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Correction Notice

The data points in the abstract and introduction sections referring to a reduction in annual greenhouse gas emissions based on complete transition to telework have been modified. In the section titled Reductions in greenhouse gas emissions, the second paragraph referencing overall reduction in the number of kilometres travelled has changed from 35.1 to 38.8 billion and in the seventh paragraph, estimates from Version 3 calculations have been modified as have all data points in Table 8. As a result, the fifth paragraph in the conclusion section has also been modified.

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Working from home: Potential implications for public transit and greenhouse gas emissions

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Abstract

The increase in telework observed in the wake of the COVID-19 pandemic shows that far more workers are able to work from home than had been observed prior to the pandemic. This raises the following questions:

1. What was the unused telework capacity—i.e., the percentage of workers holding jobs that could be done from home but who usually did not work from home most of the time—in Canada and in several cities prior to the pandemic?
2. To what extent would a transition to full telework capacity reduce
    a. the average daily commuting times for new teleworkers
    b. public transit use
    c. greenhouse gas (GHG) emissions?

The study shows that, prior to the pandemic, roughly one in three Canadian workers held jobs that could plausibly be done from home, but usually did not work from home most of the time. Because office jobs— many of which can be done from home—are found predominantly in large cities, this unused telework capacity is greatest in large cities.

The study also finds that a full transition to telework would reduce—for new teleworkers—the average time spent commuting by nearly one hour per day.

Third, the study estimates that the total number of commutes done in a given year by workers who used public transit previously would fall by roughly one-half, thereby reducing demand for public transit by a significant amount.

Lastly, the study shows that a complete transition to telework could lead to a reduction in annual GHG emissions of about 9.5 megatonnes of carbon dioxide equivalent. This represents 6.7% of the direct GHG emissions from Canadian households in 2015 and 12.1% of their emissions due to transportation that year.

Because there are several inherent limitations to the calculations of these figures, these findings are best interpreted as providing a useful **starting point** for quantifying the impacts of transitioning to a remote economy, rather than providing final and uncertainty-free estimates of these impacts.

Keywords: COVID-19, telework, public transit, traffic congestion, climate change

Introduction

During the first few months of 2020, governments around the world began imposing lockdown restrictions to stop the spread of COVID-19 in their communities. The lockdowns caused significant reductions in economic activity. For example, in Canada, real gross domestic product declined by 11.5% in the second quarter of 2020, following large declines in household spending, business investment and international trade (Statistics Canada 2020*a*).

Closures of non-essential businesses pushed many workers into unemployment. However, for others who held jobs that could reasonably be performed from home, the pandemic led many to begin teleworking for the first time. In the last week of March 2020, 39.1% of Canadians worked from home, compared with about 15% who did so at least some of the time before the pandemic began (Statistics Canada 2018, 2020*b*). An analysis of the task content of all types of occupations in the Canadian economy suggests that **telework capacity**—i.e., the proportion of jobs that could plausibly be done from home—is about 40% nationally (Deng, Messacar and Morissette 2020). This suggests that the pandemic pushed the economy to operate near its upper limit for teleworking given the resources and technical capacity of firms at the time. This telework capacity is similar to estimates obtained in related studies from other countries (Dingel and Neiman 2020).

The economic costs of the pandemic to this point have been significant and pervasive, both in Canada and other countries. However, the rapid labour market adjustment to telework offers some potential longer-term benefits for a variety of reasons. For example, telework might—at least for some families— promote better work-life balance and increase job satisfaction, which could in turn reduce employee turnover and boost labour productivity for some firms.

More broadly, from urban planning and environmental perspectives, more widespread adoption of telework would result in less commuter traffic and greenhouse gas (GHG) emissions. This fact is well illustrated by a recent study from the University of Toronto Transportation Research Institute, which analyzed traffic data for highways in the Greater Toronto and Hamilton Area and found that average speeds during peak rush hours along many major highways were approximately 20 kilometres per hour higher in March 2020 compared with the same times one year prior, implying significant decongestion of traffic (Doherty 2020).[1] Similarly, findings published by the Brookings Institution in the United States show that driving levels across cities decreased more during the early stages of the COVID-19 pandemic than at any other time for which data were available, including 11 national recessions and an oil embargo (Tomer and Fishbane 2020). Therefore, the potential impacts of telework on commuter traffic and GHG emissions warrant investigation and are the focus of this study.

Specifically, this study estimates the extent to which commuter traffic would decrease, which modes of transportation would see the largest decreases and the resulting implications for GHG emissions if the Canadian economy were to operate at its maximum telework capacity, expressed relative to the commuter levels that prevailed before the pandemic.

To this end, the analysis proceeds in three stages. First, it provides detailed estimates of **unused telework capacity** across Canadian cities (i.e., census metropolitan areas [CMAs] and census agglomerations [CAs]). Unused capacity refers to the difference between the predicted maximum capacity and the amount of pre-pandemic telework that took place. Focusing the analysis on unused capacity ensures that any estimated effects are benchmarked against what was already occurring. This extends the work done by Deng, Messacar and Morissette (2020) to smaller geographical areas, which is important in the current context because cities vary in size, population density, average commute time

1. Transport Canada also produces a travel time index for key corridors in Canada. According to this index, travel times have dropped, resulting in less traffic congestion over this period.

and reliance on public transit. Moreover, conducting the analysis at the city level is important, as the occupational composition of local economies varies by region, which means that telework capacity is likely higher in some cities than others. The results of this analysis suggest that the overall unused telework capacity is approximately 36%. In other words, roughly one in three Canadian workers held jobs that could plausibly be done from home before the pandemic began but they were not **usually** working from home **most of the time** at that point. Furthermore, small cities have the lowest unused telework capacity, whereas large cities have the highest.

Second, this study estimates the implications of transitioning to full telework capacity on reductions in commute times and the demand for public transit in Canadian provinces and cities. To this end, the amount of time that would be saved each day and year is calculated, assuming all workers who could work from home but were not doing so began to telework. While this analysis documents significant heterogeneity across cities, worker demographics and modes of transportation, one key finding is that the time savings for the average new teleworker are significant. More precisely, it is estimated that a full transition to telework would reduce the average time spent commuting by close to one hour per day for new teleworkers. Because this estimate applies to roughly one in three workers, the implied effect on traffic decongestion is significant.

Another key finding is that the total number of commutes done in a given year by workers who used public transit initially would fall by roughly one-half, significantly reducing demand for public transit.

Lastly, the study shows that a transition to full telework capacity could lead to a reduction in annual GHG emissions of about 9.5 megatonnes of carbon dioxide equivalent (CO2e). This represents 6.7% of the direct GHG emissions from Canadian households in 2015 and 12.1% of their emissions due to transportation that year.

These numbers must be interpreted carefully. They measure the potential impact of a transition to full telework capacity, but do not account for behavioural changes that might result from the COVID- 19 pandemic. For example, once the pandemic is over, risk-averse workers may choose to abandon public transit and instead travel to work by car if a vaccine does not provide complete immunity from the risk of infection. Such behavioural change would limit the reduction in commuter traffic and GHG emissions associated with a transition to full telework capacity. It would also exacerbate the decline in demand for public transit documented in this study. Second, the analysis is based on the assumption that the economy will transition to a point of full telework capacity. Whether such a transition will actually take place once the pandemic is over remains to be seen. Third, several indirect effects of a transition to telework—documented below in the Discussion and limitations section of the study—are not captured.

Nevertheless, the reductions in GHG emissions documented in this study provide a first Canadian estimate of the **direct** potential environmental gains associated with a transition to full telework capacity.

The paper proceeds as follows: the next section describes the datasets and methodologies used, followed by an overview of the results from the three stages of empirical analysis. The paper ends with a discussion of the limitations of the study and concluding remarks.

Data and methods

This study uses three sources of information: a) a telework feasibility indicator, b) the 2016 Census of Population and c) conversion factors that determine the amount of GHG emissions produced by vehicles operating over a given distance.

The telework feasibility indicator was developed by Statistics Canada's Social Analysis and Modelling Division using a crosswalk between the U.S. 2010 Standard Occupational Classification and the 2011 National Occupational Classification (NOC). This binary indicator examines the task content of each four-digit Canadian occupation to determine whether a given occupation could plausibly be done from home.[2,3] To determine how many Canadian workers and which ones hold jobs that could plausibly be done from home, this study links this telework feasibility indicator with the 2016 Census of Population.

The 2016 Census of Population contains data on the number of Canadians who **usually** work from home **most of the time**. By combining this information with the telework feasibility indicator, one can define **telework capacity** as the number of Canadians who hold jobs that can plausibly be done from home or who usually work from home most of the time. **Unused telework capacity** refers to the number of individuals who hold jobs that can be done from home but who do not usually work from home most of the time. These include workers who a) do not work from home or b) usually work from home for only a few scheduled hours.

The distinction between working from home **most of the time** and working from home for **any scheduled hours** is important. While census data show that 3.8% of employees usually worked most of the time from home in 2015, the 2016 General Social Survey shows that 13.5% of employees usually worked some of their scheduled hours at home. Taken together, these figures indicate that, prior to the pandemic, roughly 10% (≈ 13.5% minus 3.8%) of employees usually worked from home, but did not do so most of the time.

The 2016 Census of Population also includes information on a) the mode of transportation Canadians use to get to work (e.g., car, bus, subway, train, bicycle, walking to work), b) the straight-line distance (in kilometres) between their residence and place of work, c) the amount of time (in minutes) it usually takes them to get from home to work, d) the number of weeks worked in 2015, and e) whether these weeks of work were mainly full time or part time. This information is essential for the analyses conducted in this study.

Information on the amount of time required to get to work is used to compute the hypothetical time savings resulting from a transition to full telework capacity, i.e., the reduction in average daily commuting time that potential teleworkers would experience if they started working from home.

Combined with data on the number of weeks worked per year and the number of days worked per week (as approximated by the full-time/part-time distinction),[4] information on workers' mode of transportation is used to compute the hypothetical annual reduction in public transit use that would occur if all potential teleworkers who currently use public transit (e.g., bus, subway or elevated rail, light rail, streetcar or commuter train, passenger ferry) started working from home.

Information on workers' mode of transportation is also combined with the straight-line distance between their residence and place of work to compute the hypothetical reduction in GHG emissions that would result if all potential teleworkers who currently use a GHG-emitting mode of transportation (e.g., car, truck, van, bus, passenger ferry, motorcycle, scooter, moped) started working from home. To determine

2. The methodology used is based on Dingel and Neiman (2020). An occupation cannot be done at home if it meets at least one of several criteria, including—but not limited to—the need to perform for or work directly with the public; work outdoors; operate or repair machinery and equipment; inspect equipment, structures or materials; wear common or specialized protective or safety equipment; handle or move objects; or perform general physical activities. Otherwise, the occupation can be done from home. See Dingel and Neiman (2020) for the complete list of criteria.
3. The indicator uses information from the 2010 Occupational Information Network (O*NET). When a given Canadian occupation (based on NOC 2011) is associated with some O*NET occupations that can be done from home, as well as others that cannot be done from home, an unweighted average across O*NET occupations is computed to measure the telework feasibility of this NOC 2011 occupation. For the purposes of this paper, the telework feasibility indicator is set to 1 for NOC 2011 occupations with an unweighted average of at least 0.5. Otherwise, the indicator is set to zero.
4. See Appendix 1 for details.

the resulting reduction in GHG emissions, kilometres-to-GHG-emissions factors are used.[5] Appendix 1 provides the details of these calculations.

The population of interest for the study consists of individuals who were aged 15 and older in 2016 and who had employment income (from wages or self-employment) and positive weeks worked in 2015. For consistency purposes, additional restrictions are applied to select individuals who worked in Canada and who did not change their CMA, CA or province of residence from 2015 to 2016.[6] This baseline population is used throughout the analysis with additional conditions applied where applicable.

Results

This section proceeds in three stages. First, detailed results of unused telework capacity by city and demographics are presented. Second, the predicted effects on commuter patterns and traffic decongestion are discussed, based on the assumption of full utilization of unused telework capacity. Lastly, implied impacts on GHG emissions are considered.

Unused telework capacity by city and demographics

Table 1 reports the telework capacity and unused telework capacity by CMA and CA for 2015. The numbers indicate that, in 2015, 43.1% of Canadian workers held jobs that could be done from home or usually worked from home most of the time. This corresponds to a telework capacity of 7.6 million workers. The unused telework capacity before the pandemic began was 36.3%, or approximately 6.4 million workers. Overall, 6.8% (i.e., 43.1 % minus 36.3%) of workers usually worked from home most of the time.[7]

5. These conversion factors were provided by Environment and Climate Change Canada. See Appendix 1.
6. The number of weeks worked by Canadians in a given year is a key parameter required to compute the annual reduction in public transit use and GHG emissions that various cities might experience following a complete transition to telework (Appendix 1). Because the number of weeks worked is available only for 2015, city-level statistics on these outcomes can be produced only for 2015. For this reason, the study excludes individuals who changed their CMA, CA or province from 2015 to 2016.
7. This estimate includes both employees and self-employed individuals. The propensity to work from home varies substantially across worker types: the percentage of individuals usually working from home most of the time equals 3.8% for employees (who had no self-employment income in 2015) and 34.1% for self-employed individuals (who had no wages or salary in 2015). This can be seen in the lowest panel of Table 2, by subtracting estimates of unused telework capacity from estimates of telework capacity. Employees represented roughly 85% of all workers in 2015.

Table 1-1
Telework capacity and unused telework capacity, by census metropolitan area and census agglomeration, 2015

	Telework capacity		Unused telework capacity	
	percent	thousands	percent	thousands
All workers	**43.1**	**7,635.9**	**36.3**	**6,430.9**
CMA or CA				
St. John's	41.8	46.8	37.7	42.1
Bay Roberts	26.0	1.4	22.0	1.1
Grand Falls-Windsor	33.9	2.2	31.1	2.0
Gander	36.7	2.4	33.8	2.2
Corner Brook	31.1	4.8	28.1	4.4
Charlottetown	42.2	15.5	36.9	13.5
Summerside	32.4	2.7	28.7	2.4
Halifax	46.8	97.7	40.8	85.4
Kentville	36.1	4.4	29.5	3.6
Truro	36.0	7.9	29.6	6.5
New Glasgow	33.2	5.3	29.4	4.7
Cape Breton	32.7	14.1	29.6	12.8
Moncton	45.1	34.4	39.6	30.2
Saint John	40.5	25.6	35.9	22.7
Fredericton	48.4	25.0	42.9	22.1
Bathurst	33.4	4.8	29.8	4.3
Miramichi	35.2	4.6	31.9	4.2
Campbellton	29.2	2.1	26.0	1.8
Edmundston	30.5	3.5	26.4	3.0
Matane	34.9	3.0	30.2	2.6
Rimouski	42.0	11.5	36.0	9.9
Rivière-du-Loup	35.2	5.1	30.4	4.4
Baie-Comeau	30.9	4.3	27.7	3.9
Saguenay	36.4	28.4	32.0	25.0
Alma	32.0	5.0	27.4	4.2
Dolbeau-Mistassini	27.1	2.0	23.1	1.7
Sept-Îles	33.4	4.9	29.4	4.3
Québec	47.1	201.3	41.7	178.3
Sainte-Marie	39.4	2.8	33.0	2.4
Saint-Georges	36.7	6.0	30.7	5.0
Thetford Mines	32.0	4.1	26.7	3.4
Sherbrooke	40.6	42.1	34.5	35.8
Cowansville	30.5	1.8	25.5	1.5
Victoriaville	36.9	8.7	31.4	7.4
Trois-Rivières	38.4	28.3	33.1	24.4
Shawinigan	33.3	7.6	28.2	6.5

Note: Workers aged 15 and older who worked in Canada in 2015 and did not change their census metropolitan area, census agglomeration or province from 2015 to 2016. CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Table 1-2
Telework capacity and unused telework capacity, by census metropolitan area and census agglomeration, 2015

	Telework capacity		Unused telework capacity	
	percent	thousands	percent	thousands
All workers	**43.1**	**7,635.9**	**36.3**	**6,430.9**
CMA or CA				
Drummondville	34.5	16.4	29.1	13.8
Granby	35.8	15.0	29.6	12.4
Saint-Hyacinthe	33.9	9.6	28.6	8.1
Sorel-Tracy	29.8	5.4	25.6	4.7
Joliette	34.9	7.4	30.6	6.5
Montréal	47.7	1,002.0	41.5	872.5
Salaberry-de-Valleyfield	31.8	5.9	27.6	5.1
Lachute	33.5	1.8	27.5	1.4
Val-d'Or	35.4	6.2	31.8	5.6
Rouyn-Noranda	37.2	8.2	32.8	7.2
Cornwall	31.9	8.2	27.9	7.2
Hawkesbury	27.9	1.3	25.0	1.2
Ottawa–Gatineau	54.6	370.1	48.2	326.7
Arnprior	36.0	2.8	30.0	2.3
Carleton Place	42.9	6.7	34.2	5.4
Brockville	34.6	6.1	27.9	4.9
Pembroke	34.4	3.5	30.1	3.0
Petawawa	37.8	2.1	32.5	1.8
Kingston	42.6	32.7	36.4	27.9
Belleville	35.3	16.5	29.9	14.0
Cobourg	37.2	2.9	30.4	2.4
Port Hope	35.9	2.7	27.3	2.1
Peterborough	39.0	22.2	31.9	18.2
Kawartha Lakes	35.1	11.8	26.6	8.9
Centre Wellington	41.6	5.9	32.1	4.5
Oshawa	42.9	81.6	37.0	70.5
Ingersoll	28.9	1.9	24.8	1.6
Toronto	50.8	1,541.4	44.0	1,335.6
Hamilton	42.9	160.5	36.7	137.0
St. Catharines–Niagara	36.2	70.5	30.3	59.1
Kitchener–Cambridge–Waterloo	42.8	117.8	36.9	101.5
Brantford	35.4	23.3	29.9	19.7
Woodstock	29.9	6.0	26.0	5.2
Tillsonburg	28.8	1.9	24.1	1.6
Norfolk	32.5	9.8	23.5	7.1
Guelph	42.5	34.7	35.8	29.3
Stratford	34.1	5.6	28.0	4.6
London	41.5	101.1	35.3	85.9
Chatham-Kent	35.2	17.0	28.1	13.6
Leamington	29.4	6.5	22.8	5.0
Windsor	34.5	51.1	30.3	44.9

Note: Workers aged 15 and older who worked in Canada in 2015 and did not change their census metropolitan area, census agglomeration or province from 2015 to 2016. CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Table 1-3
Telework capacity and unused telework capacity, by census metropolitan area and census agglomeration, 2015

	Telework capacity		Unused telework capacity	
	percent	thousands	percent	thousands
All workers	**43.1**	**7,635.9**	**36.3**	**6,430.9**
CMA or CA				
Sarnia	33.2	15.0	28.1	12.7
Wasaga Beach	34.8	2.6	27.5	2.1
Owen Sound	34.1	5.1	27.2	4.1
Collingwood	38.8	3.8	29.0	2.8
Barrie	39.5	40.3	33.3	34.0
Orillia	34.9	4.8	29.5	4.0
Midland	31.0	4.8	25.8	4.0
North Bay	39.2	13.1	33.8	11.3
Greater Sudbury	36.6	30.4	32.8	27.2
Elliot Lake	28.2	0.9	22.6	0.7
Timmins	32.6	7.2	29.6	6.5
Sault Ste. Marie	35.3	13.0	32.0	11.8
Thunder Bay	36.1	21.9	32.5	19.7
Kenora	34.3	2.7	30.8	2.5
Winnipeg	42.7	175.0	38.3	157.1
Winkler	33.9	5.0	25.8	3.8
Steinbach	32.6	2.4	28.0	2.1
Portage la Prairie	33.7	2.0	30.8	1.9
Brandon	33.0	9.8	28.5	8.5
Thompson	30.7	2.2	29.1	2.1
Regina	44.1	56.7	39.4	50.6
Yorkton	36.9	3.5	30.6	2.9
Moose Jaw	34.0	5.8	29.6	5.0
Swift Current	35.8	3.5	29.6	2.9
Saskatoon	39.7	63.5	34.2	54.6
North Battleford	36.4	3.5	31.2	3.0
Prince Albert	36.4	7.5	31.6	6.5
Estevan	31.4	2.5	25.5	2.0
Weyburn	33.5	1.9	28.1	1.6
Medicine Hat	31.9	12.3	25.8	10.0
Brooks	31.5	4.0	21.1	2.7
Lethbridge	37.2	22.3	30.4	18.3
Okotoks	43.6	6.3	35.7	5.1
High River	36.7	2.3	29.2	1.9
Calgary	46.9	361.1	40.5	311.7
Strathmore	35.5	2.4	29.8	2.1
Canmore	42.6	3.3	32.0	2.5
Red Deer	32.9	17.9	28.7	15.6
Sylvan Lake	32.6	2.4	27.6	2.0
Lacombe	35.6	2.3	30.7	2.0
Camrose	33.8	3.2	29.1	2.7

Note: Workers aged 15 and older who worked in Canada in 2015 and did not change their census metropolitan area, census agglomeration or province from 2015 to 2016. CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Table 1-4
Telework capacity and unused telework capacity, by census metropolitan area and census agglomeration, 2015

	Telework capacity		Unused telework capacity	
	percent	thousands	percent	thousands
All workers	**43.1**	**7,635.9**	**36.3**	**6,430.9**
CMA or CA				
Edmonton	40.1	289.9	34.9	252.3
Lloydminster	33.4	6.3	28.5	5.4
Cold Lake	28.2	2.1	25.4	1.9
Grande Prairie	32.1	11.5	28.5	10.2
Wood Buffalo	28.3	12.5	24.9	11.0
Wetaskiwin	28.8	1.7	24.7	1.4
Cranbrook	34.7	4.5	28.9	3.8
Nelson	39.9	3.6	28.6	2.6
Penticton	33.8	6.5	26.5	5.1
Kelowna	38.9	37.5	30.4	29.2
Vernon	36.8	10.1	28.5	7.9
Salmon Arm	37.0	2.9	28.6	2.3
Kamloops	35.1	18.1	29.8	15.4
Chilliwack	35.9	16.2	27.4	12.4
Abbotsford–Mission	34.1	29.6	26.8	23.3
Vancouver	46.5	592.7	38.9	496.1
Squamish	39.7	4.1	28.9	3.0
Victoria	45.2	82.8	37.2	68.1
Duncan	35.7	6.8	26.0	5.0
Nanaimo	37.0	17.8	29.5	14.2
Parksville	38.2	3.7	26.9	2.6
Port Alberni	28.4	3.0	22.6	2.4
Courtenay	35.2	8.0	26.1	5.9
Campbell River	31.5	5.5	25.0	4.3
Powell River	28.7	2.0	22.6	1.6
Williams Lake	28.7	2.6	23.1	2.1
Quesnel	27.5	3.1	21.7	2.5
Prince Rupert	28.6	1.9	25.1	1.7
Terrace	32.0	2.6	29.3	2.4
Prince George	34.2	15.9	30.0	13.9
Dawson Creek	28.0	1.8	24.2	1.5
Fort St. John	32.8	5.3	27.1	4.4
Whitehorse	46.3	7.7	39.1	6.5
Yellowknife	48.6	5.7	44.9	5.3

Note: Workers aged 15 and older who worked in Canada in 2015 and did not change their census metropolitan area, census agglomeration or province from 2015 to 2016. CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Telework capacity and unused telework capacity varied substantially across regions. For example, telework capacity and unused telework capacity amounted to 50.8% and 44.0%, respectively, in Toronto—much higher than the corresponding estimates of 26.0% and 22.0% observed for Bay Roberts (Newfoundland and Labrador). The difference likely results from the prevalence of jobs in large cities that are done in an office setting (i.e., so-called white-collar jobs) versus the higher prevalence of agricultural, fishing, construction and manufacturing jobs (i.e., blue-collar jobs) in smaller cities and rural areas. This distinction seems relevant in general, as smaller cities appear to have the lowest telework and unused telework capacities, and large urban centres (e.g., Vancouver, Calgary, Halifax, Montréal, Toronto and Ottawa–Gatineau) all have the largest capacities for telework.

To explore the relationship between telework capacity and workers' personal characteristics, Table 2 presents the results disaggregated by gender, age, educational attainment, immigrant status, marital status, the presence of children (aged 0 to 18) and class of worker. While this analysis is repeated for both telework capacity and unused telework capacity, the findings are consistent with those of Deng, Morissette and Messacar (2020). As a result, only unused telework capacity estimates are described. First, women have a higher unused telework capacity on average than men—a result that is robust across all other demographic characteristics considered. This is because because women tend to be in occupations that are more conducive to teleworking, even compared with their male counterparts employed in the same industry.[8] Second, telework capacity increases with age, which likely arises partly because workers transition into supervisory and managerial positions over time.[9] Third, unused telework capacity is very similar for both Canadian-born and immigrant workers, but it is significantly higher for workers who are married and who have children aged 18 and younger, compared with their counterparts who are either unmarried or do not have children in this age range. Fourth, unused telework capacity increases with educational attainment. Because highly educated workers generally earn more than their less-educated counterparts, this finding suggests that unused telework capacity rises with workers' wages.

8. For example, 23.4% of women were employed in business, finance and administration occupations in 2015 versus 9.1% of men. Because unused telework capacity in these occupations (75.1%) was twice as high as the national average, the overrepresentation of women in these occupations tends to raise their overall unused telework capacity.
9. While unused telework capacity declines somewhat after age 55, the drop may reflect compositional changes in the labour market as some workers begin to retire.

Table 2
Telework capacity and unused telework capacity, by selected worker characteristics, 2015

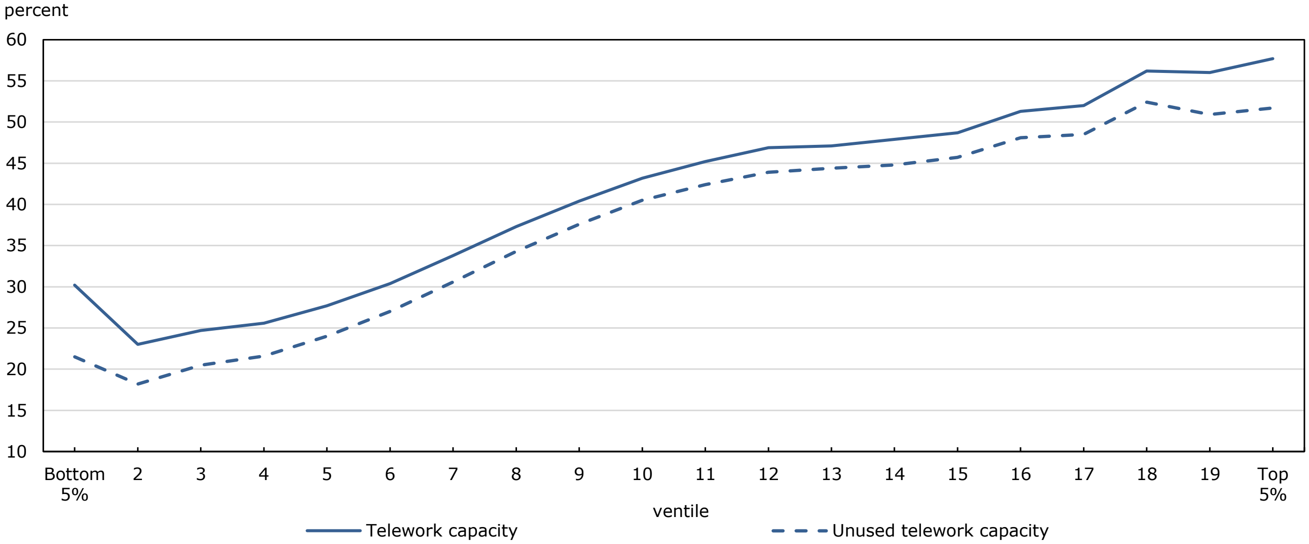
	Telework capacity			Unused telework capacity		
	Both sexes	Men	Women	Both sexes	Men	Women
	percent					
All workers	**43.1**	**35.6**	**50.9**	**36.3**	**29.1**	**43.9**
Age						
15 to 24	20.5	17.2	23.9	18.0	14.4	21.6
24 to 34	43.6	35.4	52.3	39.0	31.3	47.1
35 to 44	49.3	40.9	58.1	42.5	34.9	50.3
45 to 54	47.4	38.7	56.1	40.1	31.9	48.4
55 to 64	45.4	37.3	54.4	36.5	28.5	45.3
65 and older	50.1	45.3	57.5	32.3	27.2	40.1
Education						
Less than high school	18.3	15.0	23.4	12.3	9.1	17.3
High school	33.0	25.0	42.1	27.1	19.6	35.7
Trades certificate or diploma	21.6	14.9	37.2	16.3	10.6	29.6
PSE below bachelor's degree	46.8	38.8	53.0	39.8	31.9	45.9
Bachelor's degree or higher	67.4	67.8	67.1	59.0	58.6	59.3
Immigrant status						
Canadian born	42.9	34.6	51.8	36.1	27.9	44.7
Immigrant	43.5	39.0	48.3	36.6	32.4	41.1
Place of residence						
Living in a CMA or CA	44.6	37.7	51.9	38.4	31.8	45.3
Living outside CMAs and CAs	34.9	25.5	45.5	24.8	15.3	35.7
Married or common law						
Yes	47.9	40.1	56.5	39.8	32.5	47.8
No	35.3	28.1	42.5	30.6	23.4	37.8
Has children up to age 18						
Yes	48.8	40.8	56.6	41.5	34.4	48.4
No	40.4	33.4	48.1	33.8	26.7	41.6
Class of worker						
Has wages and salaries and:						
no self-employment income	41.3	33.6	49.3	37.5	29.8	45.4
self-employment income	51.2	45.0	58.2	37.3	19.9	43.5
Has self-employment income and:						
no wages or salary	55.6	48.5	65.1	21.5	31.7	23.5

Note: Workers aged 15 and older who worked in Canada in 2015 and did not change their census metropolitan area, census agglomeration or province from 2015 to 2016. CMA stands for census metropolitan area, CA stands for census agglomeration and PSE stands for postsecondary education.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Chart 1 confirms this hypothesis. It shows how telework capacity and unused telework capacity vary with workers' weekly wages. Consistent with Deng, Morissette and Messacar (2020), this chart illustrates a clear positive relationship between wages and unused telework capacity, ranging from 21.5% for workers in the bottom 5% of the weekly wage distribution to 51.7% for their counterparts in the top 5%. Therefore, highly paid workers are more likely to be able to work from home. The implications of this finding for earnings inequality are discussed by Messacar, Morissette and Deng (2020).

Chart 1
Telework capacity and unused telework capacity, by weekly wage ventile, 2015



Note: Workers with no self-employment income in 2015 (see text for details).
Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Overall, Table 2 and Chart 1 show that groups of workers who have a high telework capacity also tend to have a high unused telework capacity. This implies that workers who were more likely to hold jobs that could plausibly be done from home were not always taking advantage of telework before the pandemic. Had they done so, unused telework capacity would have been similar across education levels and wages, for example. Such a pattern is not observed in the data.

Relationship between telework and traffic decongestion

Having established that there is significant capacity in the Canadian economy for increased utilization of telework arrangements relative to pre-pandemic levels, the goal of this section is to convert that unused capacity into several metrics of traffic decongestion that would be realized if that capacity were used. This informs the extent to which telework could reduce commuter traffic on roads and public transit. More precisely, two metrics are used throughout this analysis based on the data available:

1. the reduction in average daily commuting time for workers who have the capacity to telework but were not yet doing so (i.e., potential teleworkers), across commonly used modes of transportation

2. the reduction in the annual number of commutes on public transit.

The first metric provides information on the amount of time saved each day for a typical worker who has the capacity to telework but is not yet taking advantage of this time savings. In addition, the estimates are compared with the average number of working days in a year for this group of workers to allow for the annual time savings to be computed. The second metric provides targeted information on demand for public transit to inform urban-planning decisions.

Time savings for potential teleworkers

Table 3 presents estimates of the unused telework capacity of workers and the predicted average reduction in daily commuting times assuming full utilization of unused telework capacity. These results are presented in aggregate and decomposed by mode of transportation. As before, the table shows that unused telework capacity in the economy is 36.3%, but there is also significant heterogeneity by mode of transportation. For example, workers who commute as passengers in a car, truck or van; use a motorcycle, scooter or moped; or walk or take the bus are in jobs that have the least unused telework capacity (27.7% to 38.3%). In contrast, workers who commute by subway, elevated rail, light rail, streetcar or commuter train tend to be in jobs with the greatest unused telework capacity (61.2% to 73.6%).

Table 3
Hypothetical reduction in average daily commuting time resulting from a transition to full telework capacity, by mode of transportation, Canada, 2015

	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers	Percentage distribution of new teleworkers
	percent	minutes	number	percent
Mode of transportation				
Car, truck, van as driver	38.3	49.7	195.3	72.3
Car, truck, van as passenger	27.7	48.8	176.0	4.1
Bus	36.9	86.9	176.2	7.3
Subway or elevated rail	61.2	92.7	191.2	5.1
Light rail, streetcar or commuter train	73.6	111.8	200.8	3.0
Passenger ferry	50.1	96.5	194.6	0.1
Walked	38.3	28.5	181.2	5.4
Bicycle	43.6	45.6	193.3	1.6
Motorcycle, scooter or moped	30.1	44.2	195.8	0.1
Other modes	35.4	52.2	166.6	1.0
All workers	**36.3**	**55.3**	**192.0**	**100.0**

Note: New teleworkers either can work from home but are not doing so currently, or work from home but not most of the time. The number of working days shown in this table refers to the number of working days that involve commuting.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

These estimates are driven at least in part by underlying differences in telework capacity across cities of different sizes and with different commuter patterns and industry compositions. For example, cities with subways, rail, streetcars and trains are larger and, thus, have a larger share of workers in white-collar jobs for whom telework is feasible. Regardless of the selection and compositional factors that drive the results, these estimates have implications for the amount of traffic reduction if all available telework capacity was used. For new teleworkers across all modes of transportation, the average daily commuting time can be expected to decrease by about 55 minutes (i.e., just under 30 minutes in each direction). Since the average number of working days that involve commuting to work in a year is approximately 192 for these workers, this implies a time savings of 7.3 full days annually (i.e., 55 minutes times 192 days divided by 1,440 minutes per day). Coupled with the fact that this time savings is levied on approximately one in three workers, the aggregate effects of traffic decongestion are potentially large.

The reductions in daily commuting times are quite heterogeneous. The time savings are greatest for workers who take a bus, subway, rail, streetcar or commuter train (86.9 minutes to 111.8 minutes), which likely reflects the fact that these commuters reside in large and dense urban areas in which average commute times are high.[10] The time savings are significant among workers who commute by passenger ferry (96.5 minutes), but this category represents only 0.1% of all potential teleworkers. In contrast, the

10. Another possibility is that commute times might be longer when using these modes of transportation—even when distances are relatively short—because of stops and the need to walk and connect to and from transit stations.

time savings are smallest among workers who choose to walk (28.5 minutes), although this is likely because individuals do not usually walk to work when the distance is very far.

To explore how the reductions in average daily commuting times vary by region, Table 4 shows the results by CMA and CA. Larger cities such as Ottawa–Gatineau, Vancouver, Montréal and Toronto continue to exhibit among the largest time savings resulting from the transition to teleworking. In addition, so-called commuter areas such as Port Hope, Arnprior, Carleton Place and Oshawa, in which large shares of the local populations commute to work in larger cities, also exhibit significant time savings.

Table 4-1
Hypothetical reduction in average daily commuting time resulting from a transition to full telework capacity, by census metropolitan area and census agglomeration, 2015

	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers
	percent	minutes	number
Canada	**36.3**	**55.3**	**192.0**
CMA or CA			
St. John's	37.7	35.5	197.9
Bay Roberts	22.0	51.8	179.2
Grand Falls-Windsor	31.1	25.7	182.4
Gander	33.8	24.0	196.7
Corner Brook	28.1	30.0	189.3
Charlottetown	36.9	31.4	192.3
Summerside	28.7	27.9	191.3
Halifax	40.8	49.4	194.3
Kentville	29.5	36.7	186.9
Truro	29.6	39.9	190.0
New Glasgow	29.4	30.8	188.2
Cape Breton	29.6	34.5	181.2
Moncton	39.6	33.8	195.4
Saint John	35.9	39.1	195.2
Fredericton	42.9	34.7	194.5
Bathurst	29.8	31.6	190.6
Miramichi	31.9	31.4	185.5
Campbellton	26.0	26.4	189.9
Edmundston	26.4	24.5	193.8
Matane	30.2	26.5	190.3
Rimouski	36.0	28.4	193.1
Rivière-du-Loup	30.4	26.9	195.0
Baie-Comeau	27.7	26.4	190.3
Saguenay	32.0	33.7	189.1
Alma	27.4	31.5	188.3
Dolbeau-Mistassini	23.1	27.4	188.2
Sept-Îles	29.4	23.1	192.1
Québec	41.7	48.0	196.8
Sainte-Marie	33.0	39.1	196.7
Saint-Georges	30.7	28.3	194.8
Thetford Mines	26.7	28.0	194.2
Sherbrooke	34.5	38.3	188.8
Cowansville	25.5	35.9	191.5
Victoriaville	31.4	29.7	193.5
Trois-Rivières	33.1	37.5	191.2
Shawinigan	28.2	39.6	188.6

Note: New teleworkers either can work from home but are not doing so currently, or work from home but not most of the time. CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Table 4-2
Hypothetical reduction in average daily commuting time resulting from a transition to full telework capacity, by census metropolitan area and census agglomeration, 2015

	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers
	percent	minutes	number
Canada	**36.3**	**55.3**	**192.0**
CMA or CA			
Drummondville	29.1	35.2	192.2
Granby	29.6	41.2	190.3
Saint-Hyacinthe	28.6	39.1	193.9
Sorel-Tracy	25.6	41.8	192.5
Joliette	30.6	41.6	191.5
Montréal	41.5	64.3	191.8
Salaberry-de-Valleyfield	27.6	43.0	192.2
Lachute	27.5	46.3	184.9
Val-d'Or	31.8	30.3	192.4
Rouyn-Noranda	32.8	29.4	190.0
Cornwall	27.9	39.8	186.6
Hawkesbury	25.0	41.1	185.4
Ottawa–Gatineau	48.2	57.8	196.3
Arnprior	30.0	66.5	189.0
Carleton Place	34.2	68.9	197.6
Brockville	27.9	39.7	190.1
Pembroke	30.1	34.6	192.3
Petawawa	32.5	35.0	189.7
Kingston	36.4	40.1	189.6
Belleville	29.9	38.4	191.0
Cobourg	30.4	48.6	187.4
Port Hope	27.3	61.5	186.5
Peterborough	31.9	43.1	190.5
Kawartha Lakes	26.6	62.2	189.9
Centre Wellington	32.1	54.7	196.2
Oshawa	37.0	75.7	193.9
Ingersoll	24.8	46.3	200.0
Toronto	44.0	72.1	193.2
Hamilton	36.7	62.3	193.4
St. Catharines–Niagara	30.3	43.9	190.3
Kitchener–Cambridge–Waterloo	36.9	46.2	194.7
Brantford	29.9	49.8	194.0
Woodstock	26.0	46.2	192.2
Tillsonburg	24.1	46.9	195.6
Norfolk	23.5	49.1	189.6
Guelph	35.8	51.9	193.6
Stratford	28.0	38.0	191.2
London	35.3	43.0	192.1

Note: New teleworkers either can work from home but are not doing so currently, or work from home but not most of the time. CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Table 4-3
Hypothetical reduction in average daily commuting time resulting from a transition to full telework capacity, by census metropolitan area and census agglomeration, 2015

	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers
	percent	minutes	number
Canada	**36.3**	**55.3**	**192.0**
CMA or CA			
Chatham-Kent	28.1	36.3	188.7
Leamington	22.8	41.4	192.3
Windsor	30.3	37.7	188.9
Sarnia	28.1	32.6	186.8
Wasaga Beach	27.5	63.5	181.7
Owen Sound	27.2	34.8	189.3
Collingwood	29.0	41.9	186.6
Barrie	33.3	62.6	192.5
Orillia	29.5	37.8	190.2
Midland	25.8	40.7	188.6
North Bay	33.8	34.4	191.0
Greater Sudbury	32.8	39.2	192.2
Elliot Lake	22.6	28.1	168.8
Timmins	29.6	28.6	190.3
Sault Ste. Marie	32.0	26.2	188.0
Thunder Bay	32.5	31.3	188.8
Kenora	30.8	23.3	185.9
Winnipeg	38.3	48.4	192.4
Winkler	25.8	22.7	188.8
Steinbach	28.0	28.3	191.2
Portage la Prairie	30.8	24.8	187.9
Brandon	28.5	27.9	191.4
Thompson	29.1	20.6	194.0
Regina	39.4	35.7	197.9
Yorkton	30.6	23.5	196.5
Moose Jaw	29.6	30.2	191.0
Swift Current	29.6	22.5	192.2
Saskatoon	34.2	37.7	192.9
North Battleford	31.2	22.9	188.5
Prince Albert	31.6	28.8	188.8
Estevan	25.5	20.5	194.6
Weyburn	28.1	21.1	187.7
Medicine Hat	25.8	29.9	187.4
Brooks	21.1	28.0	186.3
Lethbridge	30.4	31.0	191.6
Okotoks	35.7	57.1	192.8
High River	29.2	45.8	190.8
Calgary	40.5	54.6	193.3

Note: New teleworkers either can work from home but are not doing so currently, or work from home but not most of the time. CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Table 4-4
Hypothetical reduction in average daily commuting time resulting from a transition to full telework capacity, by census metropolitan area and census agglomeration, 2015

	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers
	percent	minutes	number
Canada	**36.3**	**55.3**	**192.0**
CMA or CA			
Strathmore	29.8	53.1	192.0
Canmore	32.0	44.3	188.1
Red Deer	28.7	33.6	190.6
Sylvan Lake	27.6	42.2	186.1
Lacombe	30.7	33.3	184.7
Camrose	29.1	27.8	187.7
Edmonton	34.9	51.3	193.5
Lloydminster	28.5	25.5	191.8
Cold Lake	25.4	39.3	197.0
Grande Prairie	28.5	29.7	194.6
Wood Buffalo	24.9	51.5	202.9
Wetaskiwin	24.7	34.3	193.5
Cranbrook	28.9	24.3	184.3
Nelson	28.6	35.7	177.2
Penticton	26.5	31.4	184.9
Kelowna	30.4	37.4	188.5
Vernon	28.5	33.1	183.2
Salmon Arm	28.6	28.2	181.3
Kamloops	29.8	35.0	190.7
Chilliwack	27.4	46.2	188.1
Abbotsford–Mission	26.8	48.9	186.6
Vancouver	38.9	60.4	190.9
Squamish	28.9	56.6	192.0
Victoria	37.2	45.1	190.6
Duncan	26.0	45.5	183.5
Nanaimo	29.5	35.8	186.2
Parksville	26.9	38.5	175.7
Port Alberni	22.6	27.2	178.5
Courtenay	26.1	34.2	177.9
Campbell River	25.0	32.8	184.3
Powell River	22.6	23.4	176.5
Williams Lake	23.1	27.9	186.1
Quesnel	21.7	29.2	179.9
Prince Rupert	25.1	18.1	189.3
Terrace	29.3	22.2	187.9
Prince George	30.0	31.5	190.4

Note: New teleworkers either can work from home but are not doing so currently, or work from home but not most of the time. CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Table 4-5
Hypothetical reduction in average daily commuting time resulting from a transition to full telework capacity, by census metropolitan area and census agglomeration, 2015

	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers
	percent	minutes	number
Canada	**36.3**	**55.3**	**204.7**
CMA or CA			
Dawson Creek	24.2	22.2	195.5
Fort St. John	27.1	24.7	191.8
Whitehorse	39.1	31.4	192.0
Yellowknife	44.9	24.6	202.3

Note: New teleworkers either can work from home but are not doing so currently, or work from home but not most of the time. CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

In Table 5, the estimated time savings are further decomposed by demographic characteristics of the workers. Despite the stark differences shown earlier in unused telework capacity across groups (Table 2), the results in this case tend to be more homogeneous, although there are still some differences worth noting. On balance, the reductions in commute times do not vary much by age group, marital status or presence of children in the family. However, there is a positive relationship between time savings and educational attainment; for example, workers with less than a high school diploma would save an average of 46.6 minutes per day compared with 58.5 minutes per day for those with a bachelor's degree or higher. Immigrants and those residing in CMAs or CAs stand to gain the most from teleworking relative to their counterparts who are Canadian-born or reside outside of CMAs and CAs, respectively. The higher time savings of highly educated workers and of immigrants likely result—at least in part—from their overrepresentation in large cities (e.g., Montréal, Toronto and Vancouver), in which time savings are generally significant.

Table 5-1
Hypothetical reduction in average daily commuting time resulting from a transition to full telework capacity, by selected worker characteristrics Canada, 2015

	Both sexes			Men			Women		
	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers
	percent	minutes	number	percent	minutes	number	percent	minutes	number
All workers	**36.3**	**55.3**	**192.0**	**29.1**	**58.8**	**199.3**	**43.9**	**52.9**	**186.8**
Age									
15 to 24	18.0	54.5	127.1	14.4	55.6	123.3	21.6	53.8	129.8
24 to 34	39.0	57.0	192.8	31.3	58.2	201.9	47.1	56.1	186.6
35 to 44	42.5	56.7	202.1	34.9	61.3	212.2	50.3	53.5	194.9
45 to 54	40.1	55.1	205.9	31.9	60.0	212.6	48.4	51.9	201.4
55 to 64	36.5	53.3	193.9	28.5	57.4	202.0	45.3	50.5	188.3
65 and older	32.3	49.8	149.4	27.2	52.8	159.8	40.1	46.6	138.7
Education									
Less than high school	12.3	46.6	172.0	9.1	49.0	179.5	17.3	44.6	165.8
High school	27.1	51.5	183.9	19.6	54.9	189.1	35.7	49.3	180.6
Trades certificate or diploma	16.3	50.7	192.9	10.6	54.0	200.7	29.6	48.0	186.3
PSE below bachelor's degree	39.8	54.8	194.1	31.9	60.1	202.2	45.9	52.0	189.8
Bachelor's degree or higher	59.0	58.5	195.7	58.6	60.8	203.1	59.3	56.5	189.6
Immigrant status									
Canadian born	36.1	51.9	192.6	27.9	55.6	199.7	44.7	49.5	187.9
Immigrant	36.6	66.0	191.2	32.4	67.8	199.5	41.1	64.5	184.2
Place of residence									
CMA or CA	38.4	56.6	192.6	31.8	59.5	199.6	45.3	54.5	187.5
Outside CMAs and CAs	24.8	44.5	186.7	15.3	51.1	195.6	35.7	41.3	182.3

Note: New teleworkers can work from home but are not doing so currently, or work from home but not most of the time. CMA stands for census metropolitan area, CA stands for census agglomeration. PSE stands for post-secondary education.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Table 5-2
Hypothetical reduction in average daily commuting time resulting from a transition to full telework capacity, by selected worker characteristrics Canada, 2015

	Both sexes			Men			Women		
	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers	Unused telework capacity (all workers)	Reduction in average daily commuting time for new teleworkers	Average number of working days in a year for new teleworkers
	percent	minutes	number	percent	minutes	number	percent	minutes	number
All workers	**36.3**	**55.3**	**192.0**	**29.1**	**58.8**	**199.3**	**43.9**	**52.9**	**186.8**
Married or common law									
Yes	39.8	55.0	197.4	32.5	59.6	207.1	47.8	51.6	190.1
No	30.6	55.8	180.6	23.4	56.8	180.8	37.8	55.2	180.6
Has children up to age 18									
Yes	41.5	56.1	198.6	34.4	61.6	213.3	48.4	52.2	188.3
No	33.8	54.8	188.1	26.7	57.1	191.1	41.6	53.2	186.0
Class of worker									
Has wages and salaries and:									
no self-employment income	37.5	55.6	193.0	29.8	59.2	200.5	45.4	53.2	188.1
self-employment income	37.3	55.0	187.8	19.9	58.6	196.0	43.5	52.0	181.0
Has self-employment income and no wages or salary	21.5	49.0	177.3	31.7	52.3	186.4	23.5	45.2	167.0

Note: New teleworkers can work from home but are not doing so currently, or work from home but not most of the time.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Impact on public transit

Of all potential teleworkers, 15.5% used public transit in 2015. Because 36.3% of workers are potential teleworkers, the percentage of workers who could work from home and who used public transit in 2015 equals 5.6%. Table 6 presents estimates, for these workers, of the predicted decrease in annual number of commutes using public transit resulting from the transition to full telework capacity. Specifically, the estimates are reported both as the number of commutes (in thousands) and as a percentage of all commutes done by workers who use public transit.

Table 6-1
Hypothetical reduction in the total annual number of commutes on public transit resulting from a transition to full telework capacity, by province and selected census metropolitan areas and census agglomerations, 2015

	Decrease in the total annual number of commutes on public transit	
	Number	As a percentage of all commutes done in 2015 by workers using public transit
	thousands	percent
Canada	**369,921**	**51.8**
Newfoundland and Labrador	334	16.2
Prince Edward Island	88	32.5
Nova Scotia	4,174	44.9
New Brunswick	819	31.3
Quebec	102,997	55.6
Ontario	173,839	54.2
Manitoba	8,405	43.9
Saskatchewan	1,671	35.9
Alberta	34,056	45.5
British Columbia	43,440	45.7
CMA or CA		
St. John's	261	23.8
Corner Brook	14	15.7
Charlottetown	82	42.2
Halifax	4,024	47.6
Cape Breton	54	14.2
Moncton	294	35.8
Saint John	314	35.8
Fredericton	167	39.4
Rimouski	14	22.2
Saguenay	156	31.4
Québec	8,608	54.2
Sherbrooke	409	35.1
Trois-Rivières	91	18.7
Shawinigan	21	24.4
Drummondville	29	25.6
Granby	53	37.6
Saint-Hyacinthe	60	38.1
Sorel-Tracy	68	48.6
Joliette	37	42.6
Montréal	86,765	55.9

Note: CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Table 6-2
Hypothetical reduction in the total annual number of commutes on public transit resulting from a transition to full telework capacity, by province and selected census metropolitan areas and census agglomerations, 2015

	Decrease in the total annual number of commutes on public transit	
	Number	**As a percentage of all commutes done in 2015 by workers using public transit**
	thousands	percent
Canada	**369,921**	**51.8**
CMA or CA		
Cornwall	64	27.7
Ottawa–Gatineau	25,737	61.8
Carleton Place	90	75.7
Brockville	13	23.4
Kingston	554	35.2
Belleville	111	33.9
Peterborough	171	29.4
Kawartha Lakes	37	40.5
Oshawa	3,710	61.5
Toronto	136,436	55.7
Hamilton	5,121	43.5
St. Catharines–Niagara	537	34.6
Kitchener–Cambridge–Waterloo	1,693	35.0
Brantford	118	20.0
Woodstock	20	22.1
Guelph	535	34.7
Stratford	31	27.6
London	1,958	37.8
Chatham-Kent	41	35.8
Windsor	344	25.8
Sarnia	82	26.8
Barrie	551	39.7
Orillia	44	21.6
North Bay	100	30.9
Greater Sudbury	313	26.2
Timmins	82	24.9
Sault Ste. Marie	93	24.1
Thunder Bay	145	21.7
Winnipeg	8,255	45.0
Brandon	40	10.4
Regina	900	44.2
Moose Jaw	22	32.5
Saskatoon	694	32.2

Note: CMA stands for census metropolitan area, CA stands for census agglomeration.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Table 6-3
Hypothetical reduction in the total annual number of commutes on public transit resulting from a transition to full telework capacity, by province and selected census metropolitan areas and census agglomerations, 2015

	Decrease in the total annual number of commutes on public transit	
	Number	As a percentage of all commutes done in 2015 by workers using public transit
	thousands	percent
Canada	**369,921**	**51.8**
CMA or CA		
Prince Albert	10	12.8
Medicine Hat	15	7.7
Lethbridge	116	22.7
Okotoks	113	70.6
Calgary	20,581	53.2
Red Deer	111	14.5
Edmonton	11,794	43.6
Cold Lake	15	18.7
Grande Prairie	31	12.7
Wood Buffalo	984	17.0
Penticton	17	19.9
Kelowna	248	23.8
Vernon	25	24.0
Kamloops	135	23.5
Chilliwack	51	24.4
Abbotsford–Mission	214	35.0
Vancouver	39,237	47.5
Squamish	25	35.0
Victoria	2,696	43.2
Duncan	36	34.0
Nanaimo	124	25.4
Courtenay	23	17.4
Campbell River	25	17.8
Williams Lake	18	13.5
Prince George	69	18.4
Whitehorse	65	30.1
Yellowknife	23	39.4

Note: CMA stands for census metropolitan area, CA stands for census agglomeration.
Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

The results of this analysis indicate that full utilization of telework capacity implies 369.9 million fewer public transit commutes per year—or 51.8% of all public transit commutes done by workers based on pre-pandemic traffic patterns.[11] Therefore, telework has the ability to reduce pressures on public transit systems significantly.

Table 6 also presents the results disaggregated by province and by CMA or CA. The numbers show that the reduction in the annual number of public transit commutes would—as a percentage of all commutes

11. The fact that this number (369.9 million) corresponds to roughly half of the commutes done by workers using public transit is consistent with the fact that potential teleworkers who used public transit prior to the pandemic represented roughly half (47.8%) of all workers using public transit.

done by workers who use public transit—be smallest in Newfoundland and Labrador (16.2%) and largest in Quebec (55.6%) and Ontario (54.2%). Likewise, such a reduction would vary substantially across areas, amounting to about 10% or less in communities such as Brandon and Medicine Hat, and to more than 60% in locations such as Oshawa, Carleton Place and Ottawa–Gatineau.

To explore how the reductions in the annual number of public transit commutes vary by mode of transportation, Table 7 presents the results separately for workers who took the bus or any other mode of public transit as their primary mode of transportation before the pandemic. This binary classification is used because all major cities offer bus services, whereas subways and other rail systems are available only in some larger cities. In addition, only selected CMAs are considered, as many CAs do not offer other frequently used modes of transportation because they are smaller. Again, the results of this analysis demonstrate that there are considerable gains from teleworking on traffic decongestion. For example, the average reduction in bus commutes ranges from 27.5% in Hamilton to 61.7% in Ottawa–Gatineau, and for all other modes it ranges from 41.4% in Winnipeg to 82.8% in Kitchener–Cambridge–Waterloo.

Table 7
Hypothetical reduction in the total annual number of commutes on public transit resulting from a transition to full telework capacity, by mode of transportation and selected census metropolitan areas, 2015

	Mode of transportation			Mode of transportation		
	Bus	**Other**	**Total**	**Bus**	**Other**	**Total**
	thousands			as a percentage of workers using this mode of transportation		
CMA						
Québec	8,450	158	8,608	54.0	67.6	54.2
Montréal	30,922	55,843	86,765	43.7	66.1	55.9
Ottawa–Gatineau	25,481	256	25,737	61.7	70.1	61.8
Toronto	33,014	103,422	136,436	34.1	69.8	55.7
Hamilton	2,304	2,817	5,121	27.5	82.7	43.5
Kitchener–Cambridge–Waterloo	1,543	150	1,693	33.1	82.8	35.0
Winnipeg	8,243	12	8,255	45.1	41.4	45.0
Calgary	8,919	11,661	20,581	43.1	64.7	53.2
Edmonton	7,545	4,249	11,794	36.6	65.9	43.6
Vancouver	19,102	20,134	39,237	38.7	60.4	47.5

Note: CMA stands for census metropolitan area.
Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network.

Reductions in greenhouse gas emissions

Of all potential teleworkers, 84.0% use a mode of transportation that emits GHGs (e.g., car, truck, van, bus, passenger ferry, motorcycle, scooter or moped). Because 36.3% of workers are potential teleworkers, the percentage of workers who could work from home and are **directly** producing GHGs when commuting is 30.4%. Table 8 assesses the implications—in terms of reduced GHG emissions—of a transition to full telework capacity for these workers.[12]

The first column shows the overall reduction in the number of kilometres travelled (to and from work) that would be achieved if all potential teleworkers who currently use a GHG-emitting mode of transportation

12. When transitioning to telework, workers who currently use subways, streetcars or light trains will reduce their indirect GHG emissions if the electricity needed to operate these modes of transportation requires GHG-emitting sources of energy such as oil, natural gas or coal. Such reductions of indirect emissions are not included in the calculations done in Table 8.

(e.g., car, truck, van, bus, passenger ferry, motorcycle, scooter or moped) started working from home. Following Boscoe, Henry and Zdeb (2012), this estimate is obtained by scaling up straight-line distances by a factor of 1.417 to approximate actual distances from home to work. The resulting number suggests that the overall reduction in the number of kilometres travelled would amount to 38.8 billion.

To convert the annual distance travelled in a given year into GHG emissions, the GHG emission conversion factors shown in Appendix 1 are used.

These conversion factors indicate that light-duty vehicles (e.g., cars, hatchbacks, sedans) that use gasoline emit 0.0208061 tonnes of CO2e per 100 kilometres travelled. For light-duty trucks (e.g., vans, minivans, SUVs, crossovers and trucks), the corresponding factor equals 0.0282798 tonnes of CO2e per 100 kilometres travelled.

Compared with cars, hatchbacks and sedans, vans, minivans, SUVs, crossovers, and trucks emit more GHGs. However, these two groups of vehicles cannot be distinguished in the census data—they are grouped together under “cars, vans and trucks.” For this reason, three types of calculations are performed.

Version 1 of these calculations assumes that, except for buses, all modes of transportation have a conversion factor of 0.0208061 tonnes per 100 kilometres travelled. Buses are then assumed to have a conversion factor of 0.0282798 tonnes per 100 kilometres travelled. Version 2 uses a conversion factor of 0.0282798 tonnes per 100 kilometres travelled for all modes of transportation. Since Version 1 tends to underestimate the reduction in GHG emissions resulting from a full transition to telework, whereas Version 2 tends to overestimate it, Version 3 uses a simple average of the estimates obtained from versions 1 and 2. Version 3 is the preferred calculation. Estimates from all three versions are shown in Table 8.

Estimates from Version 3 suggest that a transition to full telework capacity would reduce GHG emissions by 9.53 megatonnes of CO2e on an annual basis. This represents 6.7% of the direct GHG emissions from Canadian households in 2015 (142.94 megatonnes) and 12.1% of their GHG emissions from transportation (78.65 megatonnes from motor fuels and lubricants) that year.[13]

The lower panel of Table 8 shows that most of this reduction would come from the decrease in the personal use of cars, vans and trucks. This is expected, as most potential teleworkers use cars, vans and trucks to commute (Table 3). Table 8 also shows that Ontario’s contribution to the nationwide reduction in GHG emissions would be 44.4%, exceeding its share of the Canadian population in 2015 (38.3%). Part of this difference likely reflects the high unused telework capacity observed in cities such as Ottawa and Toronto.

13. See Wang and Mamane (2019) and https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810009701.

Table 8
Hypothetical reduction in annual greenhouse gas emissions resulting from a transition to full telework capacity, by province or territory and mode of transportation, 2015

	Nationwide annual reduction in kilometres (estimated distance)	Nationwide annual reduction in greenhouse gas emissions		
		Version 1	Version 2	Version 3
	thousands	tonnes of CO2e		
Canada	**38,808,456**	**8,079,178**	**10,974,973**	**9,527,075**
Newfoundland and Labrador	449,068	93,452	126,996	110,224
Prince Edward Island	141,771	29,501	40,093	34,797
Nova Scotia	965,988	201,073	273,180	237,127
New Brunswick	797,988	166,059	225,670	195,864
Quebec	8,766,043	1,825,112	2,479,024	2,152,068
Ontario	17,224,419	3,585,746	4,871,040	4,228,393
Manitoba	1,178,155	245,273	333,181	289,227
Saskatchewan	995,952	207,251	281,654	244,452
Alberta	4,493,102	935,361	1,270,643	1,103,002
British Columbia	3,732,345	777,109	1,055,502	916,305
Yukon	38,288	7,969	10,828	9,398
Northwest Territories	21,271	4,426	6,015	5,221
Nunavut	4,065	846	1,150	998
Mode of transportation				
Car, truck, van as driver	37,800,106	7,864,737	10,689,813	9,277,275
Car, truck, van as passenger	896,047	186,433	253,401	219,917
Bus	62,118	17,567	17,567	17,567
Passenger ferry	556	116	157	137
Motorcycle, scooter or moped	49,628	10,326	14,035	12,180

Note: Version 1 uses a conversion factor of 0.0208061 tonne of CO2e per 100 kilometres for all modes of transportation except buses. Version 2 uses a conversion factor 0.0282798 tonne of CO2e per 100 kilometres travelled for all modes of transportation. Version 3 is a simple average of the estimates obtained from versions 1 and 2.

Sources: Statistics Canada, 2016 Census of Population; Occupational Information Network; Environment and Climate Change Canada, greenhouse gas emission conversion factors.

Discussion and limitations

To obtain the estimates of traffic decongestion and reduction in GHG emissions presented in this study, several assumptions were made, as discussed in Appendix 1. While efforts were made to ensure that the assumptions were reasonable and justified, several caveats and limitations are important to note.

First, actual decreases in commuter traffic experienced at the onset of the COVID-19 pandemic may not align with predictions from this study. The pandemic resulted in mass layoffs and involuntary absenteeism among workers who would have otherwise continued to commute to work—even if the economy stayed open but telework capacity were fully utilized (e.g., bar and restaurant employees). These workers, who contributed to the reduced commuter traffic observed during the lockdowns, are not considered to hold jobs that can be done from home— and, therefore, are not counted as potential teleworkers in this study.

Second, the analysis is based on the assumption that the economy transitions to a point of full telework capacity, based exclusively on the determination of which jobs could be done from home employed by Deng, Morissette and Messacar (2020) and Dingel and Neiman (2020). Neither of these assumptions are perfectly accurate.[14,15] Nevertheless, the results of this study are informative with regard to the time savings potential and which modes of transportation would likely be impacted the most from a modest increase in telework.

Third, while this study quantifies the **direct** effects of working from home for workers with different commuter patterns and job types, it ignores several **indirect** effects:

1. Workers with young children may need to travel to bring their children to daycare regardless of whether they return home or go to an office to work (an indirect work-related trip). If this is the case, the reduction in GHG emissions that could be achieved would be smaller than that estimated in this study.

2. Fewer cars on the road mean faster travel times for those who continue to commute, which may reduce GHG emissions for these individuals. This extra reduction in GHG emissions was not incorporated into the estimates presented in the previous section.

3. Fewer cars on the road might also induce some public transit users to start using their own cars, potentially offsetting the initial reduction in GHG emissions.

4. In a post-pandemic labour market, risk-averse workers may choose to abandon public transit and travel to work by car if a vaccine does not provide complete immunity to the risk of infection. This would tend to limit the reduction in GHG emissions associated with a transition to full telework capacity, but would also exacerbate the decline in demand for public transit documented in this study.

5. The pandemic may have an impact on commuters' carpooling behaviours. Those who still must commute to work, as well as those who will commute in the future once they return to their place of work, may be less likely to carpool because of social-distancing measures and safety precautions, partially offsetting the reduction in GHG emissions documented in this study.

6. While emissions reductions resulting from a transition to full telework capacity could generate a reduction in GHG emissions, these may be offset in part by an increase in households' emissions for heating and in-home energy use.

7. The transition to telework for workers who use subways, streetcars or light trains will lead to a decline in **indirect** GHG emissions if the electricity needed to operate these modes of transportation requires GHG-emitting sources of energy such as oil, natural gas or coal. The decline in indirect emissions was not included in the calculations.

It is outside the scope of this paper to model these competing effects, but doing so would be a promising direction in which to expand this research.[16]

14. For example, many workers might prefer to work two to three days per week from home (rather than the full week) while working the remaining days at the office (Bloom 2020). In contrast, the calculations made in this study assume that full-time workers would work from home five days a week.
15. Data from the Labour Force Survey (LFS) show that, of all workers working at least one hour, 29% worked mainly from home in July 2020. Because telework capacity is estimated to equal 43% (Table 1), LFS numbers suggest that the Canadian labour market was operating below telework capacity in July 2020.
16. Another consideration is that the reduction in the number of bus commuters will not necessarily lead to a corresponding reduction in the number of bus trips in the short term. However, maintaining bus trips that are almost unused will unlikely be a sustainable (profitable) option for transit organizations in the long term. As a result, the reduction in the number of bus commuters will most likely lead to a reduction in the number of bus routes/trips in the long term, which in turn would lead to a reduction in GHG emissions.

Conclusion

This paper investigates the extent to which there was unused telework capacity in the Canadian labour market before the onset of the COVID-19 pandemic, as well as the implications of fully utilizing this capacity for both traffic decongestion and reductions in GHG emissions across Canadian cities and provinces.

Overall, the results indicate that approximately 36.0% of Canadians hold jobs that could plausibly be done from home, but were not taking advantage of telework on an intensive basis before the pandemic began. Therefore, there is significant unused telework capacity at the aggregate national level. Cities such as Montréal, Ottawa–Gatineau, Toronto and Vancouver have the largest unused capacity, as many workers in these regions tend to hold white-collar jobs that can be done from home.

The study predicts that, if these potential teleworkers transitioned to working from home exclusively, they would save an average of nearly one hour per day. These gains are the largest for workers in large urban cities with high population densities and long commute times, as well as for those living in cities that neighbour large metropolitan areas for which intercity commuting is common.

A transition to full telework capacity would also reduce the total number of commutes done in a given year by workers who use public transit by roughly one-half, reducing demand for public transit by a significant amount.

Lastly, the study shows that the resulting implications for reductions in greenhouse gas emissions are not negligible. A transition to full telework capacity could generate GHG emissions reductions that represent about 12.1%% of Canadian households' emissions from transportation in 2015.

It is important to emphasize that several limitations should be kept in mind. These limitations have been identified above. While incorporating some of these limitations into more complex calculations would lead to higher estimates of GHG emissions reductions, incorporating other limitations would move estimates of such reductions in the opposite direction. For these reasons, the numbers presented in this study are best interpreted as providing a useful starting point for quantifying the impacts of transitioning to a remote economy rather than providing final and uncertainty-free estimates of these impacts.

It should also be emphasized that widespread telework adoption could have implications for worker retention and firm productivity. Therefore, the social and macroeconomic effects of this transition would likely be much broader. The extent to which telework persists after the pandemic subsides, as well as the resulting implications for worker and firm dynamics, remain to be seen but constitutes an important avenue for future research.

Appendix 1: Methods

Reduction in average daily commuting time

The reduction in daily commuting time that new teleworkers—i.e., individuals who hold jobs that could be done from home but who do not do so currently—would experience equals the number of minutes it currently takes them to get from home to work and back again. The reduction in average daily commuting time is obtained by averaging this statistic across all new (or potential) teleworkers.

Total reduction in the annual number of commutes on public transit

The total reduction in the annual number of commutes on public transit is estimated as follows. First, the number of workers who hold jobs that could be done from home but who do not usually work from home most of the time **and** who use public transit[17] is estimated. For each of these workers, the annual number of commutes, Commutes__i, is obtained by multiplying the number of weeks worked in 2015 by the number of working days per week and by the number of commutes per working day (i.e., two):

Commutes__i = Weeks worked in 2015 * Working days per week * Two commutes per working day

Because the number of working days per week is not available in census data, it is assumed that workers who worked mainly full time in 2015 worked an average of five days per week.[18] Likewise, it is assumed that workers who worked mainly part time in 2015 worked an average of three days per week. Summing Commutes__i across all of the aforementioned workers yields the total reduction in the annual number of commutes on public transit.[19]

Total reduction in annual greenhouse gas emissions

The total reduction in annual greenhouse gas (GHG) emissions that would result from a complete transition to telework is computed as follows. First, the number of workers who hold jobs that could be done from home but who do not usually work from home most of the time **and** who are using modes of transportation that generate GHG emissions is estimated.[20]

Second, the straight distance (in kilometres) between workers' home addresses and their primary work location is used. To approximate workers' actual distance from home to work, the straight distance is scaled up by 1.417, as suggested by Boscoe, Henry and Zdeb (2012).

Once this actual distance is approximated, the annual distance travelled by workers i in a given year is computed as follows:

Annual distance i =

17. Public transit includes bus, subways, elevated rail, light rail, streetcar or commuter train and passenger ferry.
18. The maximum number of weeks is set to 48 to allow for 4 weeks of holidays.
19. Annual working days (i.e., weeks worked in 2015 * working days per week) are multiplied by 0.938 to reflect the fact that, of all of the annual working days of potential teleworkers, 6.2% consist of days worked at home by potential teleworkers who currently work from home but who do not currently do so most of the time. This estimate of 6.2% is obtained from the 2016 General Social Survey.
20. The modes of transportation that generate GHGs are 1) car, truck, van as driver; 2) car, truck, van as passenger; 3) bus; 4) passenger ferry; and 5) motorcycle, scooter or moped.

Actual distance per commute * Two commutes per day * Working days per week * Weeks worked in 2015

It is assumed that workers who worked mainly full time in 2015 worked an average of five days per week, and that their part-time counterparts worked an average of three days per week.[21]

To account for ride sharing, the sampling weight of workers who travel by car, truck, and or van with passengers is divided by 2 if there are 2 people in the vehicle, and by 3 if there are 3 or more people in the vehicle. For bus and passenger ferry users, the assumption of an average capacity of 50 people per ride is adopted. Therefore, the sampling weight of these individuals is divided by 50.

Lastly, to convert the annual distance travelled in a given year into GHG emissions, the GHG emission conversion factors provided by Environment and Climate Change Canada are used. These conversion factors are shown in Appendix Table 1.

Conversion factors indicate that light-duty vehicles (cars, hatchbacks, sedans) that use gasoline emit 0.0208061 tonnes per 100 kilometres travelled. For light-duty trucks (vans, minivans, SUVs, crossovers and trucks), the corresponding factor equals 0.0282798 tonnes per 100 kilometres travelled.

Because vans, minivans, SUVs, crossovers and trucks cannot be distinguished from cars, hatchbacks and sedans in the census data, three types of calculations are performed.

Version 1 of these calculations assumes that, except for buses, all modes of transportation have a conversion factor of 0.0208061 tonnes per 100 kilometres travelled. Buses are then assumed to have a conversion factor of 0.0282798 tonnes per 100 kilometres travelled. Version 2 uses a conversion factor of 0.0282798 tonnes per 100 kilometres travelled for all modes of transportation. Because Version 1 tends to underestimate the reduction in GHG emissions resulting from a full transition to telework, whereas Version 2 tends to overestimate it, Version 3 uses a simple average of the estimates obtained from versions 1 and 2. Version 3 is the preferred calculation.

Table A.1
Converting kilometres into greenhouse gas emissions

	Average fuel efficiency	Gasoline energy content factor	Emissions per vehicle distance travelled
	litres per 100 km	terajoule per megalitre	tonnes of CO2e per 100 km
Light-duty vehicles, gasoline	8.84	33.45	0.0208061
Light-duty trucks, gasoline	12.03	33.45	0.0282798

Note: Average fuel efficiency was obtained from the 2019 Reference Case, E3MC model. The gasoline energy content factor was taken from the 2019 National Inventory Report (NIR). Emissions per vehicle distance travelled are based on a transformation of NIR emission factors from kilotonnes per unit terajoule for carbon dioxide, nitrous oxide and methane into tonnes of CO2e per 100 kilometre using given average fuel efficiencies, gasoline energy content factor and global warming potentials of 1,298 and 25, respectively. Light-duty vehicles include cars, hatchbacks and sedans. Light-duty trucks include vans, minivans, SUVs, crossovers and trucks.

Source: Environment and Climate Change Canada.

21. As is the case for the total number of commutes, the number of annual working days (i.e., weeks worked in 2015 * working days per week) is multiplied by 0.938 when computing annual distances.

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