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Remote work: Not a panacea for environmental problems

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The acceleration of remote work following the COVID-19 pandemic led many to believe that the change in the way the workforce gets around could be a key to reduce carbon emissions in the transportation sector. In practice, however, the statistics do not seem to point to a reduction in road congestion. In a CIRANO study (Dubé et al., 2026), the authors use an agent-based simulation model to assess the potential impact of remote work when home-to-work trips are replaced by other types of travels. The case study focuses on the Quebec City metropolitan area. In a scenario where 40% of employees work remotely, their results suggest that the potential reduction in carbon emissions would be on the order of 10%.

Although remote work is not a new phenomenon and was already well established before the pandemic, it quickly became an accepted norm. In theory, working from home should lead to reduced use of transportation infrastructure, less road congestion and, consequently, fewer carbon emissions. However, this conclusion holds only if home-to-work trips are eliminated and no other trips take their place.

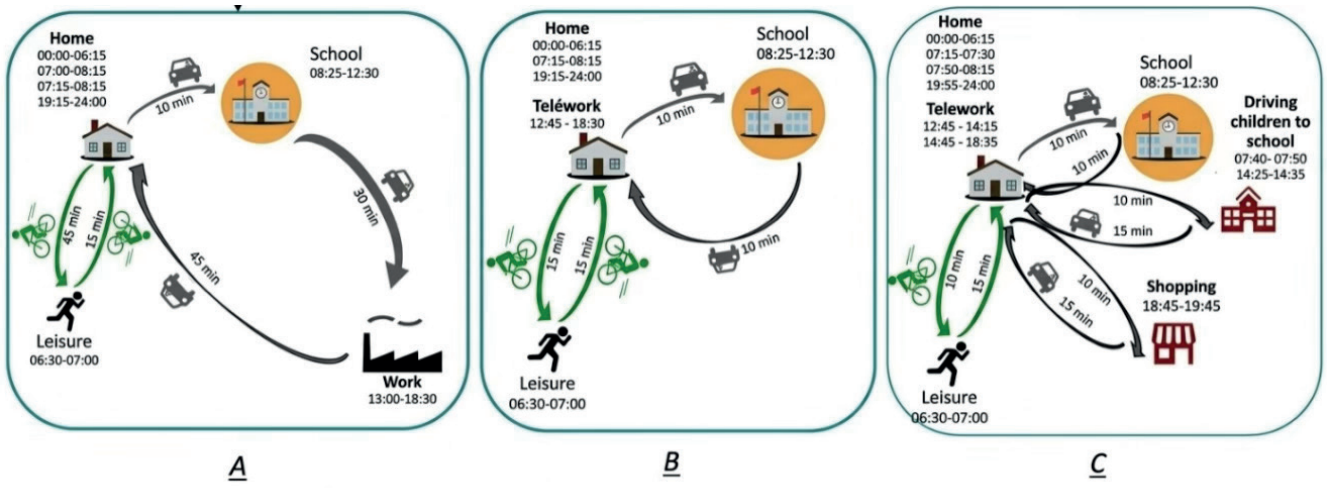
In practice, people do not stay at home on remote work days. Some take children to school, others run errands or use an extended break to engage in leisure activities. Others take advantage of downtime between meetings to go shopping. How do these substitutions affect the use of road infrastructure? How do new transportation demands affect certain environmental indicators? Using an agent-based simulation approach, we set out to address those questions.

The rebound effect

Working from home has not eliminated transportation demand. Instead, remote work has redirected the transportation demand of home-to-work trips toward other activities. This reallocation of trips is referred to as the "rebound effect," that is, the substitution that exists between a potential gain for individuals — the time spent on the road getting to work — and an increase in trips made for other purposes.

A new travel pattern has emerged: star-shaped trips. Rather than linking short stops along the linear trip to work, remote workers now make multiple trips, each one with their home being the start and finish (origin and destination). People go out but return quickly.

Transportation demand has not disappeared but has simply shifted. The figure below illustrates two examples. In the first one, the reference situation reported by a respondent in the origin-destination survey (A) is replaced by a situation in which the home-to-work trip is eliminated (B). In the second example, the reference situation (A) is replaced by a situation in which the trip is replaced by other types of trips related to shopping or leisure (C).



Examples of trip substitution, from A to B or from A to C

Simulating the effects of remote work using the MATSim platform

We used the MATSim platform, short for *Multi-Agent Transport Simulation*, to simulate the impact of likely observable changes. This exercise assumes that remote work only affects trips: no effect is introduced for a possible change in the agents' location, such as a move to the suburbs or a rural area.

The principle behind MATSim and agent-based simulation models is to reproduce the travel conditions of a city, or urban area, on the basis of a reference situation modelled on the available data. The initial calibration yields a picture that reflects the available factual portrait as faithfully as possible. Scenarios then make it possible to compare the impact of certain changes against the reference situation. Once the model is in place, various scenarios are built and used to assess the impacts of specific changes in the built environment relative to a reference scenario, or in the travel habits of the agents (see, for example, Gharavi, Dubé and Ciari, 2025).

In this case, the model for the Quebec City metropolitan area is calibrated on data from Statistics Canada's census (2016) and the property assessment roll (2018) in order to recreate the spatial distribution of households and activities. The origin-destination survey data (2017) are then used to model the agents' trips on the actual habits of respondents. Information on road networks and public transit schedules (2024) delimits the various travel possibilities and constraints faced by the agents.

Pooling the data makes it possible to reproduce an environment that imitates the travel decisions for all agents, who then choose the combination that maximizes their utility. Overall, the model appears to adequately represent the travel habits of the population of the Quebec City metropolitan area. The agents' behaviours accurately reproduce the lengths of actual trips, using all possible combinations.

Remote work has relatively little impact on how people travel

To assess the impacts of remote work on travel habits, we used the MATSim platform and retained a total of six scenarios based on the percentage of workers who work remotely — 10%, 20% or 40% of workers work remotely — and on whether or not there is a rebound effect.

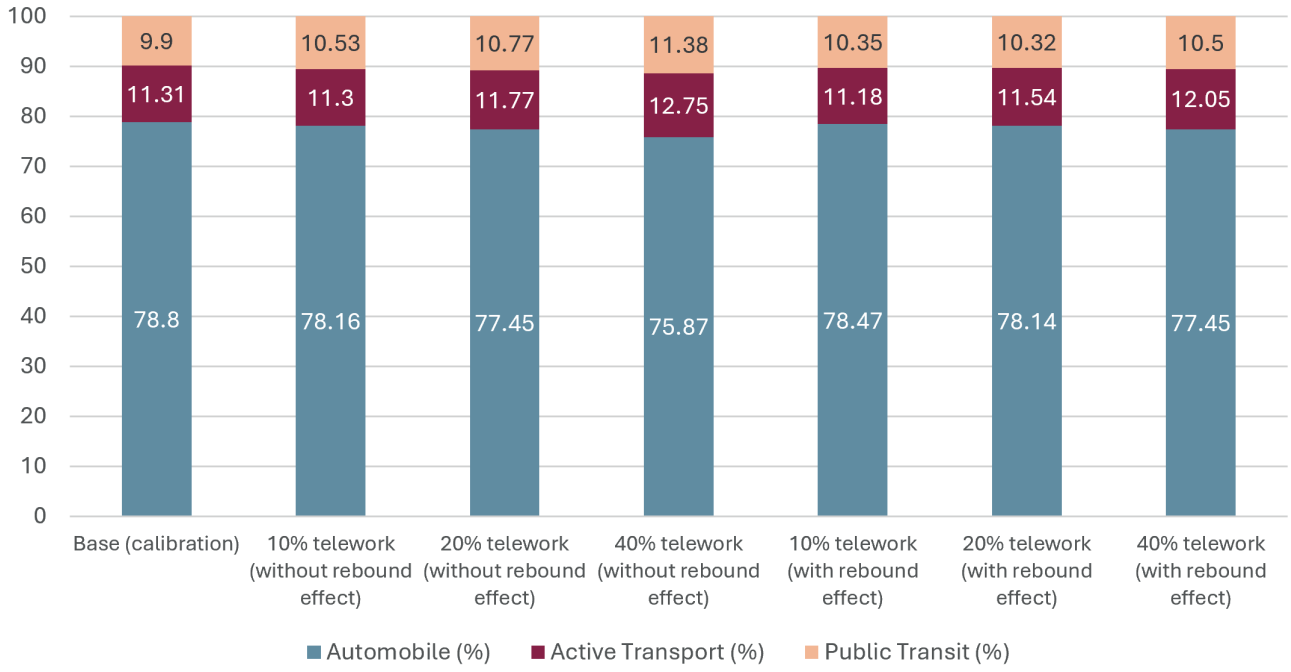
In cases where there is a rebound effect, remote workers are assumed to replace the home-to-work trip with another trip, mainly for leisure or shopping purposes at the end of the day (45% of cases), or to get to a third place to work (30% of cases).

Trip purposes are distributed according to observations from the origin-destination survey, with 64% related to shopping and 36% to leisure.

The results of our simulations suggest that, overall, remote work has relatively little impact on how people travel. The breakdown among car, active transportation and public transit remains relatively constant regardless of the scenario selected.

The proportion of trips made by car accounts for more than three-quarters of the total. In the reference situation, the modal shares of trips are distributed as follows: 78.8% of trips are made by car, 11.31% by active transportation and 9.9% by public transit. The no-rebound scenario shows a larger reduction in car use. In that case, the modal share falls by nearly three percentage points, to 75.87%, when 40% of employees work remotely without adding a trip to their day.

When the rebound effect operates, car use remains higher. The reduction in the car's modal share is then just over one percentage point when 40% of the workforce work remotely. The decline in the car's modal share is split equally between public transit and active transportation.



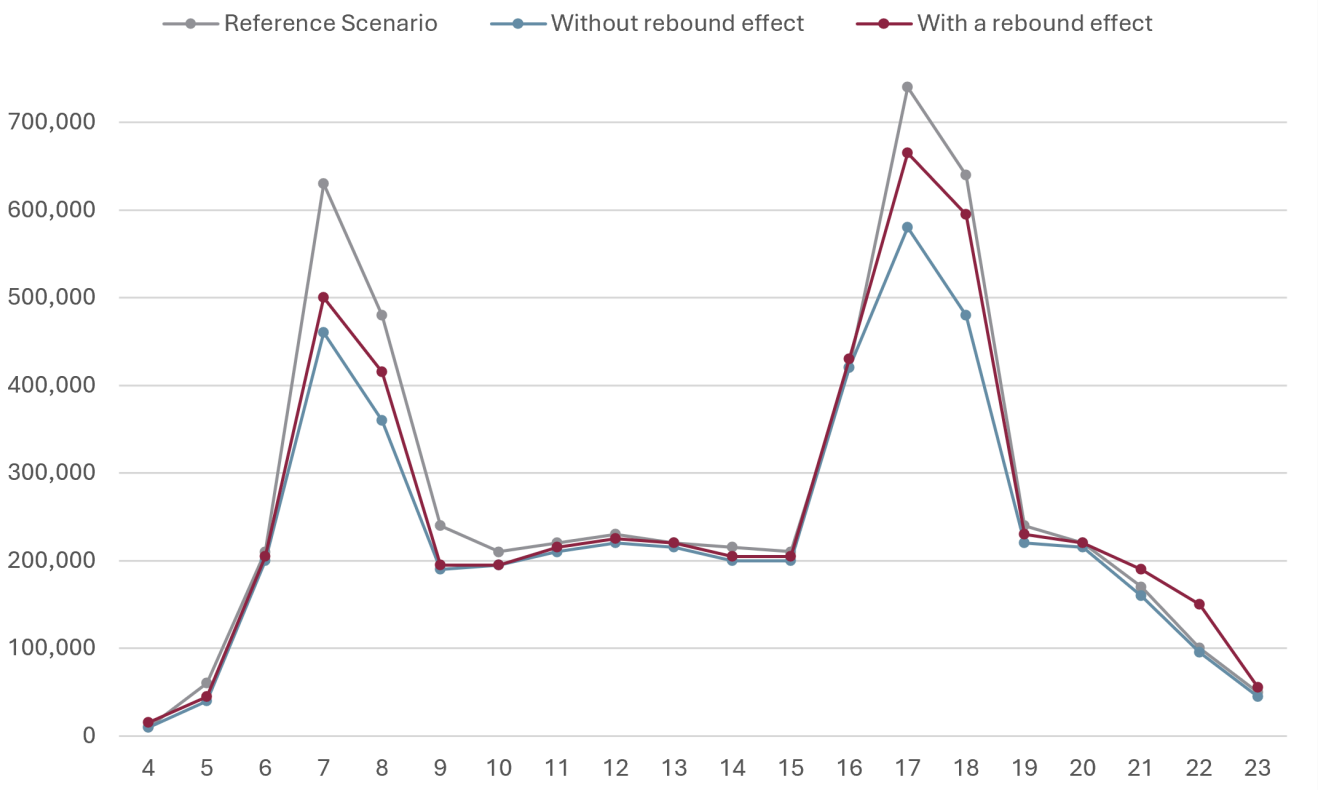
Comparison of trip modal shares across the six scenarios selected

Remote work has a marginal influence on the average length of trips

Distances travelled prove to be a better indicator for quantifying the potential impact on carbon emissions. Assuming that 40% of workers work remotely without replacing the eliminated home-to-work trip, total kilometres travelled decrease by more than 2.4 million. When the rebound effect operates, this decrease in kilometres travelled is less than 1 million. These figures, while impressive, represent, at best, a reduction of 0.34 km on a typical 10-km trip. This result is based on a constant location of agents – a move to the suburbs or rural areas by remote workers could cancel out this gain.

The figure below illustrates the volume of trips made on a typical day, assuming a remote work adoption rate of 40%, with and without a rebound effect. When 40% of home-to-work trips are removed, peak periods remain present on a typical day, even assuming that remote workers stay at home throughout the workday (blue line). Remote work does, however, reduce traffic at peak hours, especially in the morning.

By contrast, the results show an increase in the volume of trips outside peak hours when the rebound effect operates (red line). In this case, the situation is sometimes worse than in the reference scenario. The rebound effect can thus lead to greater use of infrastructure at certain times of the day, despite the prevalence of remote work.



Traffic volume by hour of the day, assuming that 40% of workers work remotely, with and without a rebound effect

Limits of the analysis

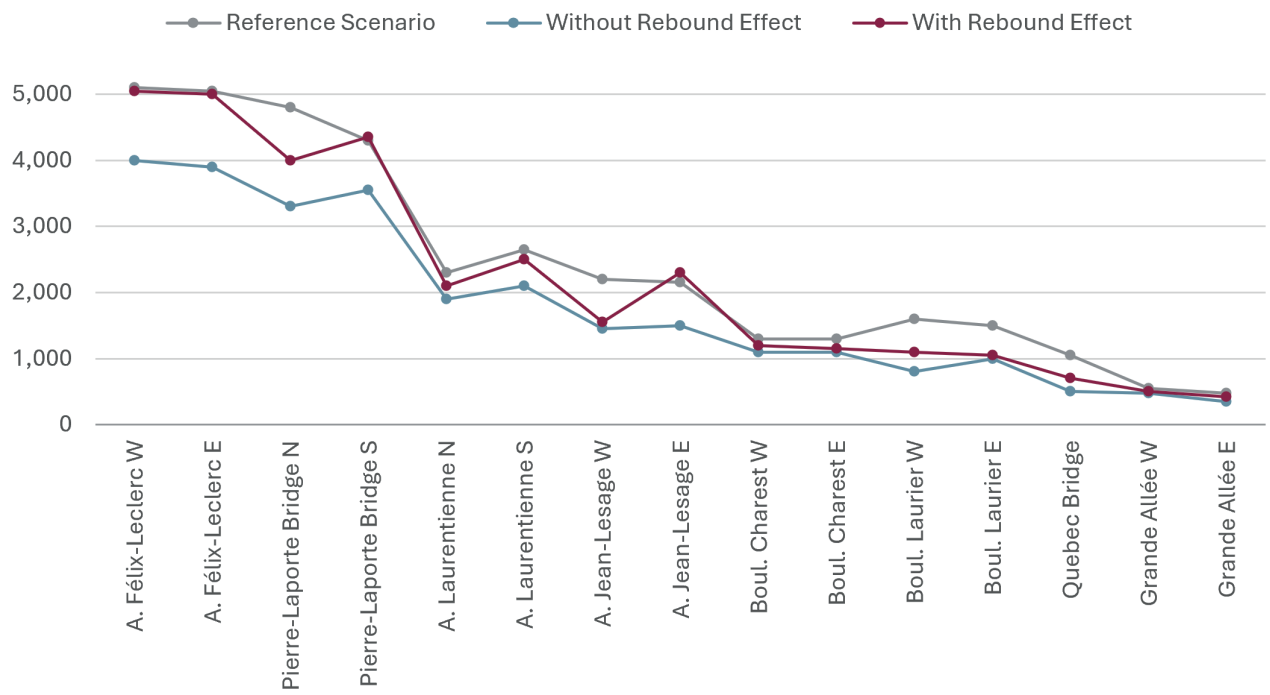
The analyses mask certain realities that could reduce the expected gains. First, the analysis is based on a fixed spatial distribution of households: the comparison lies on the assumption that households keep their location whether or not their occupants work remotely. If it turns out that some remote workers decide to move to the suburbs or rural areas to enjoy certain natural amenities, the results might overestimate the effects of remote work on travel.

Second, the use of a hybrid work arrangement, which is emerging as the most likely approach in the near future, also risks reducing the impact reported in our analyses, in which no remote worker goes to the office at all.

Remote work can result in a form of social inequity

If the rebound effect is present, traffic on certain major corridors in the Quebec City metropolitan area could appear heavy, with remote work in place. This is the case, for example, for the number of vehicles per day on Autoroute 20 (Jean-Lesage) and on the Pierre-Laporte Bridge. This difference in the use of certain segments reveals the spatial heterogeneity of mobility behaviours, but above all the impact of the distribution of households according to the type of job held.

The population of the metropolitan area is not randomly distributed. This heterogeneity in the intensification of transportation infrastructure use, in terms of both volume and timing, shows that the consequences of remote work on travel are not the same for everyone: they vary according to socio-economic profiles, households' financial constraints and, consequently, a household's location. The gains – but above all the costs – associated with remote work are therefore not uniformly distributed across space and, by extension, households.



Traffic volume by road segment according to the baseline scenario, the no-rebound scenario, and the rebound scenario (total number of vehicles per day)

Remote work is not a miracle cure for reducing carbon emissions from the transportation sector

We used statistics on the use of transportation infrastructure to translate our results into carbon emissions. This conversion is carried out using a model based on the HBEFA (*Handbook of Emission Factors for Road Transport*).

In the most optimistic scenario, that is, where home-to-work trips are simply eliminated, the results show that remote work by 40% of workers leads to a 20% reduction in carbon emissions, or half, for most of the indicators selected. With a more realistic scenario, in which some remote workers replace the home-to-work trip with other trips, the gain from remote work by 40% of workers instead materializes as a 10% reduction, or a quarter, for the selected indicators. Adding trips is thus likely to cut in half the potential gains from reducing home-to-work trips.

The analyses suggest that remote work is probably not a miracle solution to the environmental problems generated by individuals' travel choices. While the analyses reveal that remote work can reduce the number of kilometres travelled, it nevertheless reveals certain temporal and spatial variations that indicate local deteriorations in travel conditions. Some segments are used more heavily in the absence of remote work, with infrastructure remaining busier at certain times.

It should be noted that home-to-work trips account for about half of all trips recorded in the origin-destination survey. This means that if other habits remain unchanged, then, in the best case scenario, remote work is likely to influence half of the trips made.

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