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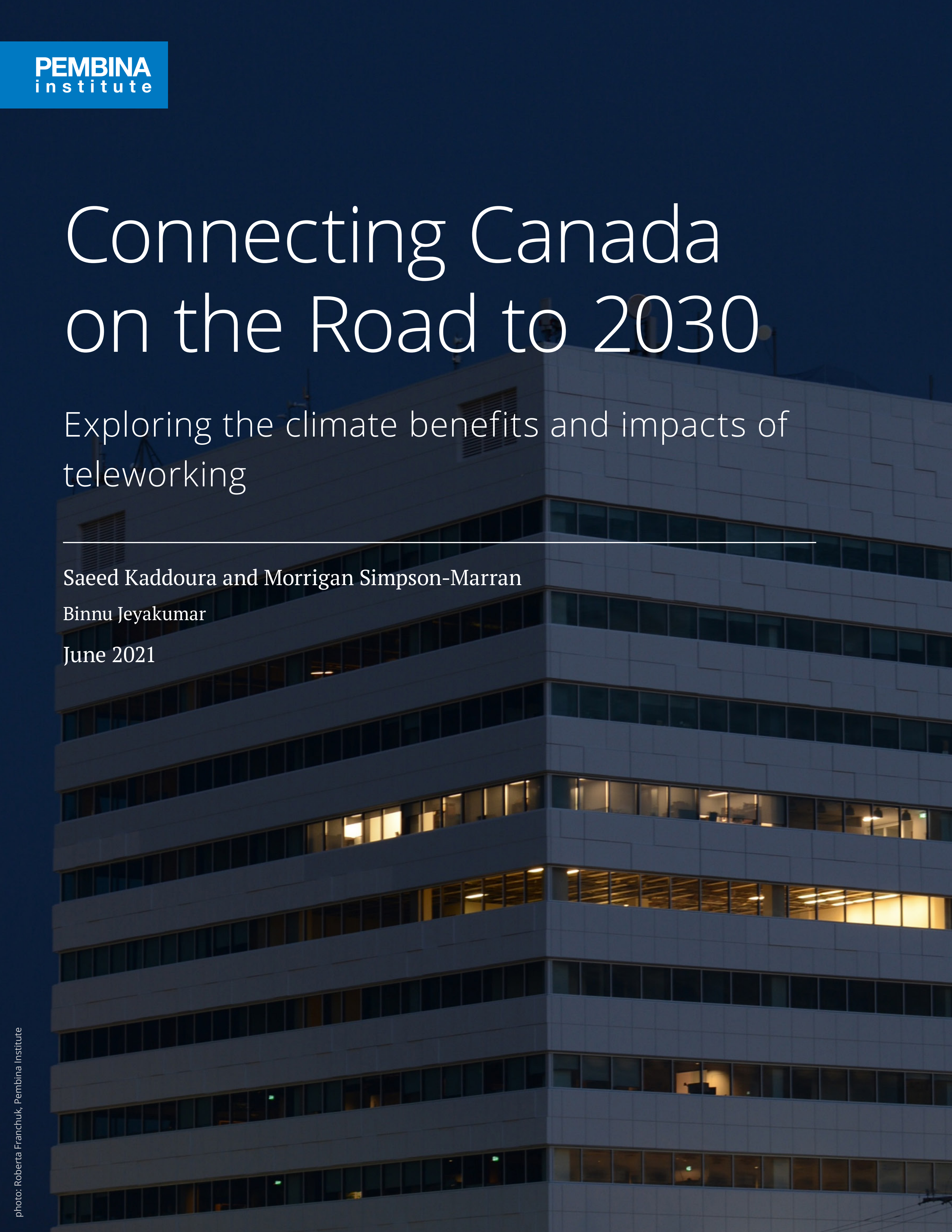
Connecting Canada on the Road to 2030

Exploring the climate benefits and impacts of teleworking

Saeed Kaddoura and Morrigan Simpson-Marran

Binnu Jeyakumar

June 2021



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The Pembina Institute
219 19 Street NW
Calgary, AB
Canada T2N 2H9
Phone: 403-269-3344

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Connecting Canada on the Road to 2030

Exploring the climate benefits and impacts of teleworking

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Executive summary

On March 11, 2020, economies across the globe began a fundamental shift, as the World Health Organization declared COVID-19 to be a pandemic and urged countries to take urgent action to limit the spread of the virus. Among the numerous impacts was the trend of a large number of people shifting to teleworking. By August 31, 2020, 27% of the Canadian workforce was fully teleworking.

In this report we conduct a preliminary examination of the role of internet use for teleworking in reducing greenhouse gas (GHG) emissions. We also identify factors that can enable GHG reductions to help meet Canada's 2030 climate target of 40–45% GHG reductions compared to 2005 levels.

In 2020, global GHG emissions dropped by 3.9% and Canada's GHG emissions dropped by 7% (51.1 million tonnes CO2e) compared to 2019. Surface transportation emissions experienced the most reductions, contributing to more than half of the GHG reductions recorded globally that year. This preliminary research aggregates data trends and averages from the U.S. where Canadian data was unavailable. Emissions from increased internet use and reduced transport were examined. The research indicates that internet usage that supports teleworking can contribute to climate action:

- In the U.S., the reduction in transportation and commercial building emissions outweigh the increase in residential emissions for employees with short commutes in personal vehicles (i.e. who do not take public transit).
- Residential emissions from internet use are primarily attributed to the energy demand of access devices, such as phones, laptops, and TVs, and the emissions intensity of the electricity grid that powers them. These emissions increase with increased use of the devices.
- The emissions from the energy demand of data storage and transmission on the other hand are less elastic with usage. The IEA estimates that energy demand of data storage and transmission will remain flat through 2022 even with an anticipated 60% increase in internet demand.
- When workers telecommute part-time, net GHG reductions were only realized when office spaces were downsized and telecommuting opportunities were maximized wherever possible.

Recommendations

The research for this report illustrates the potential for internet use in supporting the decarbonization of Canada's economy. To better understand the GHG emissions reduction potential and the pathways to maximize this potential, the following next steps are recommended:

- Examine Canadian data on internet use through teleworking and the impact on device usage, including the infrastructure for Canada's information and communications technology (ICT) sector.
- Analyze the carbon footprint of teleworking in Canada, with geography specific data where appropriate. A life cycle analysis approach should be taken inclusive of all activities and their indirect emissions.
- Examine potential for reducing the carbon footprint of the ICT sector through options such as purchasing renewable power.
- Study how the ecosystem of infrastructure and programs serving Canadians that participate in the digital economy should be expanded to encourage digital adoption.

1. Introduction

On March 11, 2020, economies across the globe began a fundamental shift, as the World Health Organization declared COVID-19 to be a pandemic and urged countries to take urgent action to limit the spread of the virus.[1] In his statement, director-general Tedros Adhanom Ghebreyesus acknowledged the pandemic was not just a public health crisis, but a crisis that would affect every sector of the economy.[2]

People around the world had to find new ways to live, work, and gather while limiting the spread of the virus. With this shift and the slowing down of the economy, greenhouse gas (GHG) emissions fell materially in almost all countries, showing us the clear link between how we live and do business, and our impact on the environment. It is estimated that globally, GHG emissions dropped by 6.2% (-2,126.3 million tonnes (Mt) of CO_2e).[3] It is estimated that during that period Canada's GHG emissions dropped by 7% (51.1 Mt CO_2e) compared to 2019.[4]

Canada has a 2030 target to reduce GHG emissions by 40–45% below 2005 levels.[5] If all federal climate policies announced to date are followed, we will reduce GHG emissions down from 815 Mt CO_2e to 505 Mt CO_2e, as shown in Figure 1. Of these reductions, 3.9% (12 Mt CO_2e) are anticipated to come from transportation sector policies, and 14% (44 Mt CO_2e) from building sector policies.

This report reviews existing data on how increasing internet access and adoption to allow more Canadians to telework — as evidenced during the pandemic — can contribute to meeting Canada's emission reduction ambition.

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[1] World Health Organization, "Listings of WHO's response to COVID-19," December 28, 2020. https://www.who.int/news/item/29-06-2020-covidtimeline

[2] World Health Organization, "WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020," March 11, 2020. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

[3] Zhu Liu et al, "Near-real-time monitoring of global CO_2 emissions reveals the effects of the COVID-19 pandemic," *Nature Communications* 11, no. 5172 (2020). https://doi.org/10.1038/s41467-020-18922-7

[4] Global Carbon Project, "Global Carbon Budget 2020." https://enactivescience.com/pandemissions/gcb-country-updates/

[5] Prime Minister of Canada, "Prime Minister Trudeau announces increased climate ambition," April 22, 2021. https://pm.gc.ca/en/news/news-releases/2021/04/22/prime-minister-trudeau-announces-increased-climate-ambition

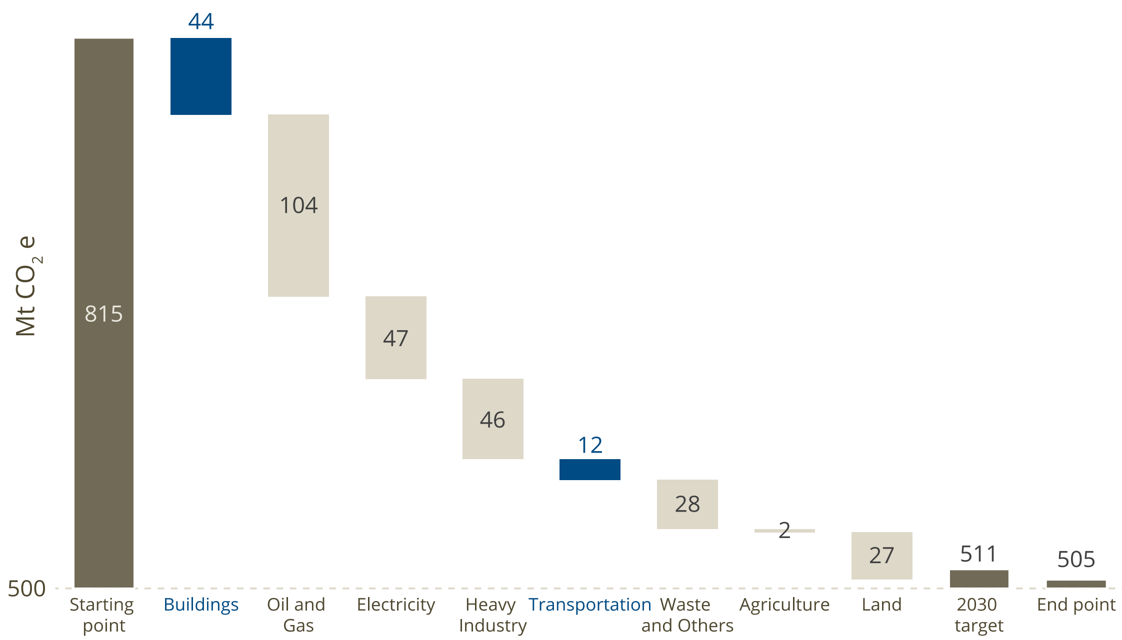

Figure 1. Cumulative sector-specific reductions by 2030 from policies implemented under Canada's strengthened climate plan

Note: This figure reflects the 30% reductions from 2005 levels by 2030 target. 40% and 45% reduction targets by 2030 are equal to 443 and 406 Mt CO_2e respectively.

Data source: Environment and Climate Change Canada[6]

1.1 Potential of emissions reduction in surface transportation

In 2020, global GHG emissions dropped by 3.9%,[7] the first global drop in emissions since the 2009 financial crisis. The sector-based breakdown is shown in Figure 2 with surface transport emissions showing the most significant GHG reductions in 2020, contributing to more than half of the GHG reductions recorded that year.

[6] Environment and Climate Change Canada, *A Healthy Environment and a Healthy Economy* (2020), 63. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy.html

[7] Robert McSweeney, Ayesha Tandon, "Global Carbon Project: Coronavirus causes 'record fall' in fossil-fuel emissions in 2020," December 11, 2020. https://www.carbonbrief.org/global-carbon-project-coronavirus-causes-record-fall-in-fossil-fuel-emissions-in-2020

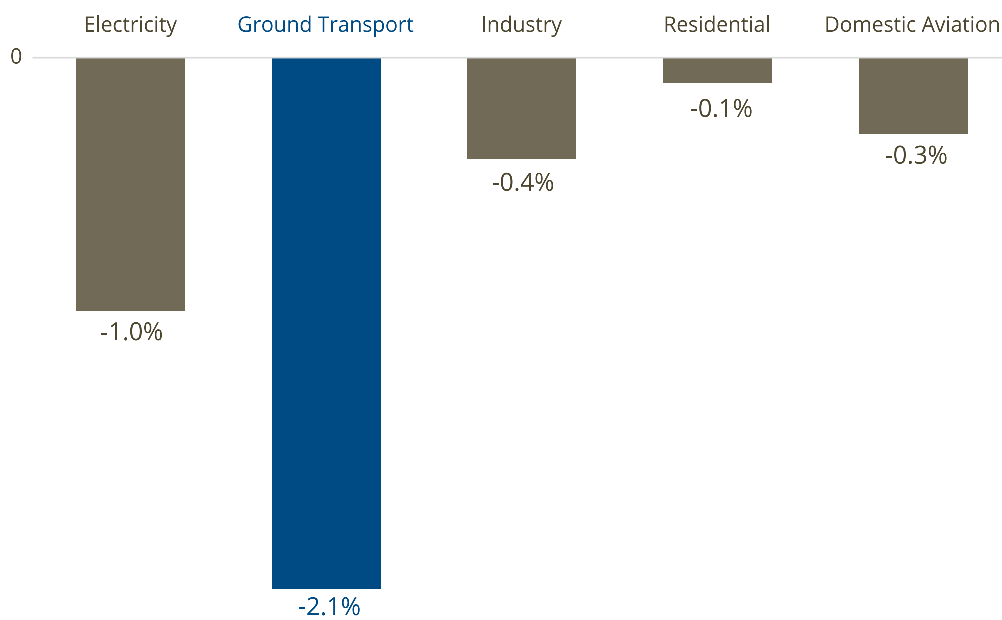

Figure 2. GHG reductions recorded in global economic sectors

Data source: Liu et al[8]

The transportation sector is the second-largest emitting sector in Canada (contributing to 26% of all national emissions in 2019 (Figure 3)), but it makes a relatively small contribution to current federal policies (-12 Mt CO_2e) toward Canada's 2030 target. This points to an emissions reduction opportunity worth exploring further, especially since more than half of Canada's transportation emissions come from passenger transportation, which is where most of the impact of teleworking is seen.

[8] "Near-real-time monitoring of global CO_2 emissions reveals the effects of the COVID-19 pandemic."

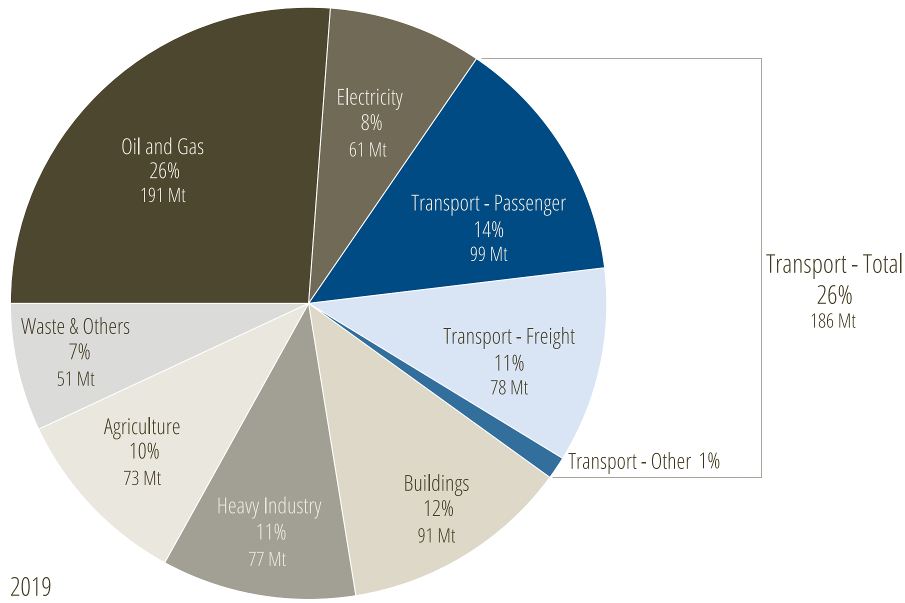

Figure 3. Transportation emissions are the second largest source of GHG emissions in Canada; most transportation emissions come from passenger vehicles

Data source: Environment and Climate Change Canada[9]

1.2 Potential for teleworking

In March 2020, Statistics Canada launched the Canadian Survey on Business Conditions (CSBC) to measure the impact of COVID-19 on businesses in Canada.[10] The study has been conducted quarterly and identifies the size of the Canadian teleworking workforce in select quarters.

Results of the survey showed that at the start of the pandemic, on March 31, 2020, only 18% of Canadian employees were teleworking full-time, and 41% were not able to telework at all because they worked in essential or frontline industries.[11] By August 31, 2020, the number of Canadians that were teleworking full-time rose to 27%, and the

[9] Environment and Climate Change Canada, *National Inventory Report 1990-2019: Greenhouse Gas Sources and Sinks in Canada Part 1* (2021), 10, 11. https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/sources-sinks-executive-summary-2021.html

[10] Statistics Canada, "Canadian Survey on Business Conditions (CSBC)," March 26, 2021. https://www.statcan.gc.ca/eng/survey/business/5318

[11] Statistics Canada, "Table 33-10-0228-01 Percentage of workforce teleworking or working remotely, and percentage of workforce able to carry out a majority of duties during the COVID-19 pandemic, by business characteristics."

number of employees not able to telework at all dropped drastically to 17%.[12] Comparing the fraction of Canadians that could not telework in March (41%) and August (17%) shows that almost a quarter of the Canadian workforce (24%) that could not telework at the beginning of the pandemic were able to telework at least part-time by August.

The latest CSBC survey results released at the end of Q1 2021 anticipate that 21% of Canadian workers will continue teleworking through Q2, and only 6% will not be able to telework at all, showing that more businesses are adapting to some level of telework.[13] A study from the U.S. estimated that 37% of American jobs can be performed entirely from home.[14]

Given the significant potential for teleworking seen during the pandemic, the following sections examine how we can build an understanding of the net climate impacts of teleworking, and how we can maximize the emissions reductions from this change in how we work.

[12] Statistics Canada, "Table 33-10-0274-01 Percentage of workforce teleworking or working remotely, and percentage of workforce anticipated to continue primarily teleworking or working remotely after the pandemic, by business characteristics."

[13] Statistics Canada, "Table 33-10-0329-01 Percentage of workforce anticipated to continue primarily teleworking or working remotely over the next three months, by business characteristics."

[14] Jonathan I. Dingel, Brent Neiman, "How many jobs can be done at home?" *Journal of Public Economics* 189 (2020). https://doi.org/10.1016/j.jpubeco.2020.104235

2. Considerations for GHG reductions from teleworking

An analysis of the GHG impacts of an increase in teleworking[15] needs to, at a minimum, compare the GHG emissions from scenarios that consider the following activities:

- transportation emissions from commuting
- commercial building emissions from heating and lighting
- commercial and industrial emissions associated with internet usage
- residential emissions from heating and lighting
- residential emissions associated with internet usage

At present we do not have complete Canadian data on all the above activities. The sections below examine the energy use trends already available in literature to provide an indication of how emissions are expected to change with increased teleworking. A more comprehensive analysis with a complete Canadian dataset is needed to quantify the net emission impacts.

2.1 Emissions impact on transportation and residential buildings

Analysis done by the IEA in the United States, China, and the European Union studied how teleworking changed residential energy demand. Energy-use trends in these jurisdictions show similar trends to those reported by the Canada Energy Regulator, that there has been an increase in residential energy use in 2020 when many of the stay-at-home orders were implemented. The IEA analysis then compared the GHG emissions from the residential sector with GHG transportation emissions from commuting to work.

The study found that in all jurisdictions, teleworking led to a significantly larger reduction of emissions from the decrease in transportation (i.e. less fuel consumption). The reduction was larger than the increase in residence-based emissions caused by

[15] Remote work usually refers to people who never enter an office and are often located far away from the office location. Telecommuters/teleworkers have the option to go into the office occasionally and are usually located closer to the office geographically.

teleworking of heating, cooling, and electricity demand for an average household size, leading to considerable reductions in net CO_2 emissions.[16]

In the United States, the closest jurisdiction studied to Canada, avoided emissions from commuting to work, averaged over the summer and winter seasons, were more than three times the additional emissions from the residential sector due to teleworking.

This study identified that in the United States, avoided vehicle travel leads to emissions reductions when passengers travel more than six kilometres to work. However, for those who travel less than six kilometres, or use public transit, emissions from residential energy demand would outweigh reductions from avoided transportation emissions.

The 2016 Canadian census showed that Canadians travel 8.7 km to work on average,[17] suggesting that teleworking in Canada yields net climate benefits.

2.2 Emissions impact on commercial buildings

In August 2020, researchers in Europe reviewed 39 studies on teleworking from around the world and analyzed its impact on changing energy use and emissions in buildings.[18] They found that in situations where workers telecommute part-time, while the business maintains the same size of commercial space, net energy use and emissions benefits were neutral or marginal at best. Energy demand benefits were only realized when office spaces were downsized.

Commercial floor space in Canada is anticipated to grow by 13% by 2030, while energy efficiency improvements are expected to reduce emissions from the commercial buildings sector by 10% (from 42 Mt CO_2e in 2017 to 38 Mt CO_2e) by 2030.[19] These reductions are primarily achieved through energy efficiency improvements such as stronger building codes, increased energy benchmarking, and more energy-related

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[16] Daniel Crow, Ariane Millot, *Working from home can save energy and reduce emissions. But how much?* (International Energy Agency, 2020). https://www.iea.org/commentaries/working-from-home-can-save-energy-and-reduce-emissions-but-how-much

[17] Statistics Canada, "Study: Long commutes to work by car," February 25, 2019. https://www150.statcan.gc.ca/n1/daily-quotidien/190225/dq190225a-eng.htm

[18] Andrew Hook et al, "A systematic review of the energy and climate impacts of teleworking," *Environmental Research Letters* 15, 9 (2020), 3003. https://iopscience.iop.org/article/10.1088/1748-9326/ab8a84

[19] Government of Canada, *Canada's Fourth Biennial Report on Climate Change* (2019), 127. https://unfccc.int/documents/209928

retrofits. A similar trend is seen in residential buildings, with GHG emissions expected to drop by 9.3% over the same period.

To maximize emissions reductions in the building sector in Canada, efforts must combine energy efficiency improvements with decentralized work styles through digital adoption when possible. Teleworking must be widespread and adopted by Canadians full-time to lead to significant net emissions reductions from commercial buildings as tenants downsize office spaces.

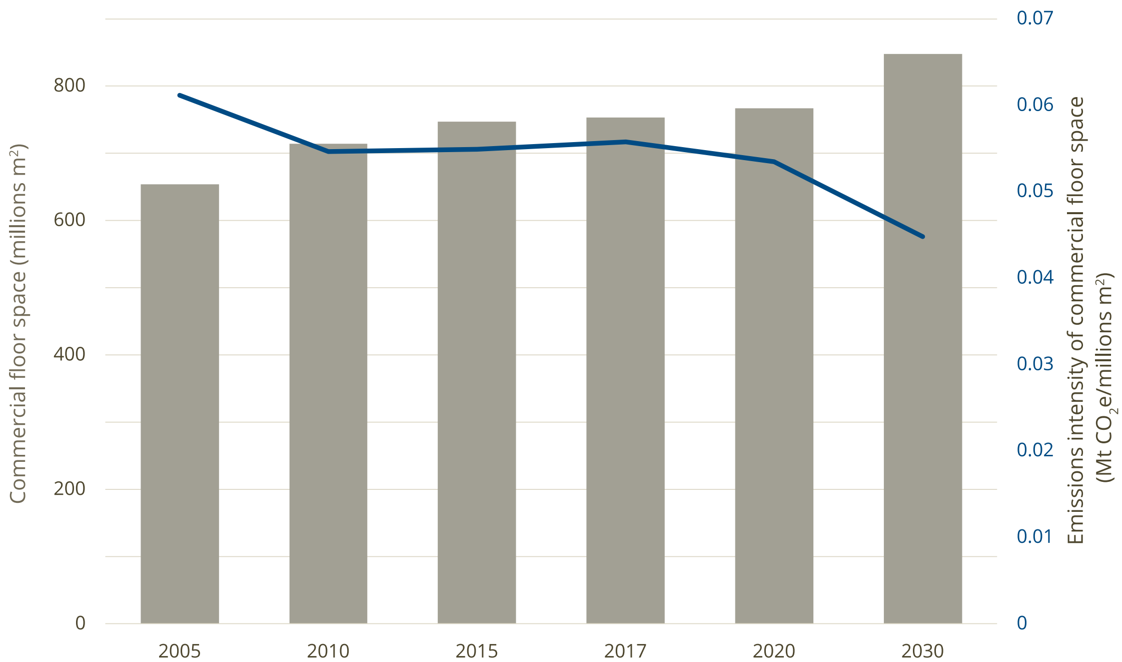

Figure 4. Energy efficiency improvements will lead to lower emissions intensity in commercial spaces by 2030

Data source: Environment and Climate Change Canada[20]

2.3 Emissions impact of increased internet use

While emissions from passenger vehicles in Canada were dropping, it might not be surprising to see that stay-at-home orders also led to a higher demand for residential heating and electricity. Studies from around the world show that the increase was quite high, rising by almost a third in some countries. The International Energy Agency (IEA) reported that some parts of the United States saw an increase of residential electricity

[20] *Canada's Fourth Biennial Report on Climate Change* (2019), 127.

use on weekdays of 20-30%, while in the U.K., residential electricity demand jumped by 15%.[21]

In Canada, the Canada Energy Regulator estimated that residential electricity demand was the only type of energy use to rise (by 9%) during the pandemic, as shown in Figure 5. There would be an associated rise in emissions from residential heating and electricity. However, emissions from electricity usage would be less in Canada compared to other OECD countries because 81% of the electricity on the Canadian grid comes from non-emitting sources, significantly higher than the OECD average of 29%.[22,23] As we continue to phase out coal and drive towards a decarbonized grid, emissions attributable to electricity use will decrease further.

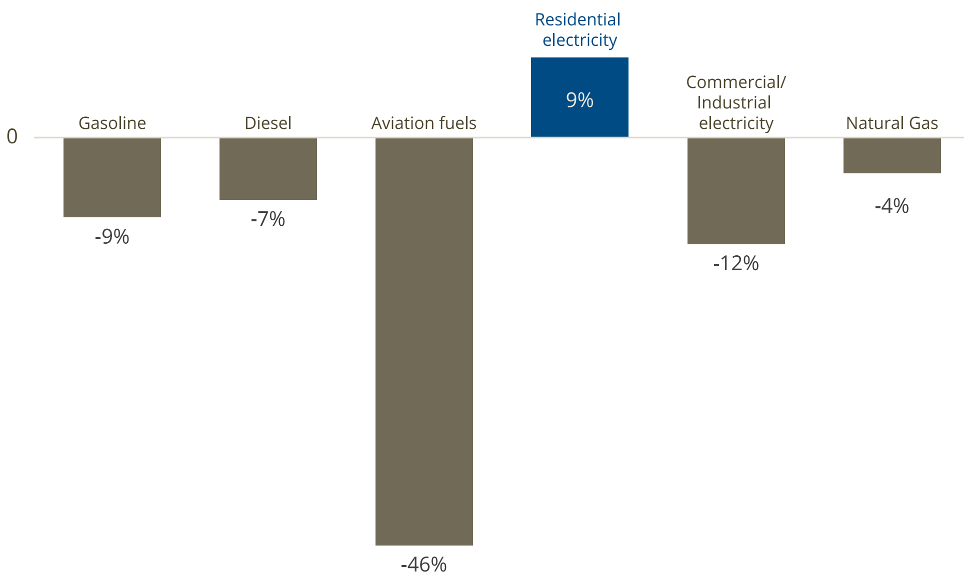

Figure 5. Demand for residential electricity was the only energy end-use demand that increased in Canada during the pandemic

Data source: Canada Energy Regulator[24]

[21] *Working from home can save energy and reduce emissions. But how much?*

[22] Canada Energy Regulator, "Provincial and Territorial Energy Profiles – Canada," April 7, 2021. https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-canada.html

[23] Mathilde Daugy, *Key electricity trends 2019* (International Energy Agency, 2020). https://www.iea.org/data-and-statistics/charts/share-of-renewable-electricity-production-in-oecd-countries-2009-2019

[24] Canada Energy Regulator, *Canada's Energy Future* (2020), COVID-19 Impacts on Energy Demand and Production in 2020. https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2020overview/2020-overview.pdf

The drop in demand for energy from transportation fuels generally aligns with the global GHG emissions trends during the pandemic (as seen in Figure 2). While official sector-specific GHG reductions during the pandemic have not been studied yet in Canada, the rising demand in residential energy demand will cause an increase in residential GHG emissions.[25]

A study of the environmental impact of COVID-19 from increased internet use at home calculated that if teleworking trends continue through the end of 2021, global emissions from increased internet use could grow by 0.07% (34.3 Mt CO_2e).[26,27] Data from this study found that the carbon footprint of internet use is dependent on the electricity generation source of a jurisdiction, directly identifying electricity use as the primary cause of internet emissions. It estimates emissions from electricity generation to power internet data storage and transmission infrastructure and internet access devices, like laptops and TVs.

By examining video streaming as a usage case, the IEA identified three emissions sources from household internet use: access devices, data transmission, and data centres from outside the residential boundary. Emissions from access devices such as phones, computers, and televisions can be directly attributable to residential energy use, and they vary with device size (Figure 6). The IEA data suggests that these emissions are consistent across internet uses with the same data volume and network type.

[25] While buildings are often cooled using electricity, heating demand could be met by electricity or by natural gas in Canada. Heating and cooling demands are variable because they depend on the outside air temperature which varies each year.

[26] Renee Obringer et al, "The overlooked environmental footprint of increasing Internet use," *Resources, Conservation and Recycling* 167 (2021), 105389. http://dx.doi.org/10.1016/j.resconrec.2020.105389

[27] Government of Canada, "Global greenhouse gas emissions", April 15, 2021. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/global-greenhouse-gas-emissions.html

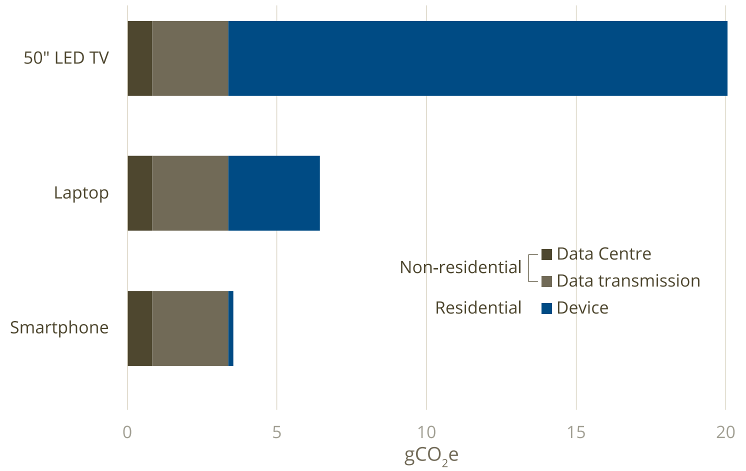

Figure 6. Residential emissions from internet use for an hour of video streaming vary primarily by device size.

Data source: Kamiya[28]

Strategies to decrease residential energy consumption, and subsequently residential emissions, should focus on using smaller or more energy efficient devices. Strategies to improve data centre and transmission emissions need to target efficiency, such as adopting more efficient virtual cloud-based data storage, as well as procuring cleaner sources of electricity by powering data infrastructure with renewable electricity.

Technological developments such as the shift from small data centres to larger, more efficient centres and development of cloud storage have allowed data centre operators to optimize their energy demand.[29] Energy efficiency of data transmission also improves every year. Energy efficiency of traffic flowing through fixed-line networks has doubled every year since 2000 in developed countries[30] and improved by 10 to 30% through mobile networks over the last decade.[31] If the current trends in technology development and energy efficiency continue, the IEA estimates that energy demand of data centres

[28] George Kamiya, "The carbon footprint of streaming video: fact-checking the headlines," *International Energy Agency*, December 11, 2020. https://www.iea.org/commentaries/the-carbon-footprint-of-streaming-video-fact-checking-the-headlines

[29] Google, "About Google Data Centers." https://www.google.ca/about/datacenters/efficiency/

[30] Joshua Aslan et al, "Electricity Intensity of Internet Data Transmission: Untangling the Estimates," *Journal of Industrial Ecology* 22, no. 4 (2018), 785-798. https://doi.org/10.1111/jiec.12630

[31] Hanna Pihkola et al, "Evaluating the Energy Consumption of Mobile Data Transfer—From Technology Development to Consumer Behaviour and Life Cycle Thinking," *Sustainability* 10, no. 7 (2018), 2494. https://doi.org/10.3390/su10072494

will remain flat through 2022 even with an anticipated 60% increase in internet demand.[32]

More Canadians are using the internet during the pandemic

In early 2020, access to broadband facilitated the decrease in travel and the shift to teleworking. Between February 1 and April 19, 2020, global internet traffic spiked by 40% with peak internet use hours — previously from 7 p.m. to midnight — extended by nine hours, from 10 a.m. to midnight.[33]

With the onset of the pandemic and enforcement of stay-at-home orders, Canadians are now spending more time online and more money on digital technologies to access the internet than they did before the pandemic. In a survey conducted by Statistics Canada, 40% of respondents said they were spending more time on social media and messaging services, while almost half of Canadians increased their video streaming time.[34]

[32] George Kamiya, *Data Centres and Data Transmission Networks* (International Energy Agency, 2020). https://www.iea.org/reports/data-centres-and-data-transmission-networks

[33] Sandvine, *The Global Internet Phenomena Report COVID-19 Spotlight* (2020), 5. https://www.sandvine.com/phenomena

[34] Statistics Canada, "Canadians spend more money and time online during pandemic and over two-fifths report a cyber incident," October 14, 2020. https://www150.statcan.gc.ca/n1/daily-quotidien/201014/dq201014a-eng.htm

3. Opportunities to reduce emissions from internet usage

3.1 Impact of Canada’s electricity grid

While 82% of Canada’s electricity comes from non-GHG emitting sources, the electricity generation profile of each province and region varies significantly. For example, approximately 43% of Alberta’s electricity is produced from coal, and 49% from natural gas.[35] In contrast, 95% of British Columbia’s is produced from hydroelectric sources.[36] Alberta has the fourth highest emitting electricity grid in Canada and emits 500 times more CO_2 per kWh than the cleanest electricity grid in Quebec.

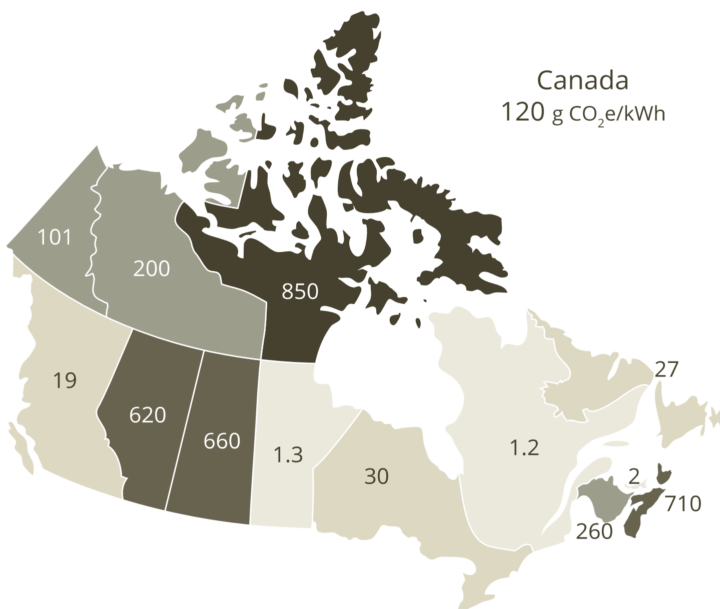

Figure 7. GHG intensities of electricity grids vary significantly across Canada

Data source: Environment and Climate Change Canada[37]

Utilities in Alberta have plans to phase out coal-fired electricity generation by 2023.[38] As Canada progresses towards its 2030 goal of 90% of electricity sources being zero-

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[35] Canada Energy Regulator, “Provincial and Territorial Energy Profiles – Alberta,” March 17, 2021. https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-alberta.html

[36] Canada Energy Regulator, “Provincial and Territorial Energy Profiles – British Columbia,” March 17, 2021. https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-british-columbia.html

[37] *National Inventory Report 1990-2019*, 60-73.

emitting,[39] and Alberta moves toward its goal of 30% renewable energy by 2030,[40] the electricity powering devices and servers will generate lower GHG emissions. However, the unique provincial energy mixes and transportation emission profiles highlight the need to examine the climate implications of increased internet access in Canada on a provincial basis.

It is important to note that electricity grid composition only tells a part of the story on how internet use affects the environment. To understand the environmental impact of the information and communications technology sector, a full life cycle analysis is required that considers emissions from facilities, activities, and infrastructure from construction to decommissioning.

3.2 Offsetting electricity emissions with renewable energy

Companies and organizations can buy renewable electricity directly from solar- or wind-power developers to offset their electricity emissions in a process called corporate renewable energy procurement, or non-utility procurement.[41] Deals between buyers and developers of wind and solar projects provide the certainty needed for renewable energy projects to receive financing and get built. In return, the buyer receives a competitive electricity price and the environmental certificates needed to offset their electricity use for a period usually between 10 and 20 years.

In the U.S. corporate buyers have bought over 35 GW of renewable electricity since 2008,[42] with telecom companies being active buyers. AT&T has committed to going carbon neutral by 2035, with a current portfolio of 1.5 GW in solar projects.[43] T-Mobile has been buying renewable electricity since 2017 and is a member of RE100, a global

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[38] Pembina Institute, "Industry plans herald a coal-free grid in Alberta by 2023," media release, December 3, 2020. https://www.pembina.org/media-release/industry-plans-herald-coal-free-grid-alberta-2023

[39] Government of Canada, "Powering our future with clean electricity," September 1, 2020. https://www.canada.ca/en/services/environment/weather/climatechange/climate-action/powering-future-clean-energy.html

[40] Government of Alberta, "Renewable energy legislation and reporting." https://www.alberta.ca/renewable-energy-legislation-and-reporting.aspx

[41] Pembina Institute and Business Renewables Centre Canada, "Renewable energy for non-utility companies and institutions." https://www.pembina.org/reports/plugging-in-fact-sheet.pdf

[42] Renewable Energy Buyers Alliance, "REBA Deal Tracker." https://rebuyers.org/deal-tracker/

[43] AT&T, "AT&T Moves Closer to Carbon Neutral Future with Solar Energy," November 18, 2020. https://about.att.com/newsroom/2020/invenergy.html

initiative of businesses committed to using 100% renewable electricity, which they plan to achieve this year[44] with deals to date for eight solar and wind projects. Verizon has also committed to carbon neutrality by 2035, with a current portfolio of 1.7 GW across 13 projects.[45]

For scale, the size of the Canadian corporate procurement market is 684 MW.[46] Only two jurisdictions, the deregulated electricity markets in Alberta and Ontario, allow these types of deals in Canada. The other regulated markets in Canada allow corporate procurement to happen with the utility as an intermediary.

Several Canadian telecom companies have committed to carbon neutrality. Bell Canada plans to be carbon neutral across its operations by 2025,[47] and TELUS has committed to carbon neutrality by 2030.[48] So far TELUS is the only telecommunication company that has signed deals to buy renewable electricity in the Canadian market, with 15 MW to finance the Brooks Solar project in 2017 in Alberta,[49] followed by a commitment to buy 80 MW from the Rattlesnake Ridge wind project in 2019,[50] and 40.5 MW from the Strathmore solar project in 2020.[51]

There is still space on two fronts for all ICT companies, not just telecom providers, to increase their ambition to buy renewable electricity from the Canadian market: by setting renewable energy targets with tangible timelines, and by procuring renewable energy to achieve those targets.

[44] T-Mobile, "100% renewable by 2021." https://www.t-mobile.com/responsibility/sustainability/renewable-energy

[45] Verizon, "Verizon becomes a leading corporate buyer of U.S. renewable energy," January 28, 2021. https://www.verizon.com/about/news/verizon-becomes-leading-corporate-buyer-us-renewable-energy

[46] Business Renewables Centre Canada, "Corporate Renewable Energy Deals in Canada." https://businessrenewables.ca/deal-tracker

[47] Bell Canada, "Bell planning for carbon neutral operations in 2025," March 11, 2021. https://www.newswire.ca/news-releases/bell-planning-for-carbon-neutral-operations-in-2025-819133798.html

[48] TELUS, "Sustainability Report 2020". https://www.telus.com/en/social-impact/caring-for-the-environment/sustainability-reports

[49] Elemental Energy, "Project represents milestone for renewable energy in Alberta," January 18, 2018. http://elementalenergy.ca/elemental-energy-completes-brooks-solar-western-canadas-first-utility-scale-solar-project/

[50] Renewable Energy Systems Canada Inc., BHE Canada, "Rattlesnake Ridge Wind Farm." http://www.rattlesnakeridgewind.com/

[51] Capital Power, "Capital Power accelerating plans towards a low carbon future," December 3, 2020. https://www.capitalpower.com/media/media_releases/capital-power-accelerating-plans-towards-a-low-carbon-future/

4. Socioeconomic considerations

4.1 Internet service in rural Canada

The COVID-19 pandemic forced Canadians to find new ways to reach out and stay connected. As stay-at-home orders were put in place, the internet became a personal and professional lifeline for people in all corners of the country. While the importance of having good internet connection was magnified, so was the disparity in access between rural and urban areas.

In 2016, Canada's broadcasting and telecommunications regulatory agency, the Canadian Radio-television and Telecommunications Commission (CRTC), established the minimum acceptable service that would allow Canadians to participate in the digital economy, called the universal service objective. The success of the universal service objective is measured by how many subscribers in a population have access to fixed broadband speeds of 50 megabits per second download speeds, 10 megabits per second upload speeds, and unlimited data allowance.

Across the country, 87.4% of all Canadian households have fixed broadband service compared to only 45.6% of rural households. For households on First Nations reserves, this figure falls to 34.8%.[52]

The latest Communications Monitoring Report[53] published by the CRTC indicates rural Canadian communities had 97.4% mobile (LTE) coverage in 2019, more than twice the coverage of fixed-line broadband,[54] which suggests that wireless networks could be an alternative pathway to improving rural connectivity.

As demonstrated by the pandemic, internet is an increasingly crucial part of Canada's economy. The Federation of Canadian Municipalities notes that broadband access "has

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52 Canadian Radio-television and Telecommunications Commission, "Communications Monitoring Report," December 10, 2020. https://crtc.gc.ca/eng/publications/reports/policyMonitoring/2020/

53 The Communications Monitoring Report provides an overview of the prices, revenues, subscriber data, and technology penetration related to the telecommunications and broadcasting industries in Canada.

54 "Communications Monitoring Report."

the power to transform rural Canada" and the need for broadband connectivity is essential for businesses, schools and other institutions.[55]

4.2 Commuting distances in rural Canada

In a 2016 study, Statistics Canada found that the average one-way commuting distance for *long* commutes was 57 kilometres.[56] Further analysis found that approximately half of commuters from rural areas worked in a large urban centre, suggesting that they are more likely to have long commutes, while half worked in their own communities or travelled to another rural community for work.[57]

To complement this, a study in the U.S. found that drivers from rural areas drove 10 miles a day more than drivers from a city centre and eight miles per day more than their suburban counterparts.[58]

Reducing the time rural workers need to spend on the road by increasing rural broadband to enable teleworking has the potential for significant emissions reductions from road transport.

The ability to reduce emissions from commuting sheds some light on the importance of increasing broadband access in rural areas. Of course, it will take years and significant investment from the public and private sector for this transition to happen noticeably, and at this stage it is too early to estimate the indirect environmental impacts from such a shift.

[55] Federation of Canadian Municipalities, *Broadband Access in Rural Canada: The role of connectivity in building vibrant communities* (2014). https://fcm.ca/sites/default/files/documents/resources/report/broadband-access-rural-canada.pdf

[56] Tetyana Yaropud, Jason Gilmore, Sebastian LaRochelle-Cote, *Results from the 2016 Census: Long commutes to work by car* (Statistics Canada, 2019). https://www150.statcan.gc.ca/n1/pub/75-006-x/2019001/article/00002-eng.htm

[57] Statistics Canada, "Commuters by place of residence and place of work," May 14, 2015. https://www150.statcan.gc.ca/n1/pub/75-001-x/2008111/tables-tableaux/10720/tbl-002-eng.htm

[58] United States Department of Energy, "Rural vs. Urban Driving Differences," December 24, 2012. https://www.energy.gov/eere/vehicles/fact-759-december-24-2012-rural-vs-urban-driving-differences

4.3 5G can unleash new climate benefits

The fifth generation of wireless communications technology, called 5G,[59] is the next step in connectivity for Canadians. 5G allows people to share large amounts of information much more quickly than was possible with previous technology. 5G is up to 100 times faster than 4G LTE and enables speeds up to 20 Gbps. It will open the door to new types of digital interaction, communication, and instant data gathering through smart sensors and will enable technologies that evolve our communities into smart cities.

In smart cities, activities are connected and communicate through the internet, a network called the "Internet of Things" (IoT). The ability to transfer large amounts of information amplifies the ability of the IoT to automate and optimize massive systems like electricity generation and distribution. The Global System for Mobile Communications Association (GSMA), a global industry association of mobile network operators, estimates that the IoT network will double from 12 billion connections in 2019 to 25 billion connections by 2025.[60] The more information that can be collected, the more realistic the possibility of optimizing these massive systems to meet resource objectives like improving energy efficiency of buildings, reducing transportation emissions through telematics, and transforming smaller renewable generation stations into large virtual power plants.

The higher network coverage of mobile networks compared to fixed broadband network suggests that mobile 5G could be a more successful way to deploy faster speeds in rural areas. Even though Canada boasts one of the fastest 4G mobile networks, policies favouring coverage over speed has led to limitations in small-scale consumer uses such as enabling videoconferencing, cloud sharing, and streaming, which require higher speeds.

The deployment of 5G however is not free of skepticism from environmental experts. France's High Council on Climate, an independent government advisory board, found that deploying 5G could increase emissions of the country's technology sector by 18% to

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[59] Government of Canada, "What is 5G?" July 20, 2017. https://www.ic.gc.ca/eic/site/069.nsf/eng/00077.html

[60] GSM Association, *The Mobile Economy 2020* (2020), 30. https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/03/GSMA_MobileEconomy2020_Global.pdf

45%.[61] The study considers emissions from building 5G infrastructure and manufacturing 5G-enabled devices. The analysis however does not consider the emissions reductions benefits that emerge from the use of 5G that were described earlier in this section. To understand the full environmental impact of 5G a full life cycle analysis is required that includes the emissions sources and sinks from its deployment and use. The climate impact of rolling out 5G cannot be judged on deployment of infrastructure and devices alone and must consider its applications for environmental improvement.

[61] Dave Keating, "5G Could Worsen Climate Change, Claims French Government Advisor," December 21, 2020. https://www.forbes.com/sites/davekeating/2020/12/21/5g-could-worsen-climate-change-claims-french-government-advisor/

5. Conclusion

The Canadian government has identified the pandemic recovery as a pivotal moment to invest in sectors that would build back a stronger, more resilient economy. The commitment to achieve a net-zero economy by 2050 requires the government to particularly focus its efforts and investments in economic opportunities that will result in reduced emissions in addition to enhanced economic and social outcomes. Evidence suggests a comprehensive broadband strategy that enables teleworking should be a strong component of these efforts.

To date almost $8 billion of public and private funding has been committed to improving connectivity in Canada.[62] Current efforts include an investment of $2.75 billion for the Universal Broadband Fund to provide better internet access to Canadians,[63] and a Canadian Infrastructure Bank investment of $2 billion for large scale broadband projects in underserved communities.[64]

5.1 Net climate benefit

This report finds that teleworking can have a net climate benefit in Canada if adopted with specific considerations.

The reduction in transportation emissions outweigh the increase in residential emissions for employees who commute in personal vehicles farther than six kilometres. Encouraging teleworking is more impactful in rural Canadians where commuters are more likely to travel farther to work than their urban counterparts.

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[62] Helaina Gaspard, Sahir Khan, *Assessing the efficacy of instruments for the delivery of rural broadband* (Institute of Fiscal Studies and Democracy, 2021), 8. https://www.ifsd.ca/web/default/files/Blog/Reports/2021-04-21_Final report_Assessing the efficacy of instruments for the delivery of rural broadband .pdf

[63] Innovation, Science and Economic Development Canada, "Minister Monsef highlights Budget 2021 investments in small businesses, entrepreneurs and broadband," news release, April 21, 2021. https://www.canada.ca/en/innovation-science-economic-development/news/2021/04/minister-monsef-highlights-budget-2021-investments-in-small-businesses-entrepreneurs-and-broadband.html

[64] Canada Infrastructure Bank, "Growth Plan & Sectors." https://cib-bic.ca/en/partner-with-us/growth-plan/

The emissions reductions in office buildings are only marginally larger than the increase in household emissions when teleworking, and to maximize this benefit teleworking must be widespread and adopted full-time by employees to decrease the demand to power and heat or cool office spaces.

Residential emissions from internet use are primarily attributed to the energy demand of access devices. Industrial emissions from internet use, specifically data centres and data transmission will likely remain flat over the next few years thanks to efficiency and technology improvements.

5.2 Recommendations

The research for this report illustrates the potential for internet use in supporting the decarbonization of Canada's economy. To better understand the GHG emissions reduction potential and the pathways to maximize this potential, the following next steps are recommended:

- Examine Canadian data on internet use through teleworking and the impact on device usage, including the infrastructure for Canada's information and communications technology (ICT) sector.
- Analyze the carbon footprint of teleworking in Canada, with geography specific data where appropriate. A life cycle analysis approach should be taken inclusive of all activities and their indirect emissions.
- Examine potential for reducing the carbon footprint of the ICT sector through options such as purchasing renewable power.
- Study how the ecosystem of infrastructure and programs serving Canadians that participate in the digital economy should be expanded to encourage digital adoption.

To ensure future emissions reductions, governments must recognize the environmental value of connecting homes in rural and underserved areas to broadband, coupled with investments from government and industry in clean energy to ensure all possible emissions reductions are achieved. As Canada continues to stimulate its economy post-pandemic by investing in improving internet infrastructure, that goal should align with the evolution of a clean energy economy and the reduction of future emissions in rural and urban communities alike.