NAC Green Rooms Carbon Estimation

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Summary

For a given group of attendees at a conference style event—such as the National Arts Centre's Green Rooms gathering—online gathering through video conference and streaming video provides significant reductions in estimated emissions. This is true for traditional single-location gatherings, as well as distributed events which are programmed across multiple sites to minimize long-haul travel. With an estimated 78% reduction in emissions as a result of eliminating the majority of long-haul air travel through a distributed number of connected gathering hubs, moving to an online-only streaming format is estimated to reduce emissions by over 99% of either a traditional or a hub-based in-person format.

Rationale

The Green Rooms was the culmination of the National Arts Centre's third Cycle. This iteration of the project, focused on climate change, convened conversations about the relationship between the environment and theatre-making in Canada.

In a pre-COVID19 context, the project took an ambitious step to reducing the carbon footprint of convening people together by conceiving of a distributed event across eight sites. Six cities would be in Canada, and two would be international. This would allow for participants to minimize their long-haul travel to a central location and participate from the location most convenient to them.

With the spread of COVID19, the Green Rooms moved online along with all public. This required a hard pivot to a streaming-only format but also meant there would be no significant travel.

To be able to show that the distributed format would reduce the environmental impacts of the event, the CSPA was engaged to estimate the emissions related to the event, and to compare this to the estimated impacts of a more traditional conference-style gathering. This investigation was also modified to look at the impacts related to a streaming, online-only, version of the event.

This brief report on the environmental impacts of the Green Rooms looks at all three models, and has estimated the likely carbon emission related to streaming, distributed, and traditional gathering for confirmed attendees.

STREAMING

Methodology

At the time of registration, attendees provided information about their location and the data connection used for participation. Each session within the event required a separate confirmation and provided a detailed picture of who intended to attend. This was combined with the scheduled length of each event to estimate the duration of each attendee's participation.

Attendance was also organized by the number of days of the event to provide a sense of how much time attendees would have spent at the in-person gatherings were this to have occurred.

Based on the report *On Global Electricity Usage of Communication Technology: Trends to 2030* (Andrae and Edler), which offered that the video signal of a virtual conference on a network path between Switzerland and Japan required 0.2 kWh/GB, and Netflix's ("How Can I Control How Much Data Netflix Uses?") report on streaming video, which estimated high definition video as 3GB/hour, we estimated the power consumption of the event based on 10 watts per minute of viewing.

Laptops were used by 98.5% of attendees (only 3 desktop computers were specified). Based on the expected power consumption of 40w (Ong et al.) by these devices, the total number of viewing minutes was also used to estimate the total power consumption by the devices of attendees who participated in distributed conversations through video conference and viewers who watched the live-stream via Howlround and associated outlets.

Using the provincial Green House Gas (GHG) intensity (CO_2/kWh) from the federal government's Canada Energy Regulator (N. E. B. Government of Canada), along with data from the government of the United Kingdom ("Greenhouse Gas Reporting"), conversions from the Environmental Protection Agency (US EPA) in the United States, and adjusting to the proportional participation from the respective locations, we converted the expected power consumption of the event to kilograms of carbon dioxide (kg CO_2).

Findings

Based on a total of 36,840 minutes of collective attendee participation, resulting in the consumption of 368,400-watt minutes or 6140-watt hours, we estimate roughly 6.14 kWh of consumption. We estimate that attendees generated emissions around 0.61 kg as a result of attendee video conferencing.

Based on a total of 55,963 minutes of viewership through Howlround's livestream by viewers beyond the attendees, resulting in the consumption of 559,630-watt minutes or 9,327-watt hours, we estimate roughly 9.327 kWh of consumption. We estimate that non-attending viewers generated emissions around 0.921 kg.

The total time for both attendees and viewers were used to also establish the anticipated power consumption of the devices used to connect. This was respectively 2.43kg CO_2 for attendee devices, and 3.68kg CO_2 for viewer devices.

The combined emissions resulting from the streaming of the Green Rooms is estimated to be 7.64 Kg CO_2 for the video conferencing model used to realize the Green Rooms in a COVID reality.

HUB MODEL

Methodology

Based on postal codes, attendees were matched with the most likely gathering location from the distributed or "Hub" model for the Green Rooms. Attendees were also matched with the most

likely transportation mode which would allow them to get to their respective hub and broken into five categories:

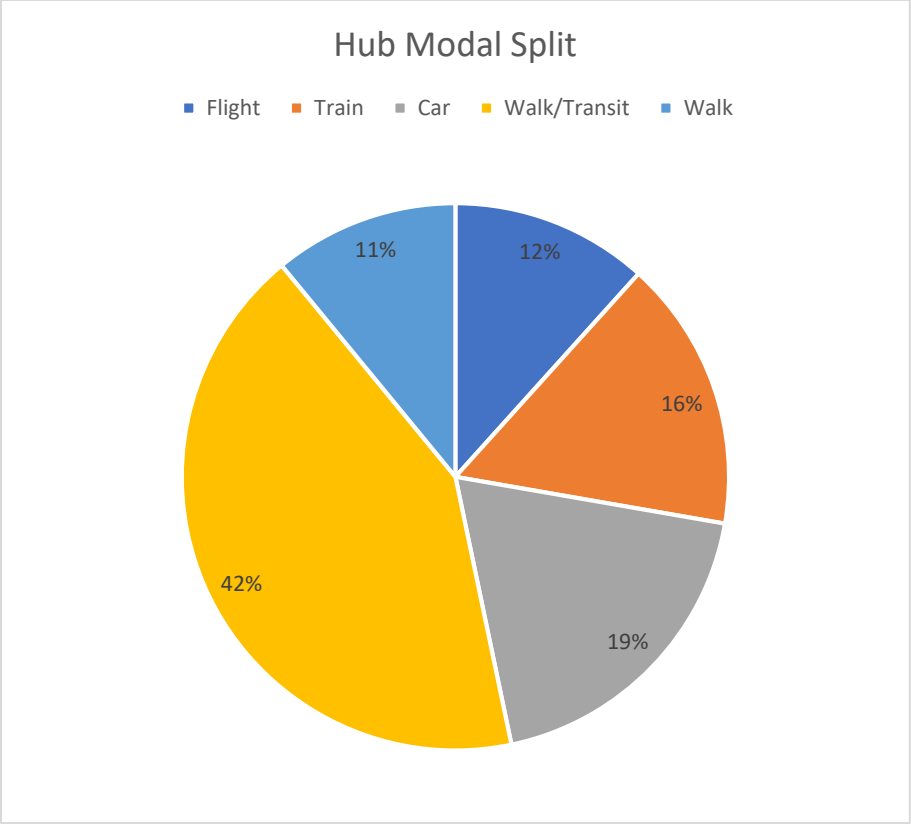
1. Flight – Long distance travel of typically more than 500 km with convenient access to a major airport, and without reasonable rail alternative.
2. Train – Medium to long distance travel greater than 50 km, but typically less than 500 km, along rail line with regular service.
3. Car – Short to long distance travel greater than 50 km, but typically less than 500 km, without access to regular rail or transit service.
4. Walk/Transit – Short to medium distance greater than 2 km within a single transit system.
5. Walk – Less than 2 km travel.

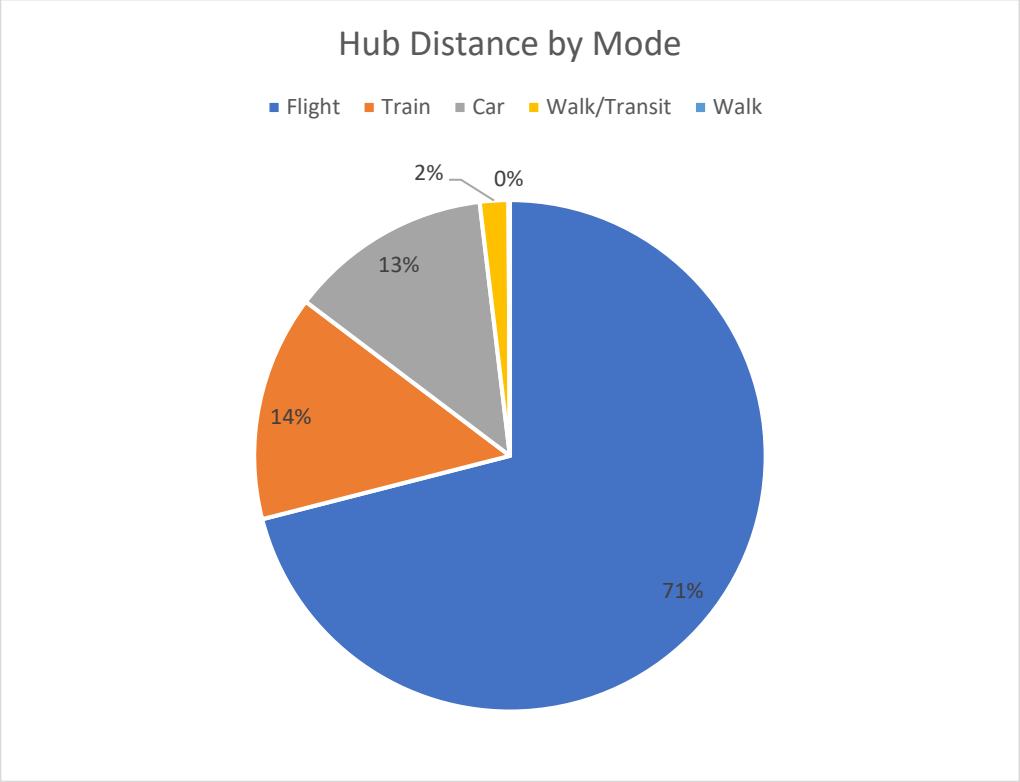
The total distance of these modes of transportation from the attendee's home postal code to the hub venue was calculated using Google maps and the distance calculator www.distance.to ("Distance Calculator - Calculate the Distance Online!"). These distances were then multiplied by an appropriate conversion factor for the mode of transportation in grams of carbon per passenger kilometer. This used the conversions for a Boeing 737-400 for flights (Campbell), VIA rail's carbon calculator ("Compare the Train with the Car and the Plane"), Nature Resources Canada's fuel ratings for a compact sedan (Honda Civic) (*2020 Fuel Consumption Guide*), and the average impact of transit from the US Department of Transportation (*Public Transportation's Role in Reducing Greenhouse Gas Emissions (January 2010)*).

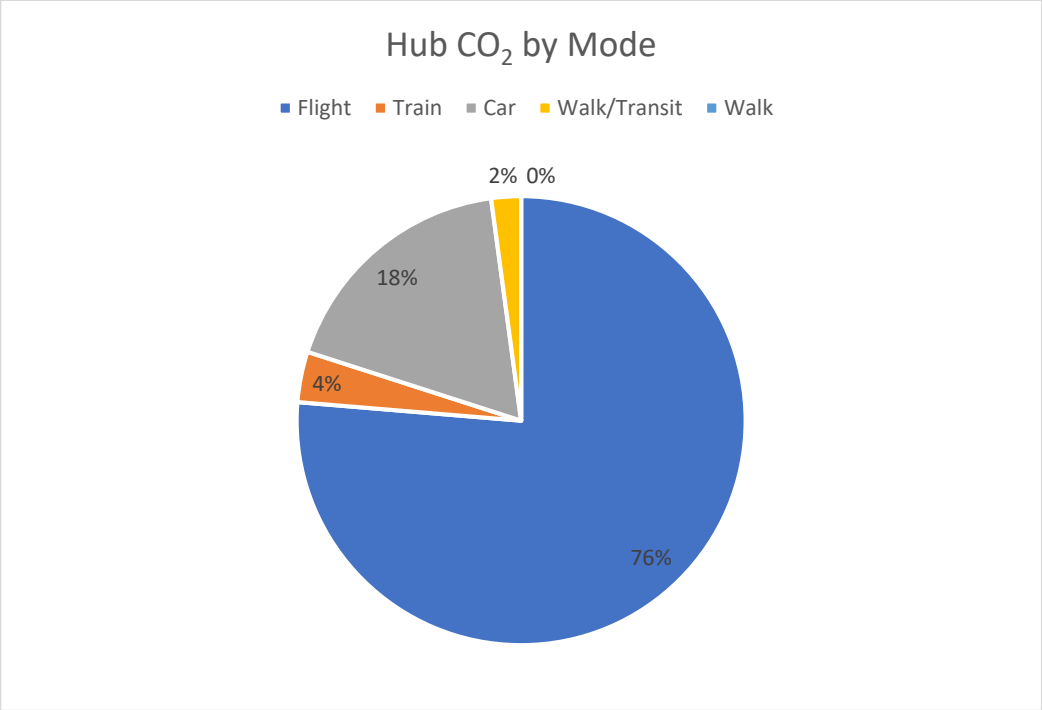
Findings

We have estimated that, based on this distributed model of convening, travel would have resulted in roughly 6,968 kg of CO_2 across all modes of transportation.

The distribution of predicted transportation model, distance traveled, and the resulting emissions are indicated in the figures that follow:


Hub Modal Split
Flight
Train
Car
Walk/Transit
Walk
12%
16%
19%
42%
11%


Hub Distance by Mode
Flight
Train
Car
Walk/Transit
Walk
2%
0%
13%
14%
71%



TRADITIONAL MODEL

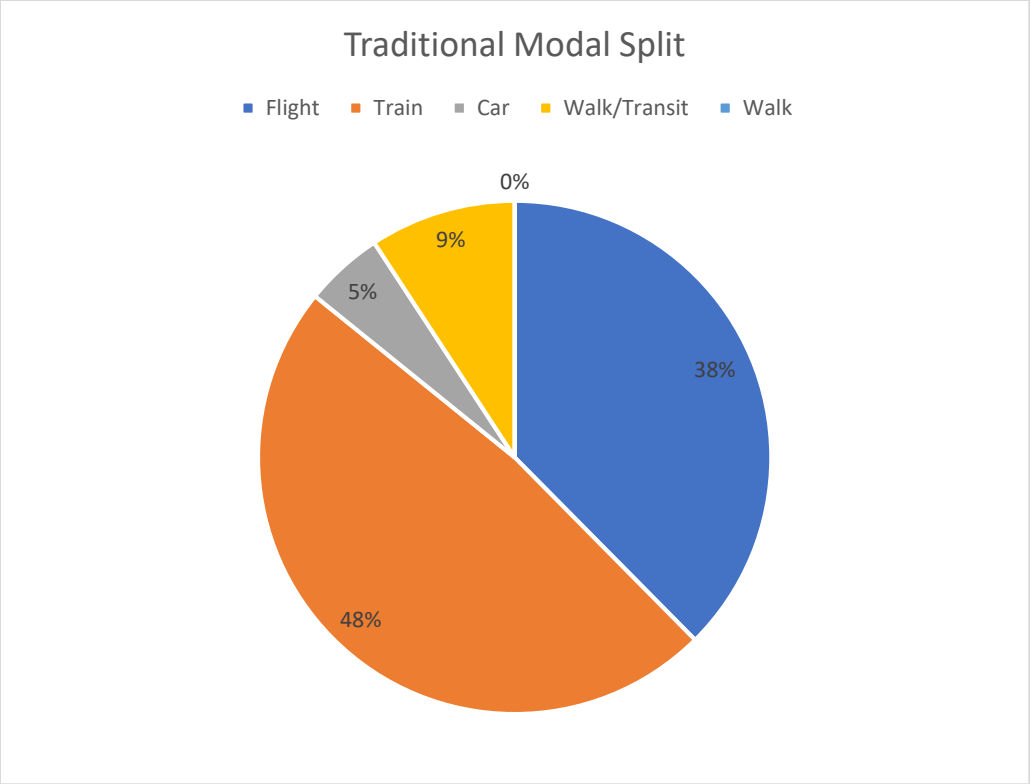
Methodology

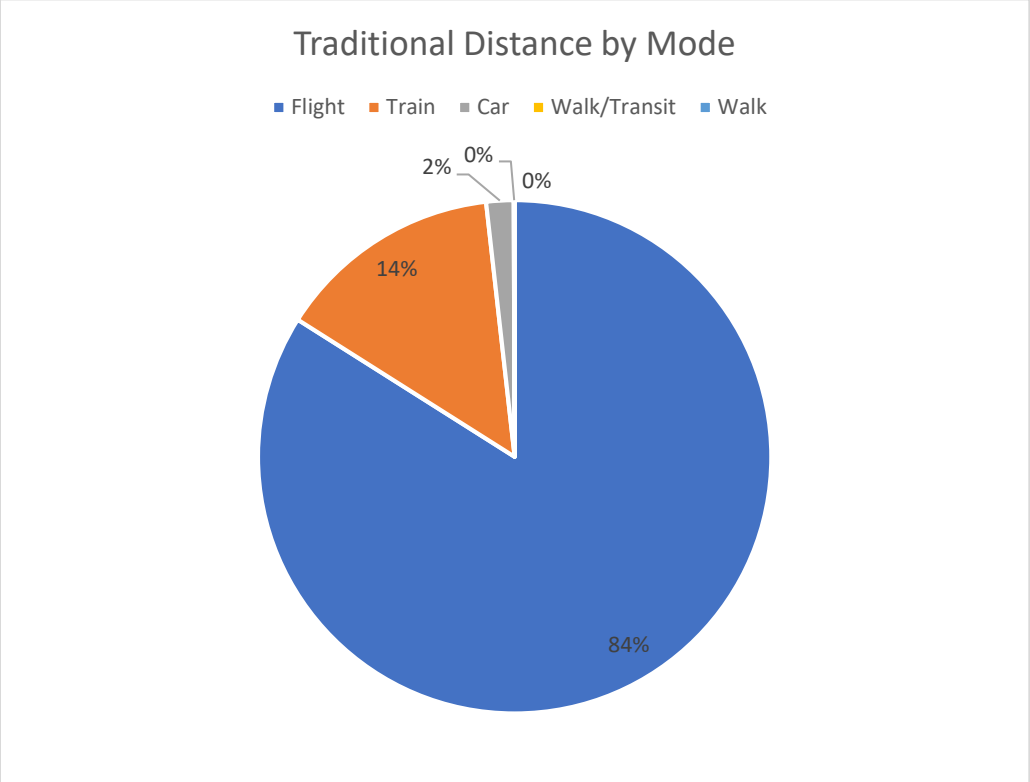
The traditional in-person model for this convening was estimated using the same methodology as the Hub model but replaced the travel to each of the available hubs with travel to a single gathering point at the National Art Centre in Ottawa.

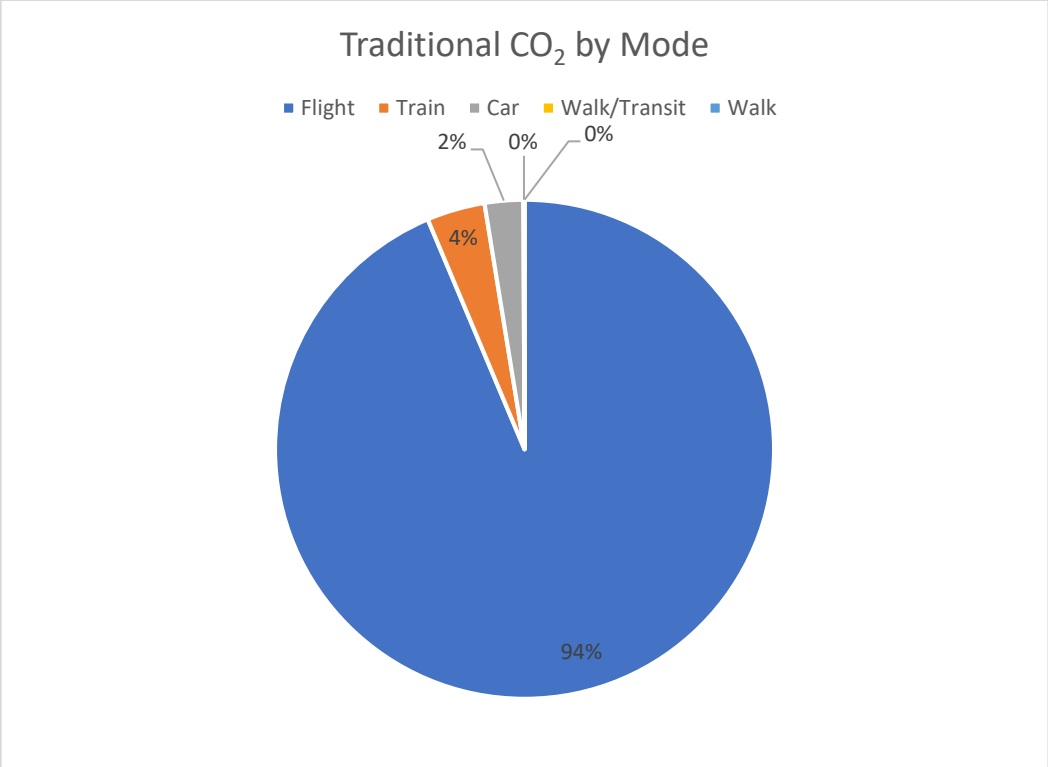
Findings

Because of the single point of gathering and the geographic distribution of the participants, this model requires significantly more air travel. We have estimated that, based on the traditional model of convening, travel would have resulted in roughly 31,902 kg of CO_2 across all modes of transportation.

The distribution of predicted transportation model, distance traveled, and the resulting emissions are indicated in the figures that follow:


Traditional Modal Split
Flight
Train
Car
Walk/Transit
Walk
0%
9%
5%
38%
48%


Traditional Distance by Mode
Flight
Train
Car
Walk/Transit
Walk
2%
0%
0%
14%
84%



COMPARATIVE FINDINGS

Based on these models for estimating the CO_2 emissions related to the Green Rooms with the documented attendance, the hub and streaming models appear to offer significant reductions in environmental impact related to modes of participation.

The hub model for the event would be predicted to result in a 70% reduction in the number of flights required for this group to gather. It is also predicted to result in an 82% reduction in the distance traveled by air and a similar reduction in the emissions that result from this mode of transportation.

Train travel would be predicted to require 68% less trips resulting in an 80% reduction in emissions related to this mode of travel.

Travel by personal vehicle would be predicted to increase by close to a factor of three, with an increase of emissions of 57%. Transit use would be predicted to increase by 346%, with a fivefold increase in related emissions. These are significant increases for each of these modes of travel. However, they remain far less emission-intensive than the air travel they replace.

Overall, it is estimated that the distributed hub model of presentation for the Green Rooms would have resulted in a 78% reduction in emissions related to transportation.

By comparison, the emissions related to the streaming version of this event are over 99% less than either the conventional (99.98%) or hub (99.89%) model of gathering. There are many

things lost by not gathering in person, but it leads to a significant reduction in emissions from participation based on these estimations.

FOR CONSIDERATION

This report focuses on “transportation” to and from the events. In this case, transportation is in quotes because it considers the streaming of video for video conferencing to be a mode of transportation.

Something which is not included in this comparison, but was calculated, is the expected emissions related to the number of days attendees participated in the event. Based on the assumption that they would be attending from home as a result of the common public policy directing people to stay home as much as possible to prevent risk of COVID-19 transmission, it is estimated that an additional 735.09 kg of CO_2 emissions were created based on the average consumption of power of the average Canadian household (S. C. Government of Canada).

This has not been included in this report because a similar consideration of the emissions related to accommodations would be required to draw an appropriate comparison. While an attendee’s patterns of consumption might be similar regardless of whether they are at home or attending a conference-type event away from home, it is also possible that the act of gathering in a shared location could result in a net reduction in consumption. Other data related to the amortization of emissions across an audience at a shared event has indicated that this can be a significant reduction in the per person impacts depending on the habits of an attendee with regards to their power consumption profile while away from home.

Another consideration, which revealed itself in building a model to estimate the required bandwidth and therefore energy needs of streaming, is the rapidly increasing efficiency of high-speed data networks. Based on the analysis of Andrae and Elder it is expected that efficiency will continue to increase.

Top Level Data

Predicted Hub Travel

MODE	COUNTS
Flight	16
Train	22
Car	26
Walk/Transit	58
Walk	14

Predicted Traditional Travel

MODE	COUNTS
Flight	53
Train	68
Car	7
Walk/Transit	13
Walk	0

Change in Travel Predictions

Hub Offsets	
37	70%
46	68%
-19	-271%
-45	-346%
-14	0%

Predicted Hub Distance Traveled

RT KM	MODE
46,242	Flight
9,300	Train
8,342	Car
1,176	Walk/Transit
58	Walk

Predicted Traditional Distance Traveled

RT KM	MODE
259,820	Flight
44,080	Train
5,330	Car
182	Walk/Transit
-	Walk

Predicted Change in Travel distance predictions

Hub Offset km	
213,578	82%
34,780	79%
(3,012)	-57%
(994)	-546%
(58)	0%

Estimated Predicted Hub emissions

grams CO2	MODE
5,317,830	Flight
253,730	Train
1,247,129	Car
149,155	Walk/Transit
-	Walk
6,967,844	**grams CO2**
6,968	**kg CO2 - Hub model**

Estimated Predicted Traditional Emissions

grams CO2	MODE
29,879,300	Flight
1,202,626	Train
796,835	Car
23,083	Walk/Transit
-	Walk
31,901,845	**grams CO2**
31,902	**kg CO2 - Traditional Model**

Estimated Change in Emissions Predictions

Hub Offset (g)	Hub Offset (kg)	
24,561,470	24,561.47	82%
948,896	948.90	79%
(450,294)	(450.29)	-57%
(126,071)	(126.07)	-546%
-	-	
24,934,001	**24,934.00**	**78%**

Attendee Streaming Totals

Minutes Watched	36,840
Watts Minutes	368,400
Watt Hours Consumed	6,140
kWh Consumed	6.14
Attendee	**0.61 kg**

Viewer Streaming Totals

Minutes Watched	55,963

Watt Minutes	559,630
Watt hours	9,327
kWh	9.327
Viewer	**0.921 kg**

Streaming Emissions

TOTAL	**1.53 kg**

Conversion Factors

Video Conference Traffic - 0.2 kWh/GB
1080P Video transmission - 3 GB/Hour

CO2 emissions per passenger	**g/km**
Boeing 737-400	115
VIA Rail Diesel Train (based on Toronto > Montreal)	27.3
Gasoline Compact Car (Honda Civic Sedan)	149.5
Average Transit (DOT (0.45 lb / mile))	126.8
Proportional Emissions Intensity, Hub Sites	**g/kWh**
Kingston	40
Toronto	40
Montreal	1.2
Halifax	600
Winnipeg	3.4
Vancouver	12.9
New York	707
London	256

Sources

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