsen in the process).

215 Bader, P. et al., "Effects of Tobacco Taxation and Pricing on Smoking Behavior in High Risk Populations: A Knowledge Synthesis," 2011, International Journal of Environmental Research and Public Health, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3228562/

216 "Greenhouse Gas Emissions," October 29, 2021, Government of Canada, https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html

217 Li, G. et al., "Self-powered soft robot in the Mariana Trench," March 3, 2021, Nature, https://www.nature.com/articles/s41586-020-03153-z

218 "After steep drop in early 2020, global carbon dioxide emissions have rebounded strongly," March 2, 2021, International Energy Association, https://www.iea.org/news/after-steep-drop-in-early-2020-global-carbon-dioxide-emissions-have-rebounded-strongly

Recent research by the National Institute of Economic and Social Research (NIESR) highlights this very real possibility, stating that carbon taxes can raise inflation and lower GDP—at least temporarily—in most OECD countries.[219] Another undesirable outcome, especially during a weak global economy, is the "leakage effect," where businesses shift production to countries where a carbon tax is not enforced.

Climate change is a global problem. Although carbon tax policy at the national level is necessary to springboard behavioural change and pave the way for phasing out harmful emissions, multinational commitments and enforcement are required to truly succeed. As countries around the world are still reeling from the economic fallout of the COVID-19 pandemic, is it crucial that longer-term environmental and wellbeing goals are implemented and enforced in a way that they are not compromised by immediate economic needs.

Key Issues and Policy Considerations

Playing to our Strengths to Boost Green Trade and Investment

Setting clear and measurable targets for R&D, commercialization, exports, and investment attraction are essential to shaping sound economic policy. Coupled with tangible commitments (such as those of the NextGenerationEU recovery plan), Canada can become an essential player in the global green economy. Canada can leverage its existing strength in the energy and manufacturing sectors to reshape production processes that can boost exports of environmentally friendly products and attract sustainable investment.

Historically, trade and investment flows have been heavily directed to the energy and manufacturing sectors. Canada has built long-lasting relationships with trading partners and investors around the world in these sectors. Supporting this shift is a significant wealth of skilled talent. Many workers in energy producing provinces such as Alberta and B.C. already possess key skills and experience that allow them to transition with relative ease to in-demand jobs in clean technology and clean energy. Illuminating these pathways is necessary, as are short-duration training programs to upskill these workers. The benefits of doing so extend beyond labour market participation and immediate output. By building a robust cleantech and clean energy ecosystem, Canadian businesses can better address the needs of global businesses and consumers, many that increasingly prioritize environmentally friendly products and solutions. Canada has a natural competitive cleantech and clean energy advantage that can be used to carve a significant role in the global marketplace.

219 "Carbon tax could temporarily raise inflation and lower GDP in most OECD economies, NIESR study shows," November 5, 2021, National Institute of Economic and Social Research, https://www.niesr.ac.uk/news/carbon-tax-could-temporarily-raise-inflation-and-lower-gdp-most-oecd-economies-niesr-study-shows

Greening Greenfield FDI

Like trade, FDI to Canada has been historically concentrated in a few sectors, including energy, manufacturing, transportation, and finance. Attracting investment into areas of the green economy that are aligned with strong market demand—like renewable energy, or agriculture—is essential. Some domestic investments have been made to advance business development and scale up, and these are effective at "signalling" opportunity to potential international investors. Building on to this should be a clear "green" FDI strategy that measures outcomes and consequences.

One key area of consideration is the "greenness" of greenfield FDI. Although greenfield FDI tends to produce longer-term and broader economic benefits for a host country, it requires additional infrastructure and construction activities, which impacts the environment and local communities. For example, building a large new manufacturing plant in a suburban area may cut into green space and displace local plant and animal life; alternatively, building the same plant in the centre of a city may disrupt community travel patterns or even impact existing methods of connection and social engagement. Where possible and reasonable, investment receiving countries like Canada can work with investors to find suitable existing infrastructure that can be leased or purchased. In some cases, existing infrastructure will not be suitable, and new infrastructure will need to be built. Here, host countries can consider incentives for investors in the construction process. This can include tax rebates for using renewable energy to power facilitates or for leveraging environmentally friendly material to build the space.

Economies of Scale to Support Growing Green Consumer Demand

Canadian consumers show a desire to develop and engage in environmentally friendly purchasing habits. Younger Canadians describe themselves as committed to environmentally friendly shopping, however, access and cost need to be addressed. Lowering costs requires building economies of scale, where more sustainable products can circulate in the market at competitive prices. This necessitates equipping SMEs—many of which are themselves committed to contributing toward a more sustainable and green future—with the resources, incentives, financial supports, and knowledge to develop, market, and export these products. Yet, the pandemic has altered, and in some cases ruptured existing business models. While many SMEs struggle to get back on their feet, resources and educational material about sustainably—such as embedding circularity into business operations—can prove valuable. In so doing, companies can also uncover new lines of business or off-shoots that can be further productized and sold. Similarly, educational materials stressing the importance of IP development and maintenance is valuable.

Next, while many consumers are inherently committed to sustainable consumption, incentives can be leveraged to push large-scale adoption to drive long-term change. Low-tech and easily implementable incentive structures like deposit-refund schemes have proven effective at encouraging recycling and creating "closed material loops." Other possible incentive structures include tax rebates or offsets. A Swedish policy incentivizes the repair of existing products and the purchase of second-hand goods through consumer tax rebates. Such policies can create a long-term cultural shift where consumers own products for longer and contribute less to landfills.

Beyond Borders: International Commitments, Measurements, and Enforcement

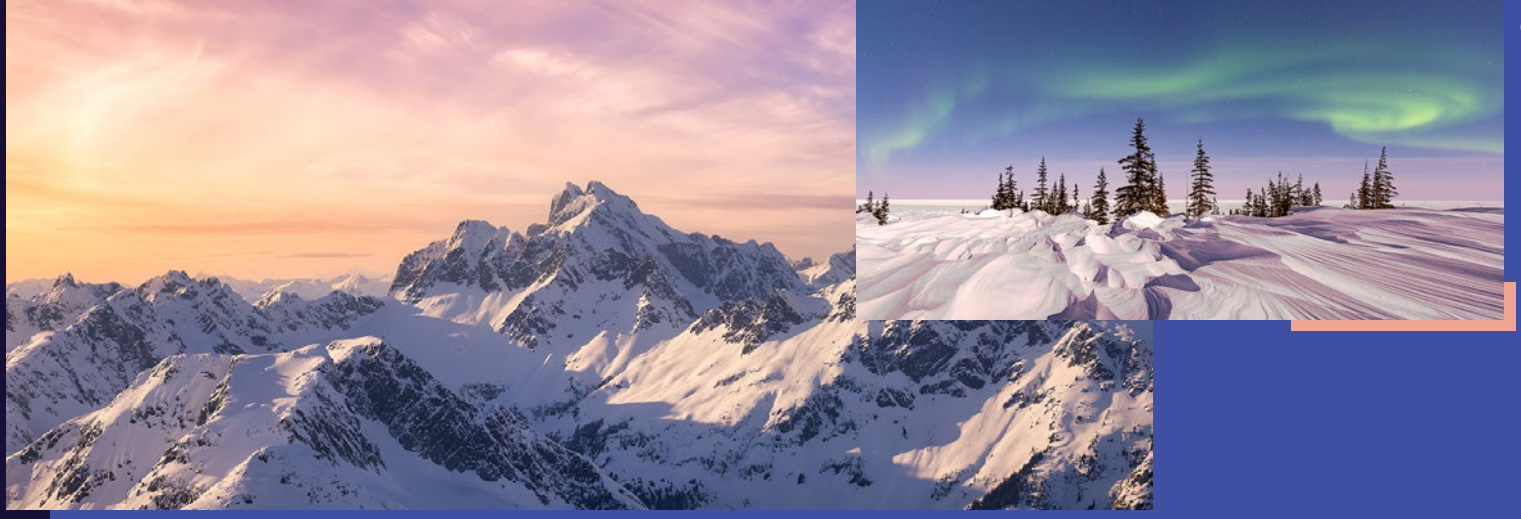
Although many countries are creating green transition plans and some FTAs include provisions dedicated to addressing climate change, commitments must come with measurable indicators, targets, and a clear roadmap to achieving objectives. Developments like the NextGenerationEU recovery plan are key examples of economic policies with clear roadmaps to a net-zero future.

Additionally, because so much of economic activity is rooted in trade, environmental protections and commitments must be met with cross-border enforcement and a common understanding of acceptable practices. For example, although newer agreements like the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) and the United States-Mexico-Canada Agreement (USMCA) entrench commitments to environmental wellbeing, enforcement is needed to tackle the global threat of climate change. Commitments are clear in these agreements, but enforcement defers to domestic legislation. For example, Article 24.3.1 of USMCA, states that "Parties recognize the sovereign right of each Party to establish its own levels of domestic environmental protection and its own environmental priorities, and to establish, adopt, or modify its environmental laws and policies accordingly."[220] Article 24.2.5 further emphasizes that "it is inappropriate to establish or use the environmental laws or other measures in a manner which would constitute a disguised restriction of trade of investment between the Parties."[221] In other words, although an entire chapter is dedicated to collective action on climate change, enforcement ultimately rests with domestic law that is subject to change as priorities fluctuate.

220 "USMCA Chapter 24: Environment," Accessed January 2022, United States Trade Representative, https://ustr.gov/sites/default/files/IssueAreas/Environment/USMCA_Environment_Chapter_24.pdf

221 Ibid.

Lastly, carbon tax policies are an example of effective negative conditionality: to achieve a desired outcome (reduced emissions), negative conditions (taxes) are imposed on excessive polluters. Yet, advancing such policies requires additional focus on tracking actual outcomes and broadening their scope. Although carbon taxes are expected to make clear strides in emissions reduction in the long run (and in some provinces they have been extremely effective in the short term as well), overall emissions still rose during the first year of its implementation in Canada—and in 2020, despite the pandemic. Moreover, some warn that in the short term, carbon taxes will curtail GDP and cause inflation to rise in most OECD countries. Many countries are already struggling to control inflation, which is at 30-year highs in some places. All sound policy must have appropriate and clear methods of measuring outcomes—both intended and otherwise—and carbon taxes are no exception. Moreover, while provincial and national policies are necessary to curtail domestic emissions, climate change is a global problem requiring a global commitment. Especially in a struggling economy, there is a risk of "leakage" (businesses shifting production to jurisdictions without carbon taxes or where they are not enforced).



Conclusion

The digital economy has grown significantly in recent years. Simultaneously, the threats of environmental degradation, climate change, and habitat loss loom larger than ever. While these appear at first to be distinct developments, they are interconnected. If the digital economy is to continue to thrive, it must do so within the paradigm of a green economy. In other words, it must focus on circular processes, sustainability, concern for equity within and across generations, and a thoughtful approach to the meaning and purpose of "growth."

The five topic areas discussed in this paper serve to categorize broad topics and high-level considerations. Although each of these topic areas is discussed in distinct sections, in reality, they are intricately interconnected: green jobs of the future are a component of ethical technology, while foundations for a digital economy, like education and infrastructure, are key for developing Canada's capacity for trade and investment in technology.

The Green Economy Coalition suggests that "by focusing on 'nexus issues' that link social, economic and environmental issues—such as health or entrepreneurship—decision makers can achieve multiple policy impacts."[222] This paper focuses on those nexus issues—areas in which the green economy and the digital economy interact and will likely see more interaction in the future. It lays the foundation for further research and action that can help make the digital economy greener and ensure that the green economy benefits from digital technology. Future research and action will take many forms: research and development to minimize carbon emissions and material resource use; labour market research that effectively forecasts green tech skills needs; the development of reskilling and upskilling programs to support career transitions and worker reallocation across evolving industries; and efforts to harness community voices and concerns (particularly from those most prone to the harms of climate change) in the development of green tech and policy.

ICTC's next steps will be to convene taskforces that work toward building a greener digital economy. Along with the CIO Strategy Council, ICTC joins part of a growing movement of organizations that see the green and digital economies as complimentary forces in building a more sustainable world.

222 Mohamed, Namja, "Inclusion Matters Policy insights and lessons from the Green Economy Coalition's national dialogues," July 2020, Green Economy Coalition, https://www.greeneconomycoalition.org/assets/reports/GEC-Reports/GEC-Inclusion-Paper-Najma-July-2020-WEB-Final.pdf