Court File No. CV-19-00631627-0000

SUPERIOR COURT OF JUSTICE

B E T W E E N:

SOPHIA MATHUR, a minor by her litigation guardian Catherine Orlando, ZOE KEARY-MATZNER, a minor by her litigation guardian ANNE KEARY, SHAELYN HOFFMAN-MENARD, SHELBY GAGNON, ALEXANDRA NEUFELDT, MADISON DYCK, LINDSAY GRAY and ECOJUSTICE

Applicants

and

HER MAJESTY THE QUEEN IN RIGHT OF ONTARIO

Respondent

RESPONDING RECORD
(Motions to Intervene)

May 6, 2022

STOCKWOODS LLP
Toronto-Dominion Centre
TD North Tower, Box 140
77 King Street West, Suite 4130
Toronto ON M5K 1H1

Nader R. Hasan (54693W)
Tel: 416-593-1668
naderh@stockwoods.ca

Justin Safayeni (58427U)
Tel: 416-593-3494
justins@stockwoods.ca

Spencer Bass (75881S)
Tel: 416-593-1657 (Direct)
spencerb@stockwoods.ca

Tel: 416-593-7200
Fax: 416-593-9345

Lawyers for the Applicants Sophia Marthur, Zoe Keary-Matzner, Shaelyn Hoffman-Menard, Shelby Gagnon, Alexandra Neufeldt, Madison Dyck and Lindsay Gray

ECOJUSTICE
777 Bay Street
Suite 1910, PO Box 106
Toronto ON M5G 2C8

Fraser Andrew Thomson (62043F)
Tel: 416-368-7533
fthomson@ecojustice.ca

Danielle Gallant (BQ 3249674)
dgallant@ecojustice.ca

Lawyers for the Applicants Sophia Marthur, Zoe Keary-Matzner, Shaelyn Hoffman-Menard, Shelby Gagnon, Alexandra Neufeldt, Madison Dyck and Lindsay Gray

TO: **ATTORNEY GENERAL OF ONTARIO, CONSTITUTIONAL LAW BRANCH**
720 Bay Street
4th Floor
Toronto ON M5G 2K1

S. Zachary Green (48066K)
Tel: 416-992-2327
Zachary.Green@Ontario.ca

Padraic Ryan (61687)
Tel: 647-588-2613
Padraic.Ryan@Ontario.ca

Dayna Murczek (82824Q)
Tel: 416-240-5198
dayna.murczek@ontario.ca

Tel: 416- -
Fax: 416-326-4015

Lawyers for the Respondent Attorney General of Ontario

AND TO: **ADAIR GOLDBLATT BIEBER LLP**
95 Wellington Street West
Suite 1830
Toronto ON M5J 2N7

Nathaniel Read-Ellis (63477L)
Tel: 416-351-2789
Fax: 647-689-2059
mreadellis@agbllp.com

Jordan Goldblatt (50755H)
Tel: 416-920-9777
jgoldblatt@agbllp.com

Tel: 416-499-9940
Fax: 647-689-2059

Lawyers for the Proposed Intervener,
Indigenous Climate Change

AND TO: **HENEIN HUTCHISON LLP**
235 King Street East
1st Floor
Toronto ON M5A 1J9

Ewa Krajewska (57704D)
Tel: 416-368-5000
ekrajewska@hhllp.ca

Meghan Pearson (82853C)
Tel: 416-368-5000
mpearson@hhllp.ca

Tel: 416-368-5000
Fax: 416-368-6640

Lawyers for the Proposed Intervener,
David Asper Centre for Constitutional Rights

AND TO: **GOLDBLATT PARTNERS LLP**
Barristers and Solicitors
20 Dundas Street West
Suite 1039
Toronto ON M5G 2C2

Dan Sheppard (59074H)
Tel: 416-979-6415
dsheppard@goldblattpartners.com

Erica Cartwright (82644B)
Tel: 416-979-4638
ecartwright@goldblattpartners.com

Tel: 416-977-6070
Fax: 416-591-7333

Lawyers for the Proposed Intervener,
Canadian Association of Physicians for the Environment

AND TO: **RATCLIFF & COMPANY LLP**
500 - 221 West Esplanade
North Vancouver BC V7M 3J3

Nathan Hume
Tel: 604-988-5201
Fax: 604-988-1452
nhume@ratcliff.com

Tel: 604-988-5201
Fax: 604-988-1452

Lawyers for the Proposed
Intervener, For Our Kids

MEAGHAN DANIEL
Barrister & Solicitor
6694 rue Mazarin
Montreal QC H4E 2X5

Tel: 514-944-8154

Lawyer for the Proposed Intervener,
For Our Kid

AND TO: **UNIVERSITY OF OTTAWA**
Fauteux Hall
57 Louis-Pasteur Private
Ottawa ON K1N 6N5

Nathalie Chalifour
natchali@uottawa.ca

Lynda Collins
lynda.collins@uottawa.ca

Erin Dobbelsteyn
edobb061@uottawa.ca

Tel: 613-562-5800 ext. 3331

Lawyers for the Proposed Intervener,
Friends of the Earth Canada

AND TO: **ASSEMBLY OF FIRST NATIONS**
55 Metcalfe Street
Suite 1600
Ottawa ON K1P 6L5

Stuart Wuttke (52078G)
Tel: 613-241-6789 ext. 228
swuttke@afn.ca

Adam Williamson (62751G)
awilliamson@afn.ca

Jeremy Kolodziej (51553A)
jkolodziej@afn.ca

Lacey Kassis (67528C)
lkassis@afn.ca

Tel: 613-241-6789
Fax: 613-241-5808

Lawyers for the Proposed Intervener,
Assembly of First Nations

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ONTARIO
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and

HER MAJESTY THE QUEEN IN RIGHT OF ONTARIO

Respondent

AFFIDAVIT

I, Ephry Mudryk, of the City of Vaughan, in the Regional Municipality of York, MAKE OATH AND SAY:

1. I am a law clerk with the law firm of Stockwoods LLP, lawyers for the Applicants, and, as such, have knowledge of the matters contained in this Affidavit. I swear this affidavit in response to the various motions to intervene that have been brought in this application.

2. The Applicants consent to the interventions of:

(a) David Asper Centre For Constitutional Rights;

(b) Friends of the Earth Canada;

(c) Indigenous Climate Action;

(d) Canadian Association of Physicians for the Environment;

(e) For Our Kids National and For Our Kids Toronto; and

(f) The Assembly of First Nations.

3. The Applicants also believe that the following documents may be useful to the Court in its determination of the intervention motions.

4. Attached as **Exhibit "A"** is a true copy of the Notice of Application, issued on November 25, 2019.

5. As this proceeding is an application, the Respondent has not filed a Statement of Defence, or any other similar pleading formally setting out its position on the Application. As a result, the affidavits that constitute the Respondent's Responding Application Record may assist the Court in determining the matters that will be at issue at the hearing of this Application. Attached as **Exhibit "B"** is a true copy of the affidavit of Dr. William Van Wijngaarden, sworn February 25, 2022, which was served on the Applicants on February 28, 2022, with the exhibits omitted. Attached as **Exhibit "C"** is a true copy of the affidavit of Phillip Cross, sworn February 28, 2022, which was served on the Applicants on February 28, 2022, with the exhibits omitted.

SWORN by Ephry Mudryk at the City of Vaughan, in the Province of Ontario, before me on May 4, 2022 in accordance with O. Reg. 431/20, Administering Oath or Declaration Remotely.

S. Bass

Commissioner for Taking Affidavits
(or as may be)

SPENCER BASS (75881S)

Ephry Mudryk

EPHRY MUDRYK

This is Exhibit "A" to the Affidavit of Ephry Mudryk,
sworn May 4, 2022.

____
A Commissioner, etc.

CV-19-00631627-0000

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Applicants

- and -

HER MAJESTY THE QUEEN IN RIGHT OF ONTARIO

Respondent

APPLICATION UNDER r. 14.05(3)(h) and (g.1) of the *Rules of Civil Procedure*

NOTICE OF APPLICATION

TO THE RESPONDENT:

A LEGAL PROCEEDING HAS BEEN COMMENCED by the Applicants. The claim made by the Applicants appears on the following pages.

THIS APPLICATION for will come on for a hearing on a date and time to be fixed by the Registrar, at the City of Toronto.

IF YOU WISH TO OPPOSE THIS APPLICATION, to receive notice of any step in the application or to be served with any documents in the application, you or an Ontario lawyer acting for you must forthwith prepare a notice of appearance in Form 38A prescribed by the Rules of Civil Procedure, serve it on the Applicants' lawyer or, where the Applicants do not have a lawyer, serve it on the Applicants, and file it, with proof of service, in this court office, and you or your lawyer must appear at the hearing.

IF YOU WISH TO PRESENT AFFIDAVIT OR OTHER DOCUMENTARY EVIDENCE TO THE COURT OR TO EXAMINE OR CROSS-EXAMINE WITNESSES ON THE APPLICATION, you or your lawyer must, in addition to serving your notice of appearance, serve a copy of the evidence on the Applicants' lawyer or, where the Applicants do not have a lawyer, serve it on the Applicants, and file it, with proof of service, in the court office where the application is to be heard as soon as possible, but at least four days before the hearing.

IF YOU FAIL TO APPEAR AT THE HEARING, JUDGMENT MAY BE GIVEN IN YOUR ABSENCE AND WITHOUT FURTHER NOTICE TO YOU. IF YOU WISH TO DEFEND THIS PROCEEDING BUT ARE UNABLE TO PAY LEGAL FEES, LEGAL AID MAY BE AVAILABLE TO YOU BY CONTACTING A LOCAL LEGAL AID OFFICE.

Date: Nov 25, 2019

Issued By ______________________
Local Registrar

Address of court office
Superior Court of Justice
393 University Ave
Toronto, ON M5G 1E6

TO: ATTORNEY GENERAL OF ONTARIO
Crown Law Office – Civil
8th Floor, 720 Bay Street
Toronto, ON
M7A 2S9

APPLICATION

OVERVIEW

1. Climate change is an existential threat to all people living in all nations. There is a scientific consensus that failure to take urgent steps over the next 11 years will lead to catastrophic consequences. Governments must act now to avoid disaster. Ontario has not met this challenge. To the contrary, it has abdicated a responsibility that it owes to all Ontarians, and in so doing, has violated Ontarians' constitutional rights protected under the *Canadian Charter of Rights and Freedoms* (the "***Charter***").

2. The public interest youth applicants Sophia Mathur, Zoe Keary-Matzner, Shaelyn Hoffman-Menard, Shelby Gagnon, Alexandra Neufeldt, Madison Dyck and Lindsay Gray (the "Applicants") are a part of a generation whose future faces an existential threat from the catastrophic impacts of climate change. They are alarmed that Canada is rapidly warming at twice the rate of the global average. They know that there is a scientific consensus that climate change is leading to more frequent and severe wildfires, more intense and numerous heatwaves and floods, an increased risk of dangerous and often fatal infectious disease, rapidly melting northern landscapes, and cascading environmental destruction. They understand the cost of these increasing impacts on the health and lives of Canadians. They understand that these impacts will soon reach calamitous levels if urgent corrective measures are not taken, and that the window of opportunity to correct course is quickly closing. They are angered by the fact that their governments have known about these risks for decades but have failed to take adequate action to remedy this threat.

3. They also know that there are viable solutions to this existential problem but what is lacking is the political will of governments to immediately take bold and decisive action. A global climate catastrophe can still be avoided if countries ensure rapid reductions in greenhouse gas ("**GHG**") emissions before 2030 and reach net zero emissions by 2050. There is an international scientific consensus that global emissions of climate-warming GHGs must be reduced to "net zero" — or the point at which the "flow" of human caused GHG emissions (chiefly, carbon dioxide) into the atmosphere is balanced with human removals of GHGs — as soon as possible. The international scientific community also agrees that global warming must be held to below 1.5°C above pre-industrial temperature in order to avoid some of the worst impacts of climate change, and that the impacts of climate change become even more devastating if temperatures rise beyond 2°C.

4. In a global effort to curb this existential threat, 194 countries and the European Union have signed the Paris Agreement within the United Nations Framework Convention on Climate Change (the "**Paris Agreement**"). The Paris Agreement commits parties to holding the increase in global average temperature to "*well below* 2°C above pre-industrial levels" (emphasis added) and with best efforts made to limit the temperature increase to 1.5°C.

5. Owing in large part to Ontario's dangerously inadequate GHG reduction target, Canada is not on track to meet the Paris Agreement temperature standard. Even on the most generous projection, Ontario's emissions reduction target will lead to a dangerous level of climate change. As a result, Ontarians will face a range of devastating consequences to their lives, health, livelihood and ability to make

fundamental life choices, including (but not limited to) increased death and illness from extreme heat events and overall warming temperatures; the spread of infectious diseases spread through ticks, mosquitos and other vectors; more frequent and intense forest fires; more frequent and intense flooding events; the spread of harmful algal blooms in waterways; an increase in toxic contamination; and an increase in mental health impacts. These impacts will be visited disproportionately on Ontario's youth and future generations, as well as vulnerable and marginalized communities.

6. The Applicants therefore bring this challenge in solidarity with millions of youth in Ontario and around the world who are aware of the short period left to fight for their futures and who recognize the scientific consensus that there are just over 11 years left to ensure that temperatures do not increase above unsafe levels.

7. The focus of this Application is the 2030 GHG reduction target set by Ontario under s. 3(1) of the *Cap and Trade Cancellation Act*, *2018*, S.O. 2018, c. 13 ("***CTCA***"), and articulated in "Preserving and Protecting our Environment for Future Generations, A Made-in-Ontario Environmental Plan" (the "**Plan**"), which is to reduce GHG emissions by only 30% below 2005 levels by 2030 (the "**Target**"). The Target will lead to climate catastrophe and thus will violate the Applicants' rights under s. 7 of the *Charter*. Given the dire threats posed by climate change to the Applicants and other Ontarians and the role of the Ontario government in causing GHG emissions, only a target that avoids, rather than promotes, irreversible climate catastrophe can withstand constitutional scrutiny.

RELIEF SOUGHT

8. The Applicants seek the following relief on behalf of their generation and future generations of Ontarians:

    a. A declaration, under s. 52(1) of the *Constitution Act, 1982,* that the Target violates the rights of Ontario youth and future generations under sections 7 and 15 of the *Charter* in a manner that cannot be saved under s. 1, and is therefore of no force and effect;

    b. A declaration, under s. 52(1) of the *Constitution Act, 1982*, that the Target violates the unwritten constitutional principle that governments are prohibited from engaging in conduct that will, or reasonably could be expected to, result in the future harm, suffering or death of a significant number of its own citizens;

    c. A declaration that section 7 of the *Charter* includes the right to a stable climate system, capable of providing youth and future generations with a sustainable future;

    d. A declaration, under s. 52(1) of the *Constitution Act, 1982*, that ss. 3(1) and/or 16 of the *CTCA*, which repealed the *Climate Change Mitigation and Low-carbon Economy Act, 2016*, S.O. 2016, c. 7 ("***Climate Change Act***") and allowed for the imposition of more lenient targets without mandating that they be set with regard to the Paris Agreement temperature standard or any kind of science-based process, violates sections 7 and 15 of the *Charter* in a manner that cannot be saved under s. 1, and is therefore of no force and effect;

e. In the alternative, the same declaratory relief sought in the paragraphs above pursuant to s. 24(1) of the *Charter* and/or this Court's inherent jurisdiction;

f. An order that Ontario forthwith set a science-based GHG reduction target under s. 3(1) of the *CTCA* that is consistent with Ontario's share of the minimum level of GHG reductions necessary to limit global warming to below 1.5°C above pre-industrial temperatures or, in the alternative, well below 2°C (*i.e.* the upper range of the Paris Agreement temperature standard);

g. An order directing Ontario to revise its climate change plan under s. 4(1) of the *CTCA* once it has set a science-based GHG reduction target;

h. Costs of this Application; and

i. Such further and other relief as counsel may advise and this Honourable Court may deem just.

GROUNDS

The Applicants

9. The Applicants are Ontario residents with genuine interests in preventing catastrophic climate change that will pose pervasive and serious risks to the health and wellbeing of those in their generation and future generations of Ontarians. They range in age from 12 to 24 years old. Their generation has done the least to cause

climate change but will bear the burden of its worst impacts, including catastrophic impacts if emissions are not rapidly reduced.

10. The Applicants have demonstrated commitment to pushing for rapid and effective government action through individual and collective action. They have significant concerns over the risks that climate change poses to their health and wellbeing, their futures, their lives, their communities as well as the environment. They are worried that Ontario is not doing its part to prevent the catastrophic impacts of climate change.

11. Sophia, who is 12 years-old and lives in Sudbury, is the first youth outside of Europe to strike from school in solidarity with Greta Thunberg and has played an active role within the Fridays for Future movement in Ontario.

12. Zoe, who is 13 years-old and lives in Toronto, has also been actively involved in the Fridays for Future movement and has spoken at many climate change-related rallies, press conferences and other events within Ontario.

13. Shaelyn, who is 22 years-old and lives in Peterborough, works on the issues of climate change, biodiversity, Indigenous-led conservation, youth and community engagement on environmental issues and cultural and language revitalization.

14. Shelby, who is a 23 year-old artist and lives in Thunder Bay, works on Indigenous food sovereignty in northern Ontario communities and has taken local action to help her own community become more sustainable in response to climate change.

15. Alexandra, who is 23 years-old and lives in Ottawa, has been actively involved with Citizens Climate Lobby Canada through lobbying elected officials and doing public outreach to promote effective climate action.

16. Madison, who is 23 years-old and lives in Thunder Bay, has sailed throughout Lake Superior giving presentations on climate change impacts in surrounding communities and to youth.

17. Lindsay, who is 24 years-old and two-spirit, goes by the name Beze and lives in the Township of Tiny, is a community organizer focused on environmental, climate and Indigenous issues, including in their home community of Aamjiwnaang First Nation.

18. The Applicants have demonstrated a serious and genuine interest in the subject matter of this litigation. This Application is a reasonable and effective way to bring these issues to the court for reasons that include: (i) the claim at issue impacts all Ontario youth and future generations; (ii) the Applicants have the support of counsel with the expertise, resources and commitment to bring this Application forward; and (iii) the Applicants are well-placed to bring this Application and it is unreasonable to expect that other children (or future generations) will bring a similar application now.

The Respondent

19. Ontario has (at the very least) shared constitutional responsibility with Canada for controlling GHG emissions within the province.

20. Ontario exercises its authority over GHG emissions by setting the Target that will govern the amount of GHG emissions in the province, and by regulating the conduct

and consequences of emitters and emissions under a variety of statutory schemes, including but not limited to the *Environmental Protection Act*; *Electricity Act*; *Gasoline Tax Act*; *Fuel Tax Act*; *Oil, Gas and Salt Resources Act*; *Mining Act*; *Environmental Assessment Act* and the *Environmental Bill of Rights*. More generally, Ontario exercises regulatory authority over a broad range of sectors that contribute to GHG emissions, including the transportation, industrial, building, land use and forestry, electricity, energy and waste sectors.

21. Previously, Ontario legislated in areas relating to GHG emissions by instituting a cap-and-trade system under the *Climate Change Act* and through the incentives set out in the *Green Energy Act, 2009*. (Both of these statutory schemes have since been repealed.)

22. Ontario also impacts the extent of GHG emissions through subsidies, direct spending programs, investments, tax exemptions and other incentives provided to emitters in Ontario, including but not limited to in the natural gas, heavy industry, manufacturing, oil and gas and mining sectors.

23. Finally, Ontario itself contributes to GHG emissions through its own facilities and activities.

Climate Change: Caused by Human Life and Urgently Requires Human Intervention

24. "Climate change" describes the shift in worldwide weather phenomena and physical states of the Earth system (e.g. melting polar regions, rising oceans, etc.) associated with an increase in global average temperatures. It encompasses both global warming and the climatic changes caused by this increase in global temperature.

While the Earth's climate is always changing over geological time periods, "climate change" as used in this pleading refers to the human-caused climate change that has been evident since at least the 20th century and continues to accelerate in the 21st century.

25. The development of human life on Earth has depended upon the atmosphere functioning as a "greenhouse", in which a layer of gases in the lower atmosphere — including GHGs — trap heat from the sun as it is reflected back from the Earth into space, keeping our planet at a temperature that supports life for humans and other species. Human civilization and the elements on which it depends have developed over the last 10,000 years within a narrow set of climatic conditions that have been neither too hot nor too cold to support the flourishing of our species.

26. GHGs are present in the atmosphere due to a combination of human activities and naturally occurring processes. The GHGs emitted as a result of human activities include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other gases. The most important GHG for climate change is CO_2 because of its prevalence and long residence time in the atmosphere. A molecule of CO_2 emitted into the atmosphere will exert a warming effect for centuries, on average. For this reason the cumulative "stock" of CO_2 in the atmosphere is the primary driver of long-term global warming.

27. Since the Industrial Revolution, and particularly since the 1980s, human activity has created an unprecedented and dangerous buildup of CO_2 and other GHGs in the atmosphere. About three quarters of this buildup has been due to the combustion of

fossil fuels, including coal, oil, and natural gas, with the remainder caused mostly by deforestation and other land-use activities. The total "stock", or level of CO_2 in the atmosphere is rising and is now around 410 ppm — far above the approximately 280 ppm level that was present through the relatively stable climate of the last 10,000 years.

28. The buildup of CO_2 and other GHGs in the atmosphere has warmed the planet by approximately 1°C on average since the pre-industrial period (1850-1900), with global temperature now increasing at the rate of 0.2°C per decade. Human-caused GHG emissions — including those allowed under the Target — are responsible for virtually all of the observed increase in global temperatures since the late 19th century and will likely be the dominant cause of further warming over the coming century.

29. If all human-caused GHG emissions ceased immediately, the Earth's climate would still heat up by several tenths of a degree Celsius because of the latency time between GHG accumulation in the atmosphere and warming in the Earth's climate system. Continued GHG emissions will cause the Earth's climate to heat up further.

30. The Earth's climate will continue to heat up until the "flow" of human-caused GHG emissions (chiefly, CO_2) into the atmosphere is balanced with human removals of GHGs, a concept known as "net zero". Maintaining net zero GHG emissions is expected to cap the "stock" of CO_2 in the atmosphere and stabilize global average temperature at some higher level. The extent of this new normal temperature will depend on how long it takes the world to reduce CO_2 emissions down to the point of

net zero. The new normal temperature will dictate the climatic extremes in which the future of human civilization will have to exist as it is expected to be effectively irreversible on human timescales — a millennium or more — absent highly uncertain and speculative future large-scale technological interventions to remove CO_2 from the atmosphere.

31. Simply put, the world that the Applicants' generation and future generations will inherit will be drastically different from the one their parents and grandparents experienced. Whether that world is liveable will depend largely on how effectively humanity chooses to address climate change in the coming decade.

The Target: A Significant Step in the Wrong Direction

32. The Target represents Ontario's allowable GHG emissions over the next 11 years across all sectors, actors and individuals in the province.

33. Pursuant to s. 3(1) of the *CTCA*, Ontario "shall establish targets for the reduction of greenhouse gas emissions in Ontario and may revise the targets from time to time". Ontario fulfilled this requirement by establishing the Target in the Plan.

34. The Target requires GHG reductions of 30% from 2005 levels by 2030.

35. This represents a significant *increase* in Ontario's Target for the allowable level of GHG emissions over the previous Ontario targets. In particular, the Target allows for 30 Megatonnes (MT) more in annual GHG pollution by 2030 than the 2030 target that was previously in place, or a total of 190 MT of GHGs into the atmosphere's CO_2 stock between 2018 and 2030 (assuming a linear annual decline from current annual emissions to the Target amount in 2030).

36. The Target's annual increase of 30 MT is equal to the annual emissions of more than 7 million passenger vehicles.

37. Prior to the coming into force of the *CTCA*, Ontario had three point-in-time targets for GHG reductions enshrined in legislation. Subsection 6(1) of the *Climate Change Act* set out targets for GHG emission reductions over time. Unlike the Target (which is set relative to Ontario's 2005 GHG emissions), the targets set out in the *Climate Change Act* were set relative to Ontario's GHG emissions in 1990, which were lower than 2005 levels, at 180 MT of CO_2 equivalent ("CO_2e") — a measure that includes both CO_2 and other GHGs.

38. The targets in the *Climate Change Act* called for:

    a. 15% reduction by 2020 (153 MT of CO_2e);

    b. 37% reduction by 2030 (113 MT of CO_2e);

    c. 80% reduction by 2050 (36 MT of CO_2e).

39. With the *CTCA*, Ontario has set a significantly weaker GHG reduction target for 2030 and failed to provide any GHG reduction target for 2050.

40. The *CTCA* is also a major step backwards in other ways. The *Climate Change Act* reflected the international environmental law principle of non-regression with respect to GHG reduction targets, which dictates that efforts to reduce GHG emissions must strengthen progressively over time — not weaken — given the urgency of stabilizing the Earth's climate by reaching net zero emissions (as discussed further below). Non-regression is a cornerstone principle of the international approach to combatting

climate change and is codified in the Paris Agreement. The *Climate Change Act* specifically incorporated this principle and required that the Lieutenant Governor in Council consider any temperature standards recognized under the Paris Agreement or any successor temperature standard in setting GHG reduction targets.

41. On November 14, 2018, the *CTCA* came into force and repealed the *Climate Change Act*, including the legislated targets for GHG reductions. The *CTCA* places a mandatory duty on Ontario to establish targets for the reduction of GHG emissions (s. 3(1)). However, the Act does not require that these targets be at least as strong as those previously in place. Nor does the Act require that Ontario have any regard to the Paris Agreement temperature standard, or any kind of science-based process, in setting GHG reduction targets.

Catastrophic Impacts of Climate Change in Ontario

42. Ontario has warmed about twice as fast as the global average since the pre-industrial period (1850-1900), at approximately 1.7°C. Ontario will continue to experience the impacts of global warming at an above-average rate.

43. The catastrophic impacts of global warming for Ontarians are not controversial. In the Plan and in its submissions before Ontario courts, Ontario concedes that:

   a. The climate is changing.

   b. Human activities are a major cause of climate change.

   c. Climate change is already having a disruptive effect across Canada and that, if left unchecked, its potential impact will be even more severe.

d. Further climate change threatens Ontarians' natural resources, homes, communities, businesses, infrastructure, locally grown food and crops, food security and road access for remote First Nations, as well as the health of ecosystems across Ontario.

e. Severe rain, ice and wind storms, prolonged heat waves and milder winters are much more common. Forests, waters and wildlife across the province are and will continue to be significantly impacted by these changes. People across the province – especially Northern communities – and all sectors of the economy are feeling the impacts of climate change and paying more and more for the costs associated with those impacts.

f. Extreme weather events have flooded houses, buildings and roads, overwhelmed aging stormwater and wastewater systems, damaged crops, and brought heavy ice and wind storms that have knocked out power for hundreds of thousands of people, including those who are most vulnerable.

g. Heat waves and recent drought conditions in some areas of the province, coupled with anticipated impacts of climate change and population growth, have intensified concerns related to water security for farmers, Indigenous communities, industry and municipalities.

h. Proactive action to address climate change is required.

44. Governments and courts across Ontario and Canada have recognized the dire implications of climate change. On June 17, 2019, the federal government declared that Canada was in a national climate emergency. Municipal governments across the

country have similarly declared that there is a climate change emergency, including but not limited to those of Vancouver, Edmonton, Whitehorse, Halifax, St. John's Montreal approximately 400 other cities and towns in the province of Quebec, as well as the province of Quebec itself. In Ontario, many municipal governments have declared a climate emergency, including but not limited to Toronto, Kingston, Hamilton, Burlington, West Nipissing, London, Ottawa, St. Catharines, Greater Sudbury, Vaughan, Brampton, Sarnia, Mississauga, Kitchener, Oakville, Whitby, Windsor, Waterloo, Peterborough and Kenora. Climate emergency declarations have also been made by Indigenous governing bodies and organizations such as Grand Council Treaty #3 (Ontario) and the Assembly of First Nations.

45. Courts have reached the same conclusion. A majority of the Court of Appeal for Saskatchewan recently stated that: "Climate change is doubtless an emergency in the sense that it presents a genuine threat to Canada." A majority of the Court of Appeal for Ontario recently described the situation as follows:

> The uncontested evidence before this court shows that climate change is causing or exacerbating: increased frequency and severity of extreme weather events (including droughts, floods, wildfires and heat waves); degradation of soil and water resources; thawing of permafrost; rising sea levels; ocean acidification; decreased agricultural productivity and famine; species loss and extinction; and expansion of the ranges of life-threatening vector-borne diseases, such as Lyme disease and West Nile virus… The recent major flooding in Ontario… in 2019 was likely also fueled by climate change.[1]

46. There are myriad ways that climate change impacts the health, lives, liberty and livelihood of current and future generations of Ontarians. If global warming exceeds

[1] *Reference re Greenhouse Gas Pollution Pricing Act*, 2019 ONCA 544 at para. 11.

1.5°C above pre-industrial temperatures, the impacts of climate change in Ontario will include (but will not be limited to):

a. an increase in the frequency and intensity of acute extreme heat events (*e.g.* one-in-30 year extreme "heat waves"), with a resulting increase in fatalities (in the hundreds, if not thousands), serious illness and severe harm to human health;

b. an increase in overall temperatures and heat waves (separate and apart from acute extreme heat events), with a resulting increase in fatalities, serious illness and severe harm to human health;

c. an increase in the spread of infectious diseases such as Lyme disease and West Nile Virus (along with other diseases spread by ticks, mosquitos and other vectors, as well as food and waterborne diseases), with a resulting increase in fatalities, serious illness and severe harm to human health;

d. an increase in the frequency and intensity of fire activity (including forest wildfires), with a resulting increase in fatalities, serious illness, displacement and severe harm to human health;

e. an increase in the frequency and intensity of flooding and other extreme weather events, with a resulting increase in fatalities, serious illness, displacement, loss of livelihood and severe harm to human health;

f. an increase in the spread of harmful algal blooms in water that Ontarians use for drinking and recreational purposes, with a resulting increase in serious illness, loss of livelihood and severe harm to human health;

g. an increase in exposure to contaminants such as mercury through food webs, with a resulting increase in severe harm to human health and negative impact on food security and sovereignty of certain Ontario communities;

h. an increase in harms to Indigenous peoples, including increased impacts on health, access to essential supplies, ability to carry out traditional activities, loss of livelihood and displacement; and

i. an increase in serious psychological harms and mental distress arising from the impacts of climate change, including but not limited to, the impacts set out in the paragraphs above.

47. These devastating impacts of climate change will be felt in a particularly acute way by vulnerable populations and marginalized communities, including youth, the elderly, those with pre-existing health issues and Indigenous peoples. Youth and future generations, in particular, will bear the brunt of the impacts of climate change, given that these impacts will significantly increase in severity and intensity as the years progress, and that they are among the most vulnerable to these impacts, both physically and mentally.

48. All of these devastating impacts of climate change will become even more pronounced in Ontario as the Earth's climate warms to levels approaching and exceeding 2°C above pre-industrial levels.

49. The Intergovernmental Panel on Climate Change ("**IPCC**") — a comprehensive and authoritative assessment of climate science research — has confirmed the devastating impacts of climate change in a world where global average temperatures rise to 1.5°C above pre-industrial levels, and has confirmed that these impacts would be significantly worse if temperatures rise to and exceed 2°C above pre-industrial levels.

50. Temperatures rising to, and beyond, 1.5°C also increases the risk that large-scale singular events and/or natural feedback loops (such as melting permafrost in northern regions that releases methane and CO_2, further heating the climate which leads to more permafrost to melt) are triggered, which could lead to runaway and irreversible climate change that can no longer be controlled by humans, bringing devastating impacts to the lives, health and livelihoods of current and future generations of Ontarians.

The International Imperative: Act Quickly To Reduce and Limit GHG Emissions

51. In 1992, Canada and 177 other countries signed the United Nations Framework Convention on Climate Change ("**UNFCCC**"). It was ratified by Canada on March 21, 1994. The UNFCCC had 197 parties as of December 2015.

52. Article 2 of the UNFCCC sets the international community's "ultimate objective" with respect to climate change: to achieve the stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

53. The UNFCCC recognizes that the largest share of historical GHGs that have accumulated in the atmosphere were emitted by developed countries like Canada, giving rise to "common but differentiated responsibilities" between developed and developing countries (whereby advanced countries that have already made significant contributions to total GHG emissions, and/or are in a better position to implement and bear the costs of GHG reductions, bear a greater share of GHG reductions moving forward).

54. Canada and almost every other country in the world has signed the Paris Agreement. The Paris Agreement's core objective is the temperature standard whereby the international community commits to holding the increase in global average temperature to "*well below* 2°C above pre-industrial levels" (emphasis added) and pursues efforts to limit the temperature increase to 1.5 C (the "**Paris Agreement Temperature Standard**"). The Paris Agreement also recognizes that developed countries should take the lead in emissions reductions, consistent with the notion of common but differentiated responsibilities.

55. Scientists use the concept of a global "carbon budget" to define how much more CO_2 can be emitted into the atmosphere before certain levels of global temperature warming, e.g. 1.5°C or 2°C, will be locked in and irreversible. Once the carbon budget is used up or exceeded, global temperatures will stabilize at a new, dangerously high global temperature *even if* measures are later taken to reduce global emissions of CO_2 to net zero. To put it bluntly: once the carbon budget is used up, it will be too late to fix the problem.

56. The remaining global carbon budget available to have a "likely" chance (67% confidence or greater) of stabilizing global temperatures depends on the temperature goal, as follows:

    a. to stabilize at 1.5°C, the remaining global carbon budget is 420,000 MT of CO_2. At current global rates of CO_2 emissions, this budget would be exceeded in 10 years.

    b. to stabilize at 1.75°C, the remaining carbon budget is 800,000 MT of CO_2. At current global rates of CO_2 emissions, this budget would be exceeded in 19 years.

    c. to stabilize at 2°C, the remaining global carbon budget is 1,170,000 MT of CO_2. At current global rates of CO_2 emissions, this budget would be exceeded in 28 years.

57. These carbon budget figures reflect a number of conservative assumptions. For example, they assume significant reductions of other non-CO_2 GHG emissions, some of which are emitted from the same activities that cause CO_2 emissions. If non-CO2 GHG emissions are not strictly reduced in tandem with CO_2, the remaining carbon budgets for stabilizing global average temperature at 1.5°C or 2°C would be even smaller.

58. To combat the existential threat, every jurisdiction around the world must significantly reduce GHG emissions rapidly because the climate will continue to warm at the global, national, and provincial scale until global emissions of CO_2 and other GHGs are reduced to net zero. The preamble to the Paris Agreement

recognizes "the importance of the engagement of all levels of government and various actors, in accordance with respective national legislations of Parties, in addressing climate change."

59. In this context, national and subnational governments must pursue GHG targets that reflect their obligation in terms of global GHG emissions, so that the catastrophic impacts of an increase in global temperatures beyond 1.5 C above pre-industrial levels are avoided.

The Target Falls Short of Meeting Ontario's Obligation

60. Regardless of how one approaches the question of calculating Ontario's fair share of the global GHG reductions required to avoid the catastrophic effects of climate change, the answer is the same: Ontario is not doing enough.

61. Canada's share of the remaining global carbon budget is (at most) 2,000 MT of CO_2, in order to likely avoid the catastrophic consequences of global temperatures rising beyond 1.5 C above pre-industrial levels.

62. This calculation provides Canada with a very generous allocation of the global carbon budget. It ignores any considerations of equity, any sense of historic responsibility, and any application of the "common but differentiated responsibilities" principle — all recognized principles under the UNFCCC. Incorporating any of these considerations would reduce Canada's share of the global carbon budget to a number close to, or equal to, net zero today.

63. Ontario's actual share of Canada's emissions has been in the range of between 23% (in 2017) and 30% (in 2005). Applying these figures to Canada's (generous) 2,000

MT carbon budget provides Ontario with a maximum carbon budget of between 460 MT (23%) and 670 MT (30%) of CO_2. Because these figures are based on Canada's 2,000 MT carbon budget, they do not account for any considerations of equity, historic responsibility, or common but differentiated responsibilities.

64. Under the Target, Ontario's total CO_2 emissions from now until 2030 will be 1,670 MT, or between 250-363% greater than Ontario's share of the global carbon budget, and almost *all* of Canada's budget. In fact, Ontario's total emissions beyond 2030 will exceed its share of the global carbon budget by an even greater amount, since Ontario has no longer term plans for further emissions reductions following 2030 and it is unrealistic to expect that Ontario will go from 142.8 MT in 2030 to net zero emissions following 2030. In other words, Ontario will almost certainly continue emitting CO_2 after 2030 — even after already surpassing its maximum carbon budget for CO_2 by between 250-363%.

65. If the carbon budgets described above are adjusted to avoid global temperatures rising beyond 2°C above pre-industrial levels (rather than 1.5°C), Ontario will still exceed — or, at best, barely meet — its maximum carbon budget by 2030. But even meeting (or being slightly less than) the maximum carbon budget represents a failure by Ontario to guard against catastrophic climate change, as Ontario will inevitably continue to emit CO_2 in the years following 2030, and thereby surpass its share of the global carbon budget.

66. If other jurisdictions followed Ontario's level of ambition with the Target and adopted GHG reduction targets that exceeded their carbon budgets and failed to

incorporate common but differentiated responsibilities, equity and historic responsibility, then this would result in catastrophic climate change of at least 3°C and potentially as much as 5°C over pre-industrial temperatures by 2100 — well above the Paris Agreement Temperature Standard, and squarely within a zone of devastating impacts on human civilization.

The Target is Unconstitutional

67. Ontario's repeal of the *Climate Change Act* and its Target pursuant to the *CTCA* violates the rights of Ontario's youth under s. 7 of the *Charter* by compromising their right to life, liberty and security of the person, in a serious and pervasive manner that does not accord with the principles of fundamental justice.

68. The Target is wholly inadequate to hold global average temperatures increases to 1.5°C above pre-industrial levels (or, for that matter, 2°C above pre-industrial levels) and thereby avoid catastrophic climate change impacts. Rather than maintain or increase the pre-existing commitment to GHG reductions, the Target will ensure a higher level of GHG emissions that will cause or contribute to death, serious illness and severe harm to human health of Ontario's youth and future generations, interfering with their right to life and security of the person.

69. The Target also violates the right to liberty of Ontario's youth and future generations because the impacts of climate change interfere with their ability to choose where to live, their right to personal autonomy, and their right to make other decisions of fundamental importance.

70. At the very least, the Target will materially increase the risk that Ontario's youth and future generations will suffer from the many harmful impacts of climate change. This is sufficient to ground a s. 7 violation for breaching the life, liberty and security of the person rights, as outlined above.

71. Ontario's deprivation of the life, liberty and security of the person rights of Ontario's youth and future generations is not in accordance with the principles of fundamental justice. Indeed, there is no principle of fundamental justice that can justify the Target, given its attendant risks and consequences. Climate change presents an unprecedented and existential threat, unlike anything seen in human history. The reaction of national and subnational governments to this issue — in particular, over the next 11 years — will determine whether, and in what form, human civilization confronts that threat.

72. The Target is grossly disproportionate to Ontario's stated objective of taking proactive action to address climate change. Even if the Target's objective is characterized differently by the Respondent, it remains grossly disproportionate, given the severity and extent of the harm caused by such a high level of GHG emissions, as explained above.

73. The Target is also arbitrary. Ontario's objective in adopting the Target was to take proactive action to address climate change. The Target bears no relation to and is inconsistent with that objective, as explained above.

74. To the extent Ontario may rely on economic justifications, such justifications ring hollow. For example, the societal cost of an additional 190 MT of GHG emissions

between 2018 and 2030 is at least $7.7 billion and likely much higher. More generally, Ontario has chosen economically inefficient means of reducing GHG emissions and inaction on climate change now will prove to be increasingly costly to Ontarians in the future, including to Ontario's youth and future generations.

75. The Target also violates the principle of fundamental justice that governments are prohibited from engaging in conduct that will contribute to, or reasonably could be expected to, lead to future harm, suffering or death of a significant number of its own citizens. This principle of "societal preservation" is a legal principle that enjoys significant social consensus (both domestically and internationally), is fundamental to the way in which the legal system ought to fairly operate, and is sufficiently precise to yield a manageably standard against which to measure s. 7 deprivations. The principle of societal preservation reflects and encapsulates many other legal and societal values recognized in Canadian jurisprudence, including human dignity, the sanctity of human life and the protection of the public. It is also an unwritten constitutional principle, which binds Ontario, and which Ontario has violated.

76. Section 7 of the *Charter* must also include the right to a stable climate system, capable of providing youth and future generations with a sustainable future, as this directly implicates their rights to life, liberty and security of the person, for all of the reasons explained above. The Target violates s. 7 for this reason as well.

77. The Target violates s. 15 of the *Charter* because Ontario's youth and future generations:

a. are a uniquely vulnerable population by virtue of their age and, for some, their inability to influence political decisions at the ballot box;

b. will be disproportionately impacted by the devastating impacts of climate change, which (if Ontario maintains its current trajectory) will significantly increase in severity and intensity as the years progress; and

c. are among those who will suffer the most from the climate change impacts covered at paragraph 46, including (but not limited to) extreme heat events, warming temperatures and heat waves, infectious diseases, fires, flooding, algal blooms, toxic contamination and mental health challenges;

d. will have their pre-existing vulnerability and disadvantage heightened as a result of these impacts.

78. In addition to quashing the Target, Ontario ought to be required to adopt a new science-based GHG reduction target that is consistent with Ontario's fair share of the minimum level of GHG reductions necessary to limit global warming to below 1.5°C above pre-industrial temperature (or, in the alternative, the Paris Agreement Temperature Standard), and Ontario ought to adopt a new environmental plan that incorporates this new target. The dangers of climate change are extraordinary and existential, and require an equally extraordinary remedy in order to effectively prevent the devastating consequences that Ontario's youth and future generations will face once global average temperatures rise beyond 1.5°C above pre-industrial temperatures.

79. The *Charter* violations set out above cannot be justified pursuant to s. 1 of the *Charter*.

80. The Applicants rely on relief under s. 24 of the *Charter* or s. 52 of the *Constitution Act, 1982*. In the alternative, and in any event, this Court has the inherent jurisdiction to grant declaratory and other relief, to the extent such relief may be unavailable under s. 24 of the *Charter* or s. 52 of the *Constitution Act, 1982.*

STATUTORY INSTRUMENTS RELIED UPON

In addition to the various statutory instruments described in the preceding paragraphs, the Applicants rely on:

1. *Courts of Justice Act,* RSO 1990, c C.43.
2. *Rules of Civil Procedure,* RRO 1990, Reg 194 and, in particular, rules 2.03, 14.05, 38 and 39.
3. Such further and other grounds as counsel may advise and this Honourable Court may deem just.

DOCUMENTARY EVIDENCE

1. The following documentary evidence will be used at the hearing of the application:

   (a) The affidavit of Catherine Orlando, sworn November 23, 2019;

   (b) The affidavit of Anne Burnett Keary, affirmed November 23, 2019;

   (c) The affidavit of Sophia Mathur, to be sworn;

(d) The affidavit of Zoe Keary-Matzner, to be sworn;

(e) The affidavit of Shaelyn Hoffman-Menard, to be sworn;

(f) The affidavit of Shelby Gagnon, to be sworn;

(g) The affidavit of Alexandra Neufeldt, to be sworn;

(h) The affidavit of Madison Dyck, to be sworn;

(i) The affidavit of Lindsay Gray, to be sworn;

(j) The affidavits of expert witnesses, to be determined;

(k) Such other affidavit material and evidence as counsel may advise and this Honourable Court may deem proper.

Dated November 25, 2019

STOCKWOODS LLP
Barristers
TD North Tower, 77 King Street West
Suite 4130, PO Box 140
Toronto-Dominion Centre
Toronto, Ontario M5K 1H1

Nader R. Hasan (54693W)
Dir.: 416-593-1668
Email: NaderH@stockwoods.ca

Justin Safayeni (58427U)
Dir.: 416-593-3494
Email: JustinS@stockwoods.ca

Spencer Bass (75881S)
Dir.: 416-593-2518
Email: SpencerB@stockwoods.ca

Tel.: 416-593-7200
Fax: 416-593-9345

ECOJUSTICE
777 Bay Street
Suite 1910, PO Box 106
Toronto, Ontario M5G 2C8

Fraser Andrew Thomson (62043F)
Email: fthomson@ecojustice.ca

Danielle Gallant (BQ# 324967-1)
Email: dgallant@ecojustice.ca

Tel.: 416-368-7533
Fax: 416-363-2746

Counsel for the Applicants

CV-19-00 631627-0000

SOPHIA MATHUR, et al and HER MAJESTY THE QUEEN IN RIGHT OF ONTARIO Court File No.

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Applicants Respondent

ONTARIO
SUPERIOR COURT OF JUSTICE

Proceeding commenced at TORONTO

NOTICE OF APPLICATION

ECOJUSTICE
777 Bay Street
Suite 1910, PO Box 106
Toronto ON M5G 2C8

Fraser Andrew Thomson (62043F)
Email: fthomson@ecojustice.ca

Danielle Gallant (BQ# 324967-1)
Email: dgallant@ecojustice.ca

Tel: 416-368-7533
Fax: 416-363-2746

Counsel for the Applicants

STOCKWOODS LLP
Barristers
TD North Tower, 77 King Street West
Suite 4130, PO Box 140
Toronto-Dominion Centre
Toronto, Ontario M5K 1H1

Nader R. Hasan (54693W)
Dir.: 416-593-1668
Email: NaderH@stockwoods.ca

Justin Safayeni (58427U)
Dir.: 416-593-3494
Email: JustinS@stockwoods.ca

Spencer Bass (75881S)
Dir.: 416-593-2518
Email: SpencerB@stockwoods.ca

Tel.: 416-593-7200
Fax: 416-593-9345

Counsel for the Applicants

This is Exhibit "B" to the Affidavit of Ephry Mudryk,
sworn May 4 , 2022.

____
A Commissioner, etc.

Court File No. CV-19-00631627-0000

ONTARIO
SUPERIOR COURT OF JUSTICE

B E T W E E N:

SOPHIA MATHUR, a minor by her litigation guardian CATHERINE ORLANDO, ZOE KEARY-MATZNER, a minor by her litigation guardian ANNE KEARY, SHAELYN HOFFMAN-MENARD, SHELBY GAGNON, ALEXANDRA NEUFELDT and LINDSAY GRAY

Applicants

\- and -

HER MAJESTY THE QUEEN IN RIGHT OF ONTARIO

Respondent

AFFIDAVIT OF DR. WILLIAM VAN WIJNGAARDEN

Sworn February 25, 2022

I, WILLIAM VAN WIJNGAARDEN, of the City of Toronto, in the Province of Ontario, MAKE OATH AND SAY:

1. I live in Toronto, Ontario. I am a Full Professor of Physics at York University and have held this position since 2000. Prior to 2000, I was an Assistant Professor from 1988 to 1992 and an Associate Professor from 1992 to 1999 at York University. I hold a Masters and a PhD in Physics from Princeton University, an Honours Bachelor of Science in Physics from the University of Windsor and a Bachelor of Science in Computer Science from the University of Windsor.

2. I have authored more than 80 journal publications and given over 230 conference presentations and invited seminars. One area of my research is the physics of greenhouse gases and climate change.

3. My 2003 sabbatical was spent at Environment Canada examining archival records of humidity and temperature. During 1953-2003, temperature increased in Western Canada in winter and spring, but relative humidity decreased. My subsequent work examined data recorded at stations throughout North America during 1948-2010. I have also published work studying precipitation trends over the Earth's land mass excluding Antarctica from the 18th century to 2013 as well as Arctic temperature trends over the 19th and 20th centuries.

4. In 2016, I began a collaboration with W. Happer, Professor of Physics at Princeton, studying radiative transfer through Earth's atmosphere. We considered over 1/3 million rovibrational lines of the five most important naturally occurring greenhouse molecules: water vapour, carbon dioxide, ozone, nitrous oxide and methane. The change in heat radiated to space due to doubling each greenhouse gas was found. The work showed saturation limits the effect of future greenhouse gas increases. Satellite observations of infrared intensities taken at various latitudes were in excellent quantitative agreement with the computed results. Ongoing work is examining radiation scattering in clouds. Preliminary results show clouds decrease the global warming effect due to doubling carbon dioxide by about 30%.

5. As such, I have knowledge of the matters set out in this affidavit.[1]

[1] A copy of my *curriculum vitae* is attached to this affidavit as **Exhibit "1"**.

6. I have been asked to provide opinion evidence about climate modelling, the role of CO_2 in climate change, and the effect of Ontario's greenhouse gas emissions on global climate and extreme weather events. Specifically, I was asked to answer the following questions:

   a. What are the effects of CO_2 and other greenhouse gases in the Earth's atmosphere?

   b. Please describe how the Intergovernmental Panel on Climate Change (IPCC) makes predictions with respect to climate change.

   c. Please compare observed temperature trends with predictions made by global climate models.

   d. Please compare observed weather events and environmental phenomena (e.g. extreme storms, forest fires) with past predictions made about the impact of increasing atmospheric CO_2 concentrations on such events and phenomena.

   e. Applying global climate models, to what extent do greenhouse gases emitted in Ontario affect atmospheric greenhouse gas concentrations and their predicted effects?

   f. To what extent do greenhouse gases emitted in Ontario cause or contribute to extreme weather events or other harmful environmental phenomena in Ontario?

   g. Applying global climate models, what is the predicted impact of reducing or eliminating greenhouse gas emissions in Ontario?

7. I understand that my role is to provide opinion evidence that is fair, objective and non-partisan, related only to matters that are within my area of expertise and to provide

additional assistance as the court may require.[2] Where I have cited a source in the footnotes to this affidavit, I have relied on that source in forming my opinion and I believe it to be true.

8. My opinion can be summarized as follows:

   a. In 2019, Ontario generated only 0.35% of global CO_2 emissions. Ontario's CO_2 emissions in 2019 were 20% lower than in 2005.

   b. Ontario's contribution to global warming can be estimated using its fraction of world CO_2 production. Using the 2021 IPCC's recommended climate sensitivity value ($S = 3^oC$) gives Ontario's 2019 contribution to global warming as 0.000092 ºC or 92 microdegrees C per year. This contribution is dwarfed by that of other countries, especially China, the USA and India. Warming of 0.000092 ºC in one year is not measurable as it is orders of magnitude lower than thermometer accuracy. For example, a standard mercury thermometer measures temperature to at best 0.1 ºC accuracy. It would take thousands of years of emissions at current levels before Ontario's greenhouse gas emissions could have a measurable impact on global temperature that exceed natural variations in global temperature. Reducing Ontario's emissions from current levels would push out the time at which Ontario's emissions could have a measurable impact even further into the distant future.

   c. A complete cessation of Ontario's CO_2 emissions would reduce global warming by about 0.000092 ºC per year using IPCC's recommended climate sensitivity

[2] My signed Acknowledgement of Expert's Duty is attached to this affidavit as **Exhibit "2"**.

value. Hence, a 30% or 50% reduction of Ontario's CO_2 emissions from 2019 levels would reduce global warming by 0.000028 and 0.000046 ºC per year, respectively. Such changes would be unmeasurably small and would be vastly outweighed by emissions from other countries.

d. The Earth's average surface temperature has increased by about 1ºC since 1880. Global climate models (GCMs) are not able to account for substantial decadal variations in the rate of warming within this period. The most significant of these is the abrupt warming that occurred in the 1990s followed by the so-called hiatus from 2000 to about 2016. A comparison with observations shows a consistent overestimation of global warming by nearly all GCMs.

e. North American precipitation records show no change over the past two centuries. Precipitation recorded at Toronto from 1843 to 2020 is remarkably stable. There has been no change in either the number of total hurricanes or severe hurricanes observed worldwide during 1981 to 2021. Tornado observations using modern Doppler radar show no change for either the number of total tornadoes or strong tornadoes from 1995 to 2020 in the U.S. The number of Ontario tornadoes shows no overall trend from 1950 to 2007 but there appears to be a decrease from 1978 to 2007. The annual number of forest fires decreased in Canada and Ontario from 1990 to 2020, while the area burned in forest fires shows no clear trend.

f. Trends in precipitation, hurricanes, tornadoes and forest fires over time can be compared to the steady increases in atmospheric concentrations in greenhouse gases over the same period. There is no increase in any of these phenomena proportionate to the increase in atmospheric greenhouse gas concentrations. In particular, there is no increasing trend of precipitation, hurricanes, tornadoes or forest fires within Ontario proportionate to the increase in atmospheric greenhouse gas concentrations. Given Ontario's greenhouse gas emissions only comprise 0.35% of the global total, it is scientifically implausible to claim that Ontario's greenhouse gas emissions are responsible for extreme weather or harmful environmental phenomena.

A. Is the Earth's climate constant?

9. The occurrence of Ice Ages shows that the Earth's climate is not constant. Ice ages are caused by small changes in the Earth's orbit around the sun known as Milankovitch cycles that have periods of about 10,000 years.[3] Temperatures have also varied during recorded history. North Atlantic temperatures were warmer from 900 to about 1300 A.D which allowed the Vikings to settle in southern Greenland.[4] There was a shift to a cooler climate in the late 1300s.[5] The period from 1400 to 1700 is known as the Little Ice Age. Temperatures in Europe were cooler and Swiss villagers even offered prayers to stop advancing glaciers from destroying their alpine villages.[6]

10. The reasons for temperature fluctuations on time scales of centuries and even decades are not well understood. One possibility is variation of the amount of heat produced by the

[3] M. Milankovitch, *Canon of Insolation and the Ice-Age Problem,* Königlich Serbische Akademie (1941).
[4] D. Mackenzie Brown, *The Fate of Greenland's Vikings*, Archaeological Institute of America, ISBN 0-7368-0939-2, February (2000).
[5] G. H. Miller, A. Geirsdottir, Y. Zhong, D. J. Larsen, B. L. Otto-Bliesner, M. M. Holland, D. A. Bailey, K. A. Refsnider, S. J. Lehman, J. R. Southon, C. Anderson, H. Bjorsson and T. Thordarson, "Abrupt Onset of the Little Ice Age Triggered by Volcanism and Sustained by Sea-Ice/Ocean Feedbacks", Geophysical Research Letters 39, (2012).
[6] J. Cowie, *Climate Change: Biological and Human Aspects*, Cambridge University Press, ISBN 978-0-521-69619-7 (2007).

sun. Satellite measurements from 1975 onwards show the sun's intensity varies by about 0.1% in a cyclic fashion having a period of 11 years which coincides with the sunspot cycle.[7] Sunspots were first observed in about 1600. The sharp decreases in sunspot number in the 1600s and immediately after 1800 are known as the Maunder and Dalton Minima, respectively.[8] Possibly, the sun had fewer sunspots during the 1600s (as opposed to a lack of scientists studying sunspot activity) which corresponded to a reduced solar intensity that contributed to the Little Ice Age.

B. What are the effects of CO_2 and other greenhouse gases in the Earth's atmosphere?

I. Atmospheric carbon dioxide

11. Carbon dioxide (CO_2) is an odourless, invisible gas that plants use for food. Greenhouse growers routinely add CO_2 to promote growth. An example is shown in Fig. 1 where pine trees grow much faster at higher concentrations of carbon dioxide.[9] An increase in global vegetative productivity has been observed by satellites as shown in Fig. 2.[10] For the period 1982-2011, more than 30% of the Earth's land area greened for a 14% overall

[7] NASA Active Cavity Radiometer Irradiance Monitor, "Why NASA Keeps a Close Eye on the Sun's Irradiance", https://nasa.gov/topics/solarsystem/features/sun-brightness.html, accessed Dec. 21, 2021.
[8] I. Usoskin et al. "A Solar Cycle Lost in 1793-1800: Early Sunspot Observations Resolve the Old Mystery", *The Astrophysical Journal*, 700: L154-L157 (2009) C: (iop.org).
[9] C. D. Idso, "Earth's Rising Atmospheric CO_2 Concentration: Impacts on the Biosphere", *Energy & Environment* 12, No. 4, 287-310 (2001).
[10] R. Myneni, "The Greening Earth, Probing Vegetation Conference From Past to Future", Antwerp, Belgium, July 4-5, 2013; Z. Zhu et al, "Greening of the Earth and its Drivers", *Nature Climate Change* 6, 791-795 (2016); T. Owen, "MODIS Shows Earth is Greener", NASA, Terra Earth Observatory (2019) https://terra.nasa.gov/news/modis-shows-earth-is-greener, accessed Dec. 15, 2021, attached to this affidavit as **Exhibit "3"**.

increase in total gross vegetative productivity. This is very beneficial to farmers who provide food for the world's growing population.[11]

12. Fig. 2 shows particularly striking greening in the region bordering the Sahara Desert. Plants extract carbon dioxide from the atmosphere through small holes in their leaves called stomata. At higher carbon dioxide levels, the stomata become smaller, reducing water loss from the plant.[12] This is believed to be part of the reason for the notable greening of the Earth's arid regions.

Figure 1: Growth of Eldarica Pine Trees at CO_2 Concentrations of 385, 535, 685 and 835 ppm.[13]

[11] C. D. Idso, R. M. Carter and S. F. Singer, "Climate Change Reconsidered: 2011 Interim Report", Chicago, Heartland Institute, ISBN 978-1-934791-36-3 (2011).
[12] Ibid.
[13] C. D. Idso, "Earth's Rising Atmospheric CO_2 Concentration: Impacts on the Biosphere", *Energy & Environment* 12, No. 4, 287-310 (2001).

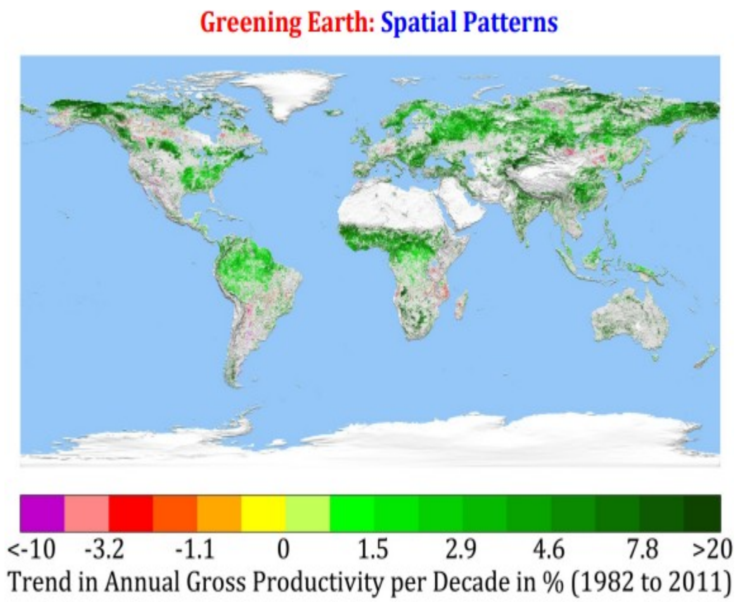


Figure 2: Global Trends in Gross Vegetative Productivity 1982-2011 from Satellite Measurements.[14] The increase of plant growth is especially noticeable in arid regions such as south of the Sahara desert. At higher CO_2 levels, the stomata in plant leaves are smaller, reducing the loss of water.[15]

13. The atmosphere is essential for making Earth habitable. Dry air consists of 78% Nitrogen, 21% Oxygen molecules and 1% Argon atoms. Carbon dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) are only found in trace amounts, with average surface concentrations in 2021 of 415, 1.9 and 0.32 parts per million (ppm) respectively. Water vapour is a very important atmospheric constituent. Its concentration varies considerably from as high as 4% in the warm tropics at high humidity to minuscule amounts in the polar regions during winter. Fig. 3 shows the observed concentration dependence of these trace gases on altitude.[16]

[14] R. Myneni, "The Greening Earth, Probing Vegetation Conference From Past to Future", Antwerp, Belgium, July 4-5, 2013.
[15] "A Primer on Carbon Dioxide and Climate", CO2 Coalition, co2coalition.org/publication-category/white-papers-other-publications/, accessed Dec. 22, 2021.
[16] G. P. Anderson, S. A. Clough, F. X. Kneizys, J. H. Chetwynd and E. P. Shettle, *AFGL Atmospheric Constituent Profiles (0-120 km),* AFGL-TR-86-0110 Air Force Geophysics Laboratory, Hanscom Air Force Base, Massachusetts, (1986).

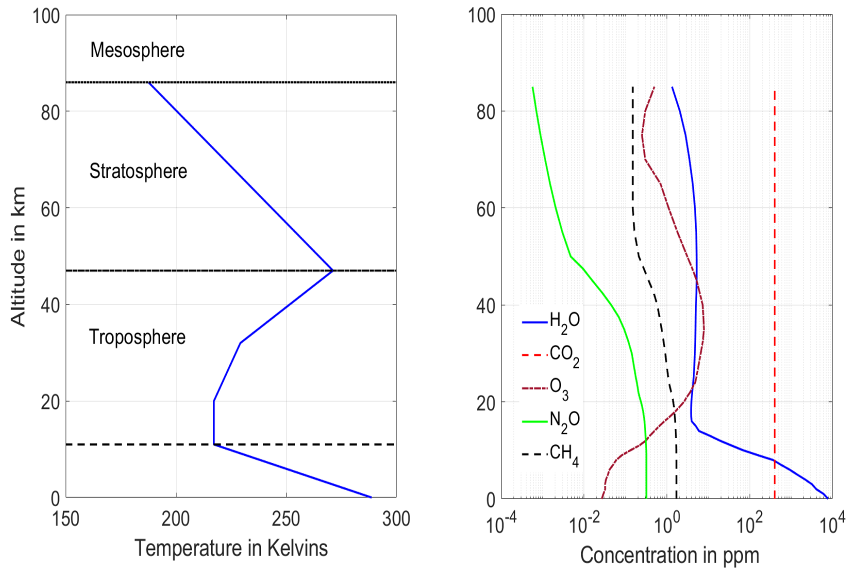


Figure 3: Left. A midlatitude atmospheric temperature profile.[17] The Earth's mean surface temperature is 15.5 degrees Celsius or 288.7 Kelvins. **Right.** Observed concentrations of greenhouse molecules in units of parts per million versus altitude.[18]

14. The temperature of the Earth's atmosphere for a midlatitude position, where Ontario is located, is shown in Fig. 3.[19] Weather events occur in the lowest part of the atmosphere called the troposphere. The temperature is observed to decrease rapidly from an average surface temperature of about 15.5 degrees Celsius or 288.7 Kelvins until the tropopause which at midlatitudes occurs at an altitude of 11 km. The temperature increases in the stratosphere located from 11 to 47 km, due to absorption of ultraviolet sunlight by ozone molecules. The temperature drops sharply in the mesosphere located above 47 km.

[17] *The U.S. Standard Atmosphere*, NASA Report TM-X-74335 (1976).
[18] G. P. Anderson, S. A. Clough, F. X. Kneizys, J. H. Chetwynd and E. P. Shettle, *AFGL Atmospheric Constituent Profiles (0-120 km)*, AFGL-TR-86-0110 Air Force Geophysics Laboratory, Hanscom Air Force Base, Massachusetts, (1986).
[19] *The U.S. Standard Atmosphere*, NASA Report TM-X-74335 (1976).

II. The Greenhouse Effect

15. All objects having a finite temperature radiate energy. The sun is very hot and therefore produces visible light. Cooler objects such as the Earth's surface and atmosphere generate heat or infrared radiation. This infrared radiation exists at a wide range of infrared colours, which scientists refer to as frequencies or wavelengths, that the human eye cannot see. In the absence of clouds, most sunlight is transmitted through the atmosphere. In contrast, infrared radiation is strongly absorbed by the atmosphere. A gas that does not absorb visible sunlight but strongly absorbs infrared radiation is called a greenhouse gas.

16. In the absence of greenhouse gases, radiation emitted by the Earth's surface would pass through a transparent atmosphere to outer space. Greenhouse gases absorb the radiation which is then reemitted in all directions, some upwards and some back to the surface, warming it. This is called the Greenhouse Effect.

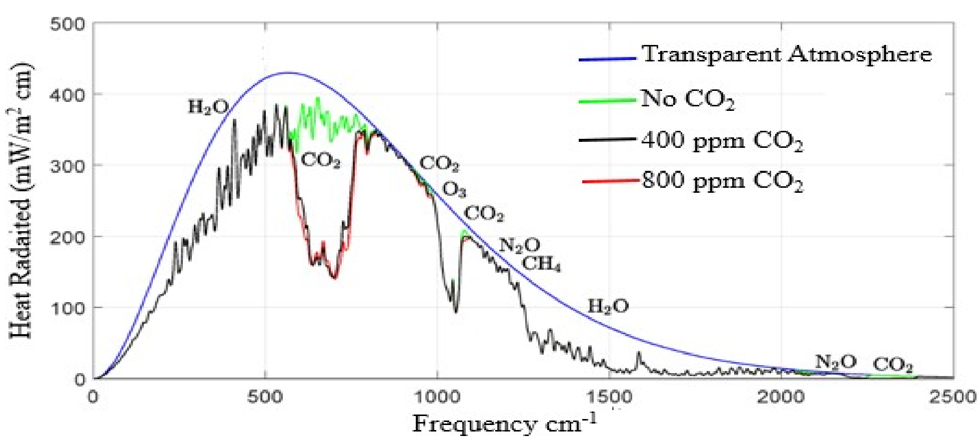


Figure 4: Effects of carbon dioxide concentration on heat radiated by Earth and its atmosphere for a clear sky.[20]

[20] W. A. van Wijngaarden and W. Happer, "Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases", Atmosphere & Oceanic Physics, arXiv: 2006.03098 (2020).

17. In Fig. 4, the smooth blue line is heat that would be radiated from a surface at temperature 15.5 Celsius or 288.7 Kelvins for a transparent atmosphere having no greenhouse gases. The three other lines consider the case of H_2O, O_3, CH_4 and N_2O as well as: no CO_2 (green line), 400 ppm CO_2 (black line) and 800 ppm CO_2 (red line). The difference between the red and black curves is what the concern about global warming is all about.

18. For the case of a clear sky, one can compute the amount of heat radiated by the Earth as is shown in Fig. 4.[21] This shows the heat radiated per unit area by the Earth and its atmosphere to outer space at the various infrared colours or frequencies. This calculation considered the 5 most important naturally occurring greenhouse gases: water vapour (H_2O), carbon dioxide (CO_2), ozone (O_3), nitrous oxide (N_2O) and methane (CH_4). The effects of water vapour are very noticeable at frequencies less than 550 cm^{-1} and in the range of 1200 to 2800 cm^{-1}. The two noticeable dips in the black and red curves are due to absorption by carbon dioxide at 660 cm^{-1} and ozone at 1050 cm^{-1}. The effects of methane and nitrous oxide are barely noticeable because their atmospheric concentrations are over 1000 times smaller than water vapour and more than 100 times smaller than carbon dioxide. One can barely distinguish between the black and red curves which correspond to carbon dioxide concentrations of 400 and 800 ppm, respectively. An important check of this work is to compare modelled results to data observed by satellites

[21] W. A. van Wijngaarden and W. Happer, "Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases", Atmosphere & Oceanic Physics, arXiv: 2006.03098 (2020).

that measure the intensity of infrared light radiated by the Earth and its atmosphere as shown in Fig. 5.[22]

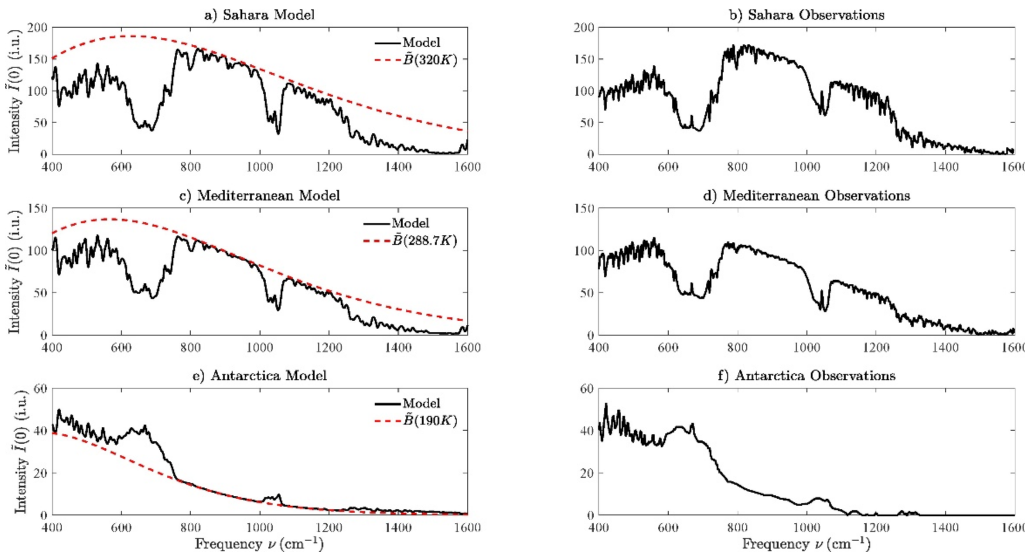


Figure 5: Comparison of modelled and satellite observed intensity of infrared radiation or heat radiated by the Earth and its atmosphere over the Sahara, Mediterranean and Antarctica.[23]

19. In Fig. 5, the intensity observed over the Sahara, whose surface temperature is a very warm 47 Celsius or 320 Kelvins, is much higher than the intensity detected over cold Antarctica where the surface temperature is only -83 Celsius or 190 Kelvins. The dashed red curves are the intensities that would be radiated by the surface, for a transparent atmosphere without any greenhouse gases. For Antarctica, very dense cold air sinks to the surface causing the surface temperature to be lower than the atmosphere a few kilometers above the surface. This slightly warmer air causes the satellite to see a higher intensity than one would expect from the very cold surface.

[22] W. A. van Wijngaarden and W. Happer, "Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases", Atmosphere & Oceanic Physics, arXiv: 2006.03098 (2020).
[23] Ibid.

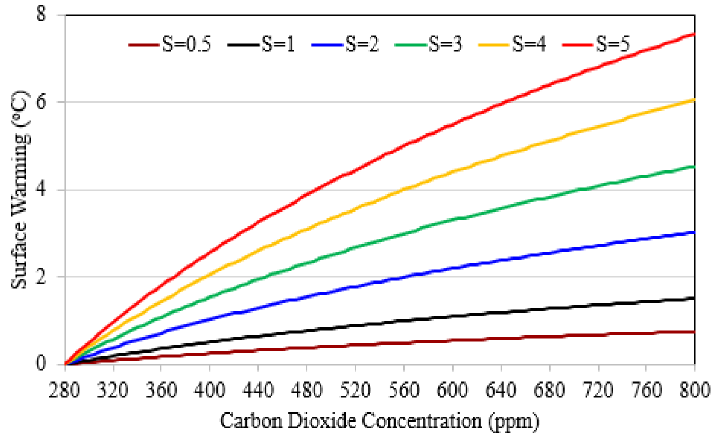


Figure 6: Surface Warming Dependence on Carbon Dioxide Concentration for various values of Climate Sensitivity *S* in units of °C as given by equation 1. The carbon dioxide concentration at the onset of the industrial revolution was 280 ppm. In 2021, the CO_2 concentration reached 415 ppm.

III. Climate sensitivity

20. The effect of doubling carbon dioxide is shown by the red and black curves in Fig. 4. Slightly less heat is radiated when the CO_2 is doubled to 800 ppm. For the Earth to be in equilibrium, the heat radiated equals the amount of absorbed sunlight. If less heat is radiated, then the Earth warms. The temperature increases by 1 ^{o}C if the warming is the same at all altitudes. The surface warming ΔT, due to the carbon dioxide concentration increasing from C*o* to C is given by

$$\Delta T = S\, log_2 \frac{C}{C_o} \quad (1)$$

where *S* is called the climate sensitivity. The warming predicted by this formula is plotted in Fig. 6. If the carbon dioxide concentration doubles from 400 to 800 ppm, the surface temperature increases by *S*. The logarithm means that for warming by 2*S*, the CO_2 concentration must double again from 800 to 1600 ppm.

IV. Water feedback

21. A warming of only 1 ^oC is not a threat to the planet. However, the maximum amount of water vapour that can be contained in a given volume of air increases at a rate of 6% per degree Celsius. Therefore, the water vapour concentration would go up in a warming atmosphere if the relative humidity remained unchanged. This so-called water feedback effect would amplify the small warming due to increasing carbon dioxide. Observations are inconclusive that water vapour has increased at the maximum theoretical rate.[24] A study that examined 1/4 billion hourly values of temperature and relative humidity at 309 stations located throughout North America during 1948-2010 found relative humidity decreased at many inland stations.[25]

22. A more sophisticated analysis of surface warming must take into account that the troposphere warms more than the higher atmosphere. S. Manabe, who received the Nobel prize in 2021, originally estimated a climate sensitivity of 1.4 C for the case of constant water vapour concentration.[26] This has been independently confirmed by several subsequent groups including our own calculations.[27] The climate sensitivity increases to about 2.3 C if one considers maximum possible water feedback such that relative humidity remains constant.

[24] B. D. Santer, S. Po-Chedley, C. Mears, J. C. Fyfe, N. Gillett, Q. Fu, J. F. Painter, S. Solomon, A. K. Steiner, F. J. Wentz, M. D Zelinka and C. Z. Zhou, "Using Climate Model Simulations to Constrain Observations", *Journal of Climate* 24, 6281-6301 (2021).
[25] V. Isaac and W. A. van Wijngaarden, "Surface Water Vapor Pressure and Temperature Trends in North American during 1948-2010", *Journal of Climate* 25, No. 10, 3599-3609 (2012).
[26] S. Manabe and R. T. Wetherald, "Thermal Equilibrium of the Atmosphere with a Given Distribution of Relative Humidity", *Journal of Atmospheric Sciences* 24, 241 (1967).
[27] W. A. van Wijngaarden and W. Happer, "Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases", Atmosphere & Oceanic Physics, arXiv: 2006.03098 (2020).

V. Global warming due to other greenhouse gases such as CH_4 and N_2O

23. All five of the Earth's naturally occurring greenhouse gases, H_2O, CO_2, O_3, N_2O and CH_4, are very strongly saturated.[28] This means that doubling any of their concentrations produces a global warming that is greater than a subsequent similar absolute increase. N_2O and CH_4 are much less abundant than H_2O and CO_2 in the Earth's atmosphere and therefore somewhat less saturated. An analogy to explain saturation is a farmer painting a barn. One notices a big difference between the first and second coat but negligible effect between the 10th and 11th coat.

24. For the case of methane, I recomputed Fig. 4 for ambient and doubled methane concentrations of 1.8 and 3.6 ppm, respectively. One additional methane molecule is 30 times more effective for global warming than one additional CO_2 molecule. However, 300 times more carbon dioxide is added to the atmosphere each year than CH_4. Hence, the overall effect of the increasing methane concentration to global warming is less than 1/10 that of carbon dioxide. The global warming contributions of other gases such as N_2O are even smaller.[29]

C. How does the Intergovernmental Panel on Climate Change (IPCC) make predictions with respect to climate change?

I. How Global Climate Models are created

25. The IPCC relies on GCMs to make its climate predictions. Efforts to construct a realistic mathematical computer model of the Earth's climate are an enormous task that have been

[28] W. A. van Wijngaarden and W. Happer, "Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases", Atmosphere & Oceanic Physics, arXiv: 2006.03098 (2020).
[29] Ibid.

ongoing for over half a century.[30] The Earth's surface area of 515 million km^2 is divided into area segments and the atmosphere into vertical slices. For an area element of 100 km^2 and a vertical step size of 100 m, one needs over 2.5 billion points. At each point, one must calculate: temperature, pressure, water vapor concentration, greenhouse gas and aerosol concentrations, wind speed and direction etc. At the surface, one must determine the fraction of sunlight reflected. Evaporation must be taken into account which is very different for an ocean as opposed to a land surface. For the latter case, the vegetation type may be important.

26. Ocean currents such as the Gulf Stream that transport enormous amounts of heat from the tropics to polar latitudes must also be modelled using an additional array of points. Ocean circulation is not well understood and cycling times of deep ocean water are estimated to take up to hundreds of years. Finally, the entire system is time dependent, as the Earth orbits annually about the sun and daily rotates about its axis.

27. Developing a Global Climate Model (GCM) requires a very large team of people and the computer programs easily exceed a million lines of code. GCMs have been developed at large centers such as the Princeton Gas Fluid Dynamic Laboratory,[31] UK Meteorological Office,[32] Boulder's National Climate Center for Atmospheric Research,[33] Max Planck

[30] Geophysical Fluid Dynamics Laboratory, https://gfdl.noaa.gov/climate-modeling, accessed Dec. 27, 2021.
[31] Ibid.
[32] HadCM3: Meteorological Office Climate Prediction Model, metoffice.gov.uk/research/approach/modelling-systems/unified-model/climate- models/hadcm3, accessed Dec. 27, 2021.
[33] National Center for Atmospheric Research (NCAR), "Models Simulating a Complex World", ncar.ucar.edu/what-we-offer/models, accessed Dec. 27, 2021.

Institut für Meteorologie[34] and the Canadian Centre for Climate Modelling and Analysis.[35]

28. Even using the world's fastest supercomputers, numerous simplifying approximations are essential. Typically, one tunes a myriad of parameters to ensure the GCM reasonably reproduces the Earth's 20th century climate. One then models future climate considering various scenarios of increasing greenhouse gases.

II. Global Climate Models, Coupled Model Intercomparison Projects, and IPCC Predictions

29. Work is ongoing to make GCMs more realistic. The Coupled Model Intercomparison Project (CMIP) attempts to evaluate and compare the different GCM results.[36] As discussed in the next section, the 2021 IPCC report uses the climate models from CMIP6, to estimate the climate sensitivity.

30. Table 1 lists the estimates for the climate sensitivity. These values have not changed spectacularly over 30 years. In 2021, the IPCC gave a value for *S* of between 2.5 and 4.0 ºC with the best estimate of 3 ºC. The 2021 uncertainty is smaller than for previous reports because it is believed the latest GCMs better model clouds. It is very challenging to determine the global warming or cooling effects of clouds, which at any time cover about two thirds of the Earth. Cooling occurs when clouds block the midday sun on a

[34] Max Planck Institut für Meteorologie, mpimet.mpg.de/en/science/models/mpi-esm, accessed Dec. 27, 2021.
[35] Environment Canada, Canadian Centre for Climate Modelling and Analysis (CCCma), profils.profiles.science.gc.ca/en/research-centre/canadian-centre-climate- modeling-and-analysis-ccma-university-victoria, accessed Dec. 27, 2021.
[36] World Climate Research Programme (WCRP), Coupled Model Intercomparison Project (CMIP6), wcrp-climate.org/wgcm-cmip/wgcm-cmip6, accessed Dec. 27, 2021.

summer day while in winter, cloudy nights are warmer than clear nights. The huge uncertainty due to clouds is the elephant in the room in Climate Science.

IPCC Report Year	Climate Sensitivity S (°C)
1990[37]	1.5 - 4.5
1996[38]	1.5 - 4.5
2001[39]	1.5 - 4.5
2007[40]	2.0 - 4.5
2014[41]	1.5 - 4.5
2021[42]	2.5 - 4.0

Table 1: Values for Climate Sensitivity *S*, the global warming caused by doubling carbon dioxide, as given in various IPCC Reports.

D. Comparison of observed temperature trends with concurrent atmospheric CO_2 concentrations and predictions made by global climate models

I. Methods for measuring historic CO_2 levels

31. Atmospheric carbon dioxide levels have varied throughout Earth's history. They were as high as 4000 ppm 500 million years ago in the Cambrian period and dropped to 180 ppm

[37] Climate Change: The Scientific Assessment, Report prepared for Intergovernmental Panel on Climate Change (1990).
[38] Climate Change: The Scientific Assessment, Report prepared for Intergovernmental Panel on Climate Change (1996).
[39] Climate Change: The Scientific Assessment, Report prepared for Intergovernmental Panel on Climate Change (2001).
[40] Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R. K. Pacauri, and A. Reisinger (eds.)]. Geneva, Switzerland, (2007).
[41] G. Myhre et al, Anthropogenic and Natural Radiative Forcing, Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom (2013).
[42] V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. aud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekci, R. Yu, B. Zhou, eds. (2021-08-09). *Summary for Policymakers. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University press (2021).

at the peak of the last ice age.[43] Carbon dioxide concentrations of the last several hundred thousand years are shown in Fig. 7. This data was obtained from ice cores extracted at Vostok, Antarctica.[44] Each year, a layer of snow as well as dust falls onto the surface. The weight of succeeding layers compress the snow which eventually turns to ice. Air is then trapped in small bubbles.

32. Fig. 7 shows the CO_2 concentration measured as a function of the depth of ice retrieved from a borehole at Vostok. The age of the ice is determined by counting the annually deposited ice layers analogous to counting tree rings. The temperature is found by measuring the abundance of the heavier isotopes of oxygen and hydrogen in the ice.[45] Regular oxygen has 8 protons and 8 neutrons and is labelled ^{16}O. A few oxygen atoms have 2 additional neutrons and are labelled ^{18}O. Similarly, some hydrogen atoms have an additional neutron and are called deuterium. These heavier isotopes cause some water molecules to be slightly heavier. It has been observed that the concentration of these heavy water molecules in snow depends on the temperature. The reason is that more energy is required to evaporate a heavier water molecule. Hence, at colder temperatures the abundance of these isotopes in water vapour is less which in turn lowers their concentration in snow. This allows the temperature to be determined.

[43] R. Berner and Z. Kothavala, "Geocarb III: A Revised Model of Atmospheric CO_2 over Phanerozoic Time", *American Journal of Science* 301, 182-204 (2001).
[44] J. R. Petit, J. Jouzel, D. Raynaud, N. I. Barlow, J. M. Barnola, I. Basilek M. Bender, J. Chappellaz, M. Davis, G. Delaygue, M. Delmotte, V. M. Kotlyakov, M. Legrand, V. Y. Pienkov, C. Lorius, L. Pepin, C. Ritz, E. Slatzman and M. Stievenard. "Climate and Atmospheric History of the Past 420,000 Years from the Vostok Ice Core, Antarctica", *Nature* 399, 485-497 (1999).
[45] H. Riebeek, "Paleoclimatology: The Oxygen Balance", https://earthobservatory.nasa.gov/features/Paleoclimatology_OxygenBalance.

33. Fig. 7 shows a very strong correlation between temperature change and carbon dioxide concentration although less so with dust that is produced by volcanoes. The obvious question is whether a carbon dioxide increase precedes a temperature increase or vice versa. A number of careful examinations have shown that the increase in CO_2 occurred about 800 years after temperature began to increase.[46] The increase in CO_2 is believed to have been caused by a warming ocean releasing carbon dioxide. A similar effect happens when a bottle of coca cola is warmed producing bubbles of carbon dioxide. Hence, increasing atmospheric carbon dioxide was not responsible for the initial temperature rise. The question remains as to what triggered the temperature increase and why it decreased at a later date when the CO_2 concentration was elevated.

[46] Ibid.

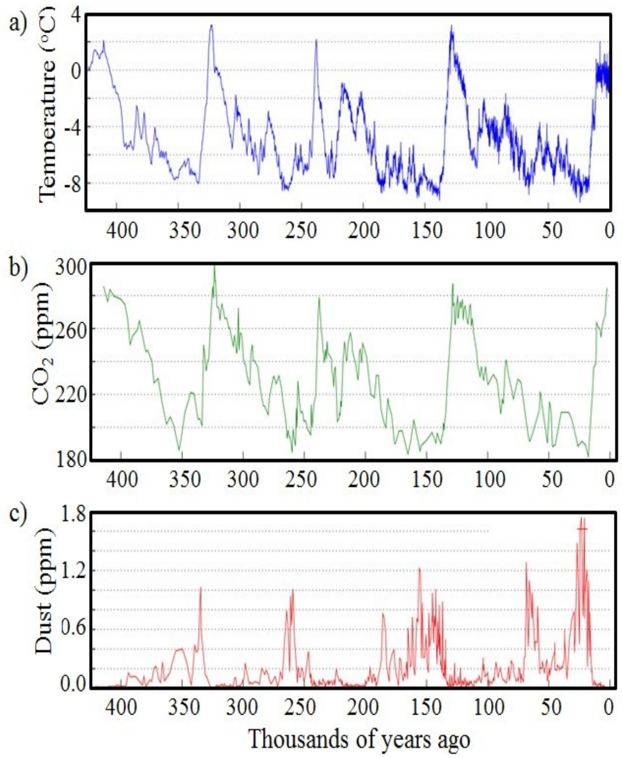


Figure 7: Vostok, Antarctica Ice Core Determination of a) Temperature Change relative to the present b) CO_2 Concentration and c) Dust Concentration for the last 400,000 years.[47] Temperature and the atmospheric CO_2 concentration are strongly correlated. Careful examination has shown that the temperature increases shown in (a) precede the increases in the CO_2 level given in (b) by about 800 years.[48]

II. Relationship between CO_2 and other greenhouse gas levels and temperature trends

34. Fig. 8 shows more recently measured concentrations of the greenhouse gases: CO_2, CH_4 and N_2O made at Mauna Loa, Hawaii. This location is distant from large industrialized cities and therefore more likely to accurately reflect the average global levels of these

[47] J. R. Petit, J. Jouzel, D. Raynaud, N. I. Barlow, J. M. Barnola, I. Basilek M. Bender, J. Chappellaz, M. Davis, G. Delaygue, M. Delmotte, V. M. Kotlyakov, M. Legrand, V. Y. Pienkov, C. Lorius, L. Pepin, C. Ritz, E. Slatzman and M. Stievenard, "Climate and Atmospheric History of the Past 420,000 Years from the Vostok Ice Core, Antarctica", *Nature* 399, 485-497 (1999).
[48] N. Caillon, J. P. Severinghaus, J. Jouzel, J. M. Barnola, J. Kang and V. Y. Kipenkov, "Timing of Atmospheric CO_2 and Antarctic Temperature Changes across Termination III", *Science* 299, 1728-1731 (2003).

gases. Since 1958, the CO_2 concentration has risen from 315 to 415 parts per million (ppm) in 2021. The pre-industrial concentrations of CO_2, CH_4 and N_2O are estimated to be 280, 0.7 and 0.26 ppm, respectively. The gas concentrations vary throughout the year. The CO_2 level decreases in spring and summer and increases during fall and winter by about 6 ppm. This is caused by biological activity. Most of the Earth's land mass is located in the Northern Hemisphere. Carbon dioxide is absorbed by plants during spring and summer. Correspondingly, vegetation decays in the fall and winter releasing carbon dioxide as well as methane back into the atmosphere. N_2O originates from the decay of nitrogen-based fertilizers as well as manure.

35. Fig. 8b shows methane concentrations stopped increasing during the period from about 1998 to 2008. The CH_4 concentration actually decreased in a few of those years. The reason for this decline is not entirely clear. It has been noted that the Russian Natural Gas industry replaced old leaking pipelines during this period. Recently, there have been reports of massive leaks from Russian pipelines during the coronavirus pandemic due to a lack of maintenance.[49]

36. The increase of carbon dioxide is due primarily to the combustion of fossil fuels such as oil, coal and natural gas that resulted from the industrial revolution that began in about 1750. There are significant other sources of greenhouse gases. As much as 20% of the annual anthropogenic production of carbon dioxide has been estimated to result from

[49] I. Gerretsen, "Methane Emissions from Russian Pipelines Surged During Coronavirus Pandemic", Climate Home News, March 3, 2021, https://www.climatechangenews.com/2021/03/04/methane-emissions-russian-pipelines-surged-coronavirus-pandemic/, accessed Dec. 23, 2021.

clearing forests by burning vegetation.[50] The most notable deforestation has occurred in Brazil where about 10% or 400,000 km^2 of the Amazonian rainforest was destroyed during 1988-2013.[51]

[50] R. E. Gullison, P. C. Frumhoff, J. G. Canadell, C. B. Field, D. C. Nepstad, K. Hayhoe, R. Avissar, L. M. Curran, P. Friedlingstein, C. D. Jones and C. Nobre, "Tropical Forests and Climate Policy", *Science* 316, 985-986 (2007); G. R. van der Werf, D. C. Morton, R. S. DeVries, J. G. J. Oliver, P. S. Kasibhatla, R. B. Jackson, G. J. Collatz and J. T. Randerson, "CO_2 Emissions from Forest Loss", *Nature Geoscience* 2, 737-738 (2009).
[51] Brazilian National Institute for Space Research (INPE), Terra Brasilis, "PRODES (Deforestation)", TerraBrasilis (inpe.br), accessed February 23, 2022.

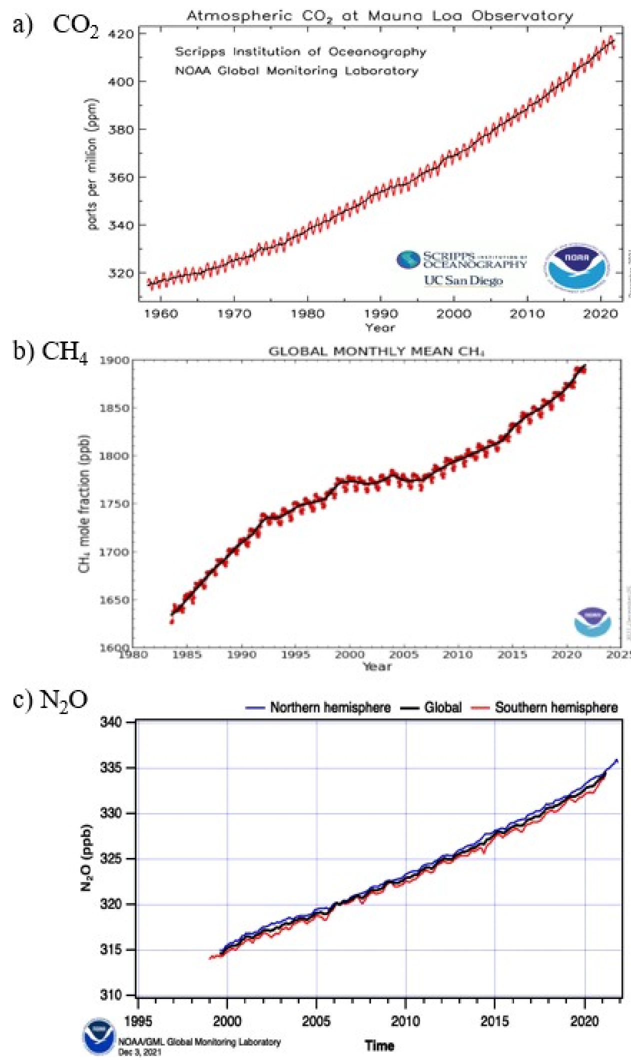


Figure 8: Observations made by NOAA's Global Monitoring Laboratory at Mauna Loa of a) CO_2, b) CH_4 and c) N_2O.[52] The increases in CO_2 and CH_4 are primarily due to the combustion of fossil fuels while the increase in N_2O is caused by greater use of nitrogen-based fertilizers. The annual oscillation of CO_2 and CH_4 are caused by the seasonal dependence of biological activity. More of the Earth's land mass is located in the Northern as opposed to the Southern hemisphere. Plants absorb CO_2 during spring and summer. It is released back to the atmosphere in the fall and winter when the vegetation decays. The rate of CH_4 increase fell sharply in the late 1990s and up to about 2010. A possible reason for this is that leaking Russian Natural Gas pipelines were fixed.

[52] NOAA Global Monitoring Laboratory, Earth System Research Laboratories, https://gml.noaa.gov/ccgg/trends/, accessed Dec. 13, 2021, attached to this affidavit as **Exhibit "4"**.

III. Comparison of observed temperature trends with predictions made by Global Climate Models

37. The predictions of Global Climate Models (GCMs), used in the 2021 IPCC report, regarding temperature were compared to observations. Records since 1880 show an overall warming of about 1 ºC. However, the GCMs do not account for observed decadal temperature fluctuations and consistently overestimate the warming. Fig. 9 shows the observed change of the average Earth's surface temperature over the last century and a half. The temperature has increased by about 1 ºC over this time. The curve shows a temperature increase as one would expect from Figures 6 and 8. However, there are notable differences:

   a. From about 1900 to 1940, there was a warming of about 0.5 ºC during which CO_2 increased from 296 to 311 ppm.[53] Using equation (1), gives a climate sensitivity of $S = 7$ which greatly exceeds the values given in Table 1. Therefore, most of this 0.5 ºC warming is not believed to be due to increasing greenhouse gases but due to natural variation or continued warming of the Earth following the end of the Little Ice Age.

   b. From 1940 to 1980, there was a slight temperature decrease. The reason for this is not clear, especially since the CO_2 concentration increased from 311 to 339 ppm.

   c. From 1980 to 2000, temperature increased by about 0.5 ºC while CO_2 increased from 339 to 370 ppm.

[53] "Atmospheric Carbon Dioxide and Methane Levels, 1800-present", https://www.sealevel.info/co2_and_ch4.html, accessed Dec. 27, 2021.

d. From 2000 to about 2016, the temperature remained stable; this is known as the global warming hiatus. The hiatus was completely unexpected as the CO_2 concentration increased from 370 to 404 ppm.

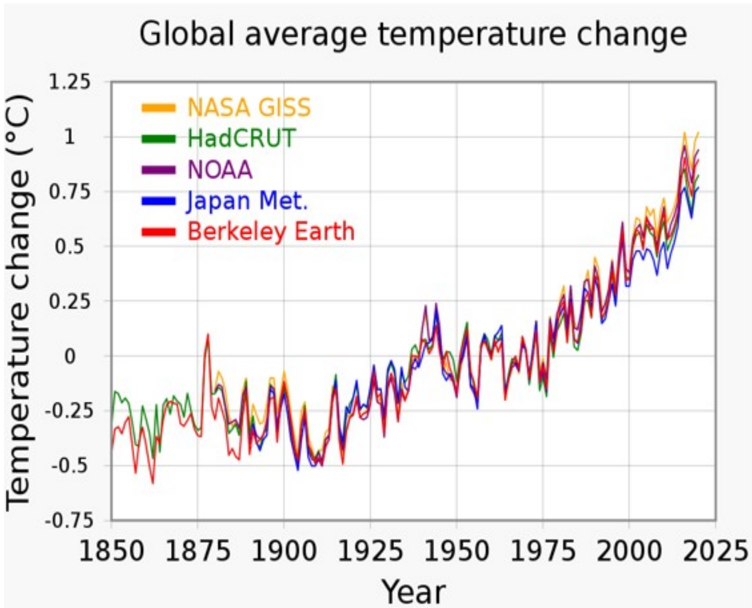


Figure 9: Change of Earth's Average Surface Temperature relative to that during 1951-1980.[54] The temperature increased by about 0.5 ºC from about 1900 to 1940. It decreased slightly during 1940 to 1980. Temperature rose by about 0.5 ºC from 1980 to 2000. The Earth's average temperature remained relatively unchanged from 2000 to 2016 which is known as the global warming hiatus. Global climate models have difficulty explaining this decadal temperature variation and failed to predict the hiatus after 2000.

38. The failure of the GCMs to predict the hiatus in global average temperature after 2000 is illustrated in Fig. 10. The observed temperature increase per decade during 1993 to 2012 is less than half predicted by nearly all GCMs.

[54] Global Average Temperature Datasets from NASA https://data.giss.nasa.gov/gistemp/graphs_v4/, NOAA https://www.ncdc.noaa.gov/cag/global/time-series/globe/land_ocean/12/12/1880-2021/data.csv, Berkeley Earth http://berkeleyearth.lbl.gov/auto/Global/Land_and_Ocean_summary.txt, U.K. Meteorological Office https://www.metoffice.gov.uk/hadobs/hadcrut5/data/current/download.html, and Japan Meteorological Office https://ds.data.jma.go.jp/tcc/tcc/products/gwp/temp/ann_wld.html.

39. The largest global warming is expected to occur at the tropopause, the boundary of the troposphere and stratosphere.[55] For midlatitudes, the tropopause occurs at an altitude of 11 km where atmospheric pressure is about 300 to 200 hPa. Atmospheric pressure at the Earth's surface is just over 1,000 hPa. Fig. 11 compares the results of the latest Coupled Model Intercomparison Project (CMIP6) to observations. It should be emphasized that these were the climate models used in the latest IPCC 2021 report. The modelled temperature trend for 1979-2019 is more than twice what was observed. The observed temperature anomaly, given by the green curves in Fig. 11b, is also much less than predicted by nearly every GCM. This shows GCMs systematically overestimate global warming.[56]

[55] W. A. van Wijngaarden and W. Happer, "Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases", Atmosphere & Oceanic Physics, arXiv: 2006.03098 (2020).
[56] J. C. Fyfe, N. P Gillett and F. W. Zwiers, "Overestimated Global Warming Over the Past 20 Years", *Nature Climate Change* 3, 767-769 (2013).

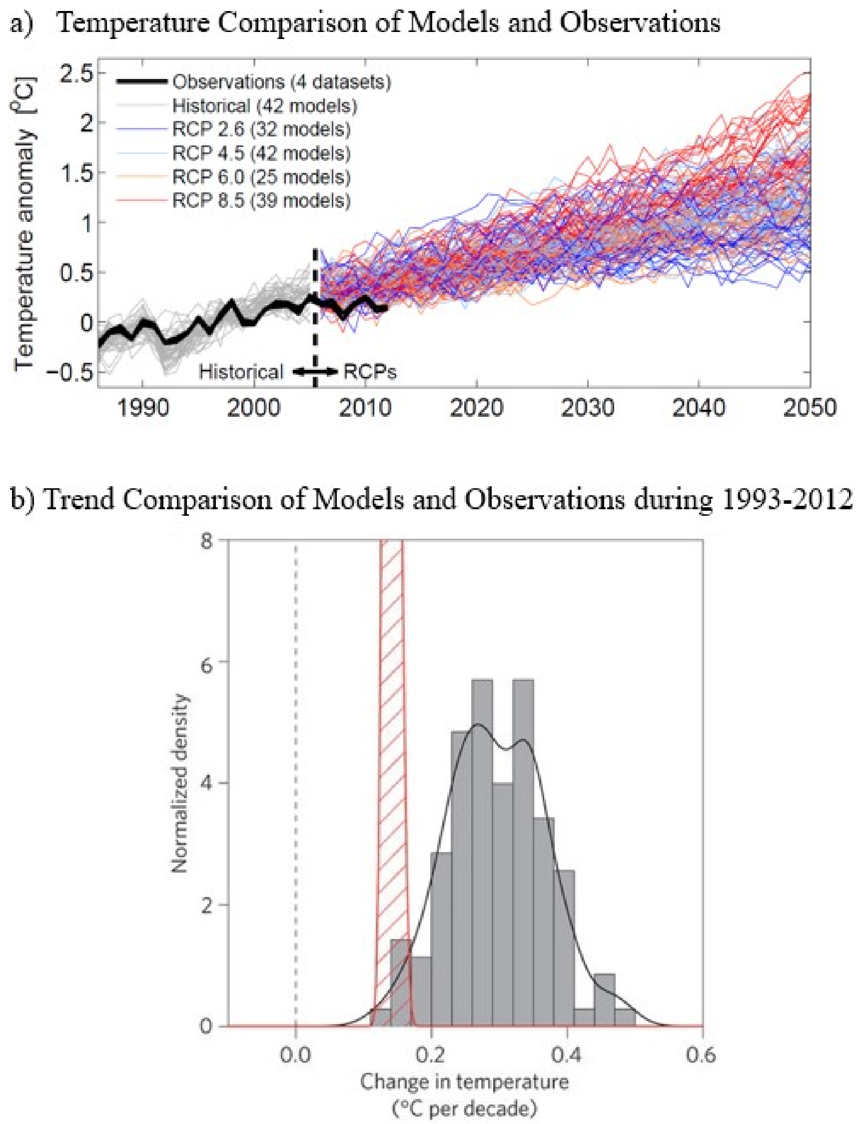


Figure 10: Comparison of Global Climate Model Projected[57] and Observed a) Temperature and b) Temperature Trends during 1993 to 2012.[58] The vertical axis entitled Normalized Density is proportional to the number of GCMs. The observed temperature trends shown by the red cross hatched area are between 0.11 and 0.17 ºC per decade. This is lower than the warming predicted by nearly all GCM trends shown in grey. The climate model warming trends range from 0.11 to 0.5 ºC per decade.

[57] G. Myhre et al, Anthropogenic and Natural Radiative Forcing, Climate Change 2013: The Physical Science Basis: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom (2013).
[58] J. C. Fyfe, N. P Gillett and F. W. Zwiers, “Overestimated Global Warming Over the Past 20 Years”, *Nature Climate Change* 3, 767-769 (2013).

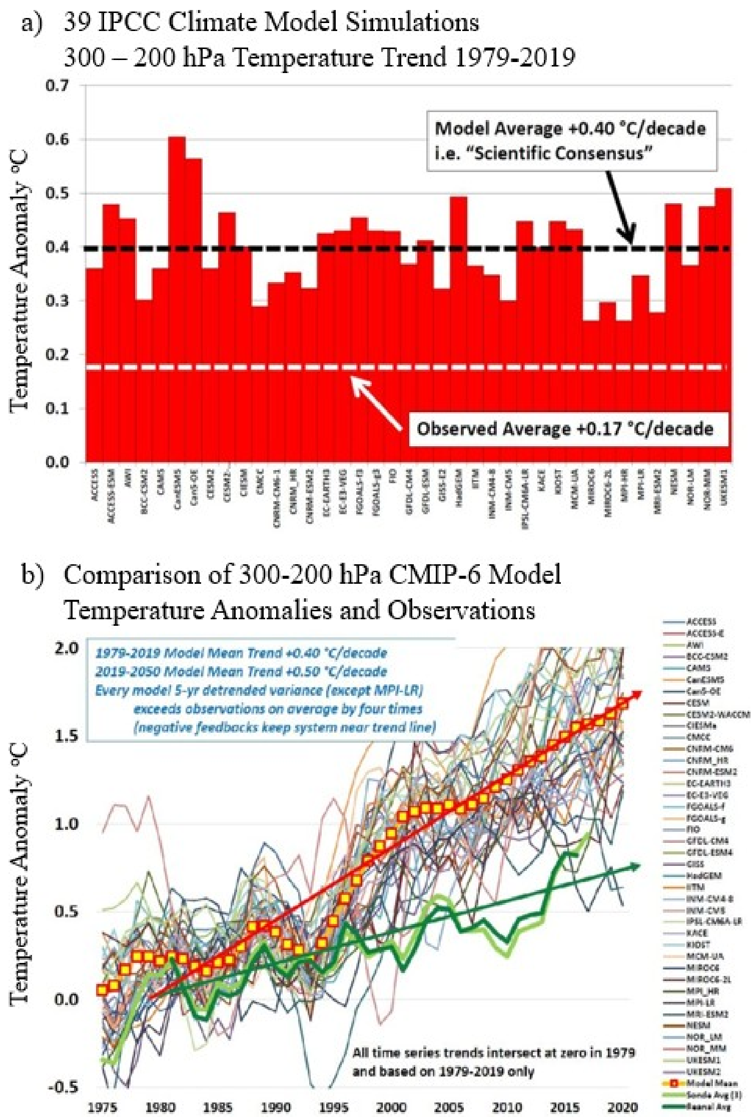


Figure 11: Comparison of Climate Model Simulated and Observed Temperatures at Altitudes of 10 – 13 km. a) Trend Comparison for 1979-2019 and b) Projected Temperature Anomaly and Observations (green). The average of the climate model runs is shown by the yellow dots bordered with red.[59] The observed temperature (green) is substantially below values predicted by nearly all GCMs.

[59] J. R. Christy, "Testing Climate Claims 2021 Update", Irish Climate Forum, Jan. 21, 2021 https://www.youtube.com/watch?v=D2Cd4MLUoN0, accessed Dec. 15, 2021.

E. Comparison of observed weather events and environmental phenomena (e.g. extreme storms, forest fires) with concurrent atmospheric CO_2 concentrations

I. Precipitation

40. The maximum amount of water vapour in the atmosphere increases 6% per degree Celsius. It is therefore reasonable to predict that precipitation should increase in a warmer world.[60] Indeed, it is hot humid summer days that produce torrential downpours. The 2007 IPCC report stated that precipitation has increased in some regions by as much as 1% in each decade of the 20th century.[61] Several studies have examined precipitation for the last part of the 20th century. The results range from a globally averaged precipitation trend that has changed by: -1 mm/year; [62] +3.5 mm/year; [63] and +0.1 mm/year.[64] These differences are not entirely surprising given that precipitation varies considerably over time scales of decades. Data is also very sparse for large regions of the Earth including the Sahara, the

[60] F. Wentz, L. Ricciardulli, K. Hilburn and C. Mears, "How Much More Rain will Global Warming Bring?", *Science Express* 317, 233-235 (2007).
[61] IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R. Pachauri and A. Reisinger, (eds.)] IPCC, Geneva, Switzerland, 104 pp. (2007); A. Dai, I. Y. Fung and A. D. Del Genio, "Surface Observed Global Land Precipitation Variations during 1900-1988", Journal of Climate 10, 2943-2962 (1997).
[62] P. Xie and P. A. Arkin, "Global Precipitation: A 17-year Monthly Analysis Based on Gauge Observations, Satellite Estimates and Numerical Model Outputs", Bulletin of the American Meteorological Society 78, 2539-2558 (1997).
[63] R. Kistler, W. Collins, S. Saha, G. White, J. Woollen, E. Kalnay, M. Chelliah, W. Ebisuzaki, M. Kanamitsu, V. Kousky, H. van den Dool, R. Jenne and M. Fiorino, "The NCEP-NCAR 50-year Reanalysis: Monthly Means", Bulletin of the American Meteorological Society 82, 247-268 (2001).
[64] R. F. Adler, G. J. Huffman, A. Chang, R. Ferraro, P. P. Xie, J. Janowiak, B. Rudolf, U. Schneider, S. Curtis, D. Bolvin, A. Gruber, J. Susskind, P. Arkin and E. Nelkin, "The Version 2 Global Precipitation Climatology Project Monthly Precipitation Analysis (1979-present)", *Journal of Hydrometeorology* 4, 1147-1167 (2003).

Amazon, oceans etc. over most of the 20th century. Hence, the resulting trends frequently are not statistically significant.

41. The need to be cautious about concluding precipitation has changed significantly is illustrated in Fig. 12. This shows winter precipitation at Medicine Hat, Alberta. The data were downloaded from the Environment Canada Climate Archive.[65] The red line is the 5-year running average. There is a sharply decreasing trend of -70.4 mm/century for the period 1952-2006, but the trend is much less if one considers data extending back to 1884. The 1930s were particularly dry. The central plains of North America were affected by a terrible drought and the region was called the dustbowl. The large fluctuations of precipitation on timescales of years to decades is common in relatively dry areas.

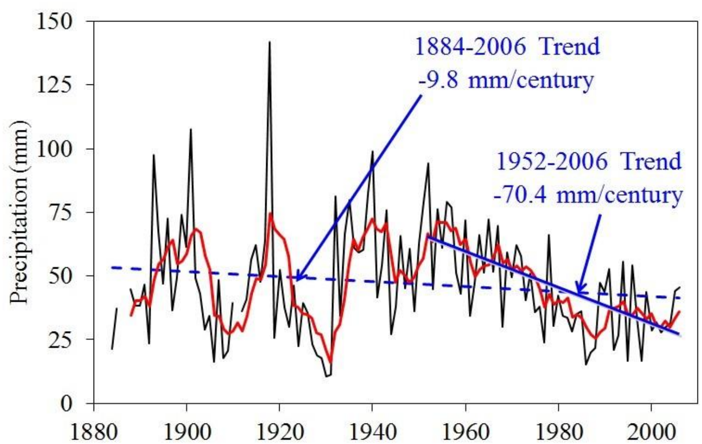


Figure 12: Winter Precipitation in Medicine Hat, Alberta from 1880 to 2006. The red line is the running 5-year average of the data. This graph was created using data from Environment Canada.[66]

42. Fig. 13 shows the percentage change in precipitation relative to 1961-1990 over the past 200 years for North America and California. The interannual variability

[65] Environment Canada, https://climate.weather.gc.ca/, accessed Dec. 16, 2021.
[66] Ibid.

of precipitation when averaged over a large area such as North America is much smaller than when one considers a drier region like California.

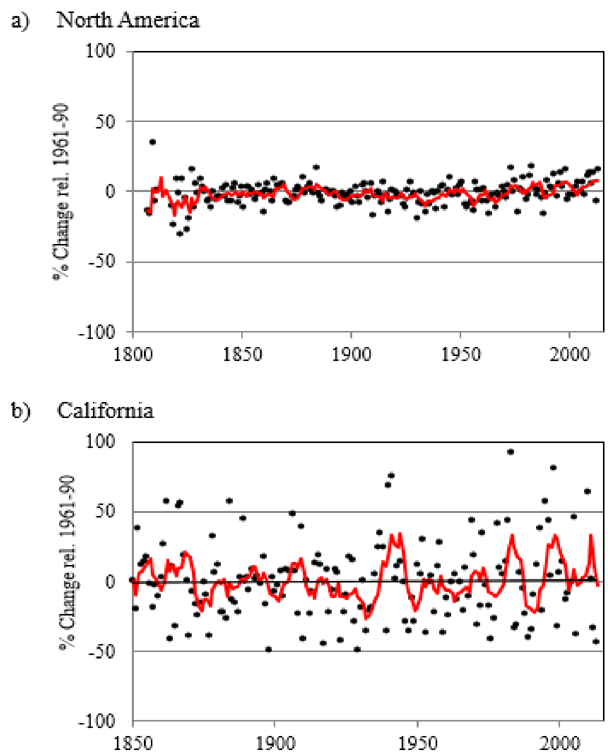


Figure 13: Percentage Precipitation Change relative to 1961-1990.[67] The red line is the running 5-year average of the data.

43. Fig. 14 shows the annual precipitation at Toronto, Ontario from 1843 to 2020 downloaded from the Environment Canada Archive.[68] There is no statistically significant trend. Ontario is blessed with a rather moderate climate not subject to prolonged multiyear droughts or floods. The data fluctuate about the average annual precipitation value of 814 mm per year.

[67] W. A. van Wijngaarden and A. Syed, "Changes in Annual Precipitation over the Earth's Land Mass excluding Antarctica from the 18th century to 2013", *Journal of Hydrology* 531, 1020-1027 (2015).
[68] Environment Canada, https://climate.weather.gc.ca/, accessed Dec. 16, 2021.

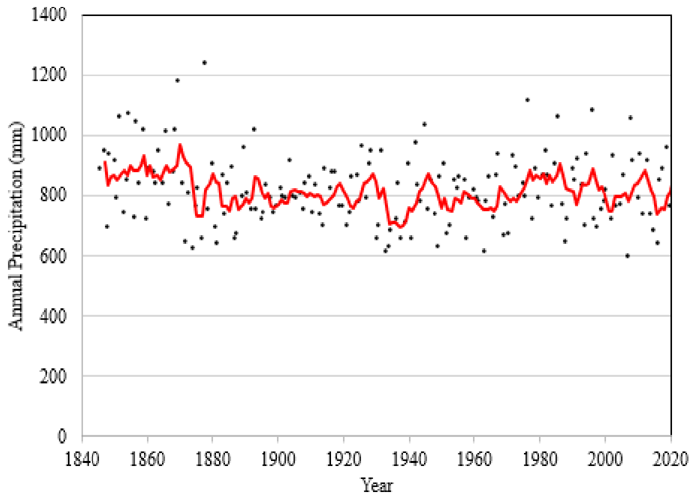


Figure 14: Annual Precipitation in Toronto from 1843 to 2020. The red line is the running 5 year average of the data. This graph was created using data from Environment Canada.[69]

44. The data shown in Figures 13 and 14 do not address whether once-in-a-century downpours are becoming more common. It is difficult to study the frequency of such events because several centuries of data are needed to make any meaningful conclusions. Data for such extended times do not exist for Ontario.

45. That is not to say that heavy rainfall events do not produce greater flooding than in the past. Such flooding, with extensive associated damage, invariably occurs in urban settings where the land surface has been greatly modified to accommodate concrete roadways, parking lots, buildings, etc. that make the surface impervious to water.[70] Whereas before it was developed, the land was able to soak up much rain like a sponge, the water now runs off into creeks turning them into raging

[69] Ibid.

[70] A. Brosnert, D. Niehoff and G. Burger, "Effects of Climate and Land-Use Change on Storm Runoff Generation: Present Knowledge and Modelling Capabilities", *Hydrological Processes* 16, 509-529 (2002).

torrents. That may be a serious problem, but not one caused by global climate change.

II. Hurricanes

46. Some predict that climate change is warming the oceans which has increased the severity and frequency of powerful storms. This would make sense for hurricanes that develop in tropical regions and get their energy from warm surface water. However, this prediction may be simplistic. An important driver of the Earth's climate is the temperature difference between the equatorial and polar regions. Weather systems transfer energy away from the tropics. Global warming is expected to be largest in the Arctic. Hence, the temperature difference between the Arctic and the equator will be reduced, with presumably a subsequent weakening or shift of wind patterns such as the Jet Stream.[71] Hurricanes, with the exception of Hurricane Hazel in 1954, seldom strike Ontario.[72]

47. The amount of hurricane damage very strongly depends on the maximum sustained wind speed. Hurricanes are categorized using the Saffir Simpson wind scale from 1 to 5, where Category 1 Hurricanes have the lowest wind speed. Damage to well-constructed homes can be major even for a Category 1 hurricane. Large tree branches may break and broken power lines may result in electrical outages for several days. Category 5 hurricanes may make an area uninhabitable

[71] D. Zanchettin, S. W. Franks, P. Traverso and M. Tomasino, "On ENSO Impacts on European Wintertime Rainfalls and their Modulation by the NAO and the Pacific Multidecadal Variability described through the PDO index", *International Journal of Climatology*, 28, 995-1006 (2008).
[72] "Explore More than 150 Years of Historical Hurricane Landfalls, Space Coast Daily" https://spacecoastdaily.com/2019/08/noaa-historical-hurricane-tracks-explore-more-than-150-years-of-historical-hurricane-landfalls/, Aug. 29, 2019.

for months. Fig. 15 shows the number of global hurricanes observed from 1981 to 2021. No obvious trend is evident in either the total number of hurricanes or the number of major hurricanes defined as having wind speed in excess of 96 knots (153 km/hr).

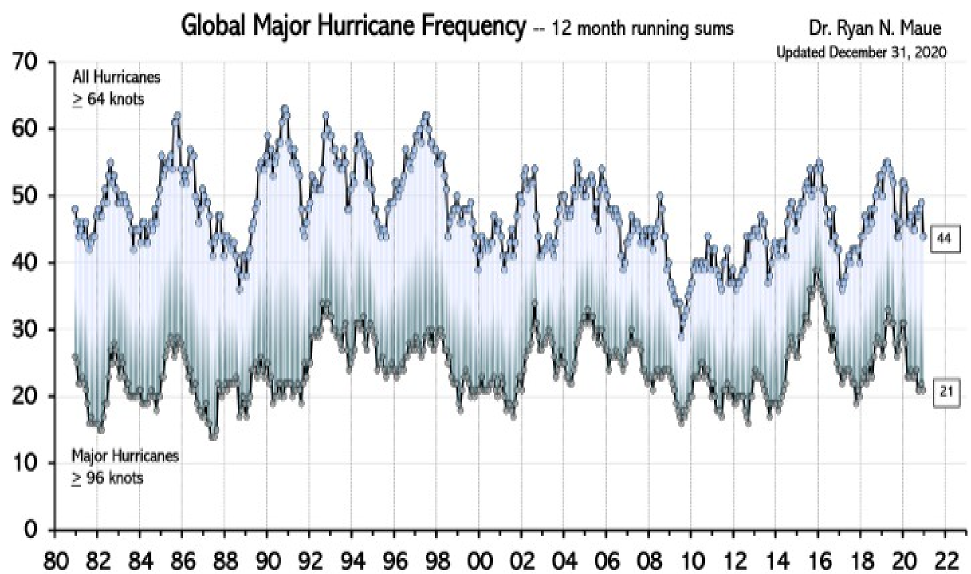


Figure 15: Annual Number of Global Hurricanes Observed from 1981 to 2021.[73]

III. Tornadoes

48. Another extreme weather event is tornadoes. Most of the world's tornadoes occur in the United States. They originate when a warm air front from the Gulf of Mexico collides with cooler air from Northern Canada.

[73] R. N. Maue, "Recent Historically Low Global Tropical Cyclone Activity", Geophysical Research Letters 38, L14803 (2011) attached to this affidavit as **Exhibit "5a";** R. Pielke Jr., A Remarkable Decline in Landfalling Hurricanes, https://rogerpielkejr.substack.com/p/a-remarkable-decline-in-landfalling1), Accessed Dec. 14, 2021 attached to this affidavit as **Exhibit "5b"**.

49. The number of tornadoes recorded has increased over the past 50 years as improved observation technology, especially Doppler radar, has been introduced.[74] Fig. 16 shows the number of tornadoes observed in the U.S. from 1995 to 2020, after the introduction of Doppler radar. There is no significant trend in either the total number of tornadoes or the number of strong tornadoes, defined as having a rating of on the Enhanced Fujita scale of EF2 or greater (wind gust > 180 km/hr).

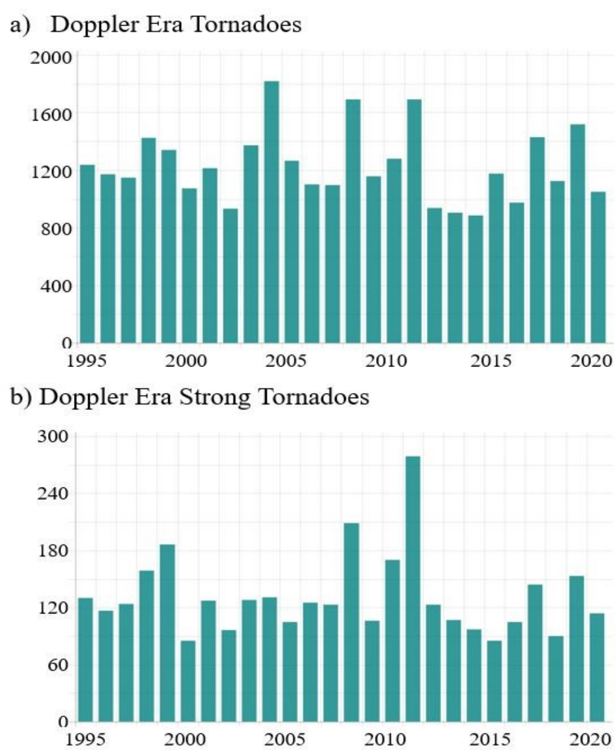


Figure 16: Doppler Era U.S. Tornadoes from 1995 to 2020 for a) All Tornadoes and b) Strong (with wind gust > 180 km/hr)[75]. No trend is evident in either the total number of tornadoes or the number of strong tornadoes. The phrase "Doppler Era" refers to observations made after the adoption of Doppler radar technology that is very sensitive to detecting tornadoes.

[74] "U.S. Tornadoes", https://www.ustornadoes.com/annual-tornadoes/, Accessed Dec. 13, 2021, attached to this affidavit as **Exhibit "6"**.
[75] Ibid.

50. Fig. 17 shows the number of tornadoes recorded in Ontario from 1950 to 2007.[76] There were fewer tornadoes recorded during the period 1950 to 1975 than in later years. This is readily explained by the introduction of better Doppler radar observing technology. There seems to be a decreasing trend after 1978.

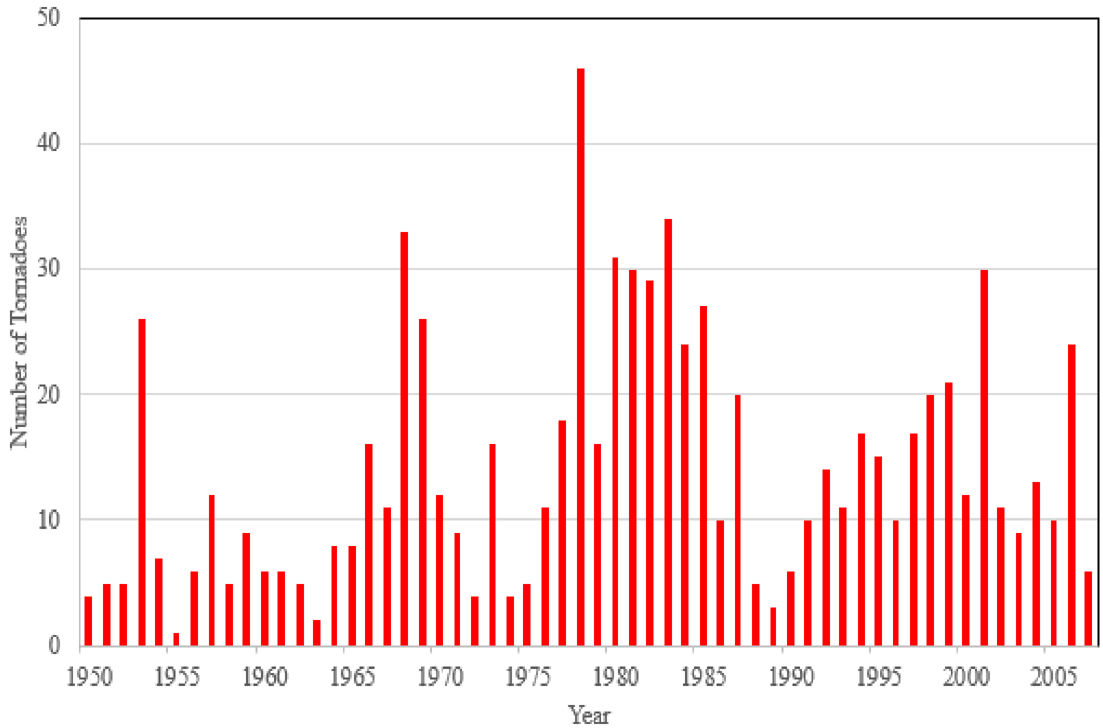


Figure 17: Annual Number of Tornadoes Observed in Ontario from 1950 to 2007.[77]

IV. Forest fires

51. A significant negative effect of decreasing precipitation and/or higher temperatures would be an increased risk of forest fires. It should be pointed out that forest fires caused by lightning are a natural part of the ecosystem. The

[76] Z. Cao and H. Cai, "Detection of Tornado Frequency Trend Over Ontario, Canada", *The Open Atmospheric Science Journal* 5, 27-31 (2011).
[77] Z. Cao and H. Cai, "Detection of Tornado Frequency Trend Over Ontario, Canada", *The Open Atmospheric Science Journal* 5, 27-31 (2011).

concern is that climate change is increasing drought severity making fires more numerous and larger. The observations do not support that concern.

52. Fig. 18 shows a small decrease in the number of wildfires in Canada and Ontario from 1990 to 2020 according to Canada's National Forestry Database.[78] There is no clear trend in the number of hectares burned.

[78] Canada's National Forestry Database (http://nfdp.ccfm.org/en/data/fires.php) sources the latest year's fire data from the Canadian Interagency Forest Fire Centre (https://www.ciffc.ca/publications/canada-reports), and all years prior from the Canadian Wildland Fire Information System (https://cwfis.cfs.nrcan.gc.ca/datamart). Fire data from Canada's National Forestry Database for Ontario attached to this affidavit as **Exhibit "7"**. Fire data from Canada's National Forestry Database for Canada is attached to this affidavit as **Exhibit "8"**.

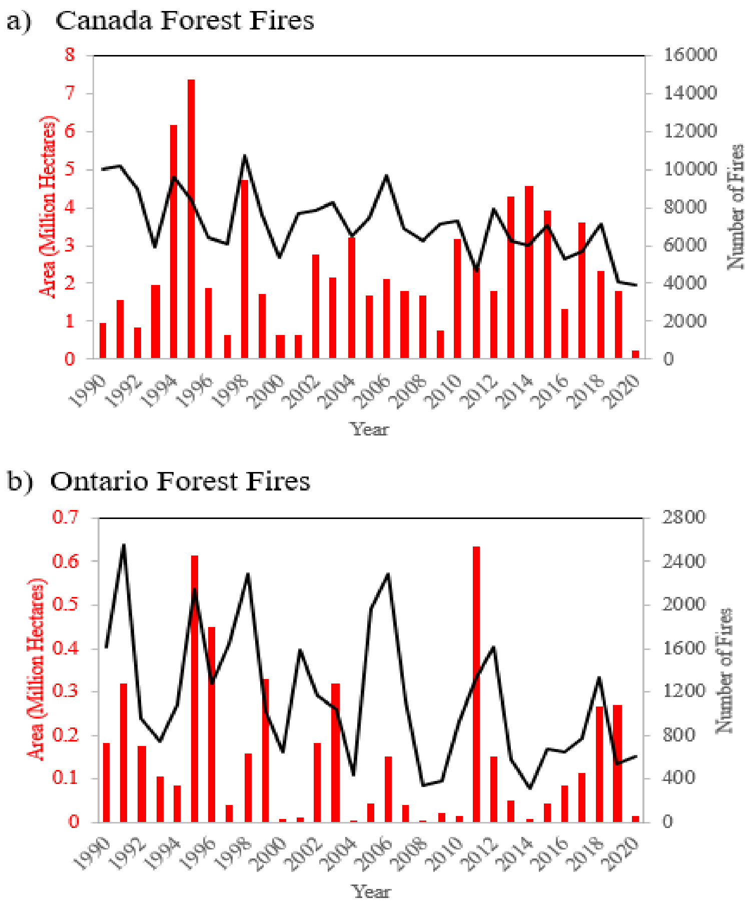


Figure 18: Area Burned and Number of Forest Fires from 1990 to 2020 in a) Canada and b) Ontario according to Canada's National Forestry Database.[79] The number of forest fires has decreased for both Canada and Ontario during the past 30 years while the area burned has not changed substantially.

53. The lack of any significant observed change in precipitation, or the frequency and severity of hurricanes, tornadoes and forest fires contrasts with the steady increase in atmospheric concentrations of greenhouse gases shown in Fig. 8. There is no increase in any of these phenomena proportionate to the increase in greenhouse gas concentrations and in particular, no increase within Ontario.

[79] Ibid.

F. Effect of greenhouse gases emitted in Ontario on atmospheric greenhouse gas concentrations and their predicted effects applying global climate models

54. A plot of carbon dioxide emissions over time is shown in Fig. 19. It shows Canada produced 582.4 megatonnes of CO_2 from burning fossil fuels for energy and cement production in 2019.[80] This represents 1.6% of the world total of 36.7 billion tons. The largest emitters are China, United States and India. The amount of CO_2 generated by the United States has decreased over the last 5 years as natural gas increasingly replaces coal. Both natural gas and coal produce CO_2 when burned but natural gas produces more energy per amount of CO_2. The amount of CO_2 produced by China and India has been accelerating as these countries develop their economies to raise living standards. The slight decrease in CO_2 generated by the world in 2020 is due to decreased economic activity resulting from the coronavirus pandemic.

[80] "Our World in Data: CO_2 emissions", https://ourworldindata.org/co2-emissions, accessed Dec. 13, 2021, attached to this affidavit as **Exhibit "9"**.

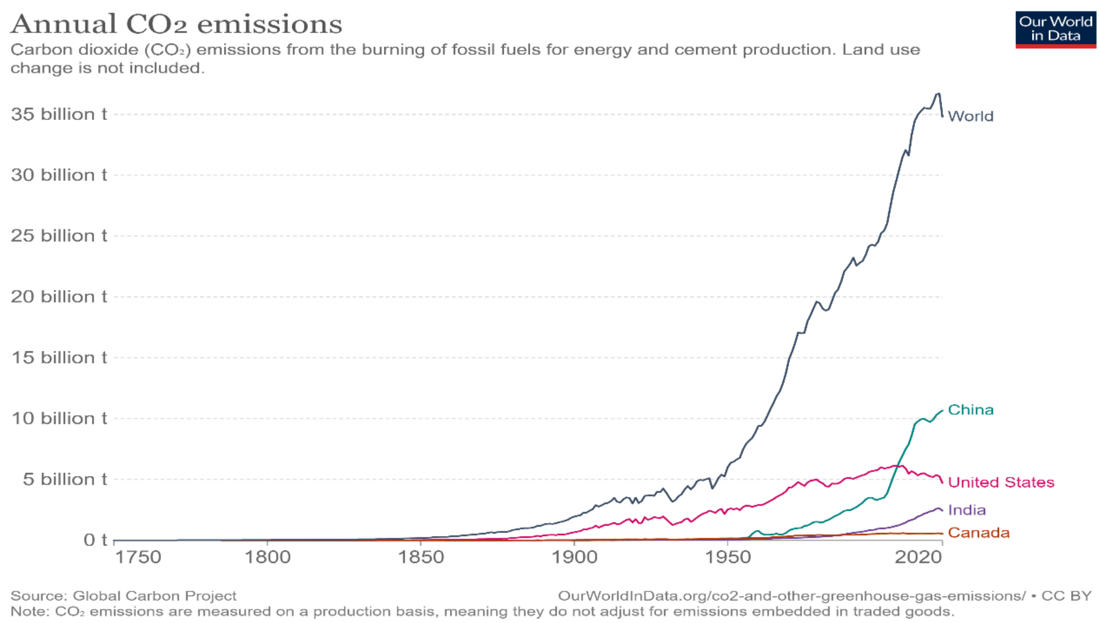


Figure 19: Annual emissions of CO_2 measured in billion metric tons from the burning of fossil fuels for energy and cement production for the World, China, United States, India and Canada.[81]

55. A detailed look at Canada's emissions from 1990 to 2019 is given in Fig. 20. This plots megatonnes of carbon dioxide equivalent which is greater than the amount of CO_2 produced because it includes the estimated global warming effect of other greenhouse gases, notably CH_4 and N_2O.[82] Fig. 21 shows the megatonnes of carbon dioxide equivalent produced in 1990, 2005 and 2019 by each of Canada's

[81] Ibid.
[82] Government of Canada, Environment and natural resources, Greenhouse gas emissions, https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html, accessed Dec. 13, 2021, attached to this affidavit as **Exhibit "10"**.

provinces.[83] Table 2 tabulates the total carbon dioxide equivalent emissions for Canada and Ontario since 2005.[84]

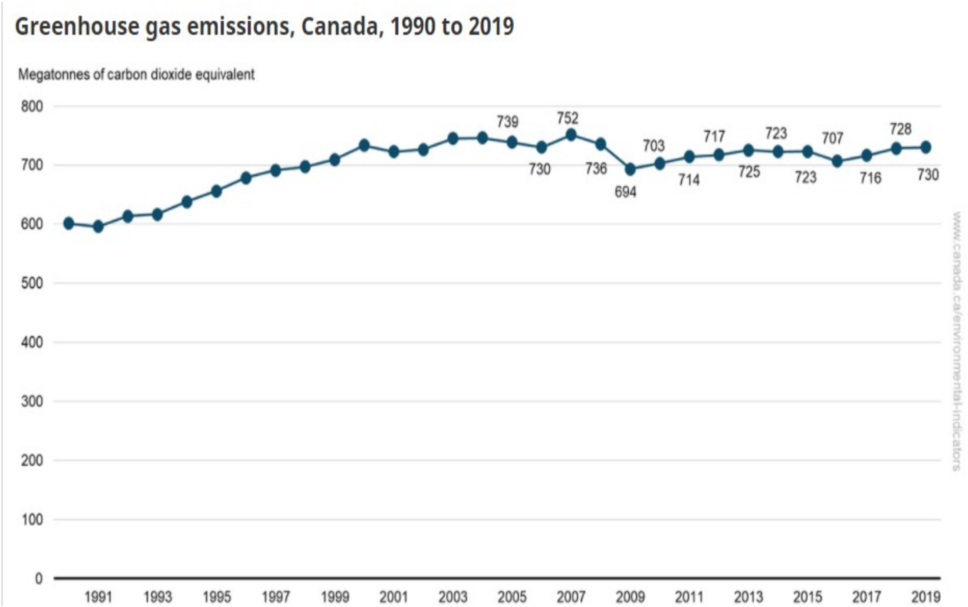


Figure 20: Megatonnes of CO_2 Equivalent Emissions by Canada from 1990 to 2019 as given by the Environment and Natural Resources Department of the Government of Canada.[85]

[83] Ibid.

[84] Government of Canada, "National Inventory Report, 1990-2010: Greenhouse Gas Sources and Sinks in Canada – Part 3" (2012) En81-4-2010-3-eng.pdf (publications.gc.ca) at p. 13 (Canada Emissions) and p. 61 (Ontario Emissions), attached to this affidavit as **Exhibit "11"**; Government of Canada, "National Inventory Report, 1990-2013: Greenhouse Gas Sources and Sinks in Canada – Part 3" (2015) En81-4-2013-3-eng.pdf (publications.gc.ca) at p. 17 (Canada Emissions) and p. 54 (Ontario Emissions), attached to this affidavit as **Exhibit "12"**; Government of Canada, "National Inventory Report, 1990-2019: Greenhouse Gas Sources and Sinks in Canada – Part 3" (2021) En81-4-2019-3-eng.pdf (publications.gc.ca) at p. 5 (Canada Emissions) and p. 25 (Ontario Emissions), attached to this affidavit as **Exhibit "13"**. In Table 2, the equivalent emissions totals for the years 2005 and 2014-2019 are taken from the 2021 National Inventory Report. The equivalent emissions totals for the years 2009-2013 are taken from the 2015 National Inventory Report. The equivalent emissions totals for the years 2006-2008 are taken from the 2010 National Inventory Report.

[85] Government of Canada, Environment and natural resources, Greenhouse gas emissions, https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html, accessed Dec. 13, 2021, attached to this affidavit as **Exhibit "10"**.

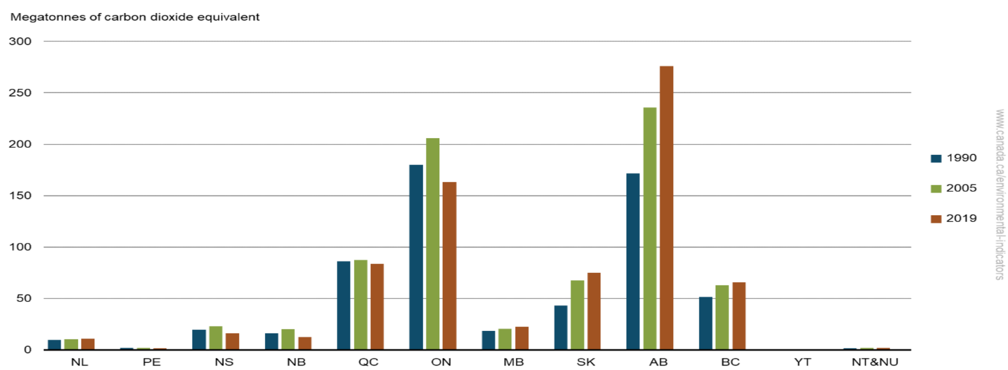


Figure 21: Megatonnes of CO_2 Equivalent Emissions by Province in Canada for 1990, 2005 and 2019 as given by the Environment and Natural Resources Department of the Government of Canada.[86]

	CO_2 Equivalent Emissions (Megatonnes)	
Year	Canada	Ontario
2005	739	206
2006	726	196
2007	751	200
2008	731	191
2009	699	171
2010	707	178
2011	709	175
2012	715	171
2013	726	171
2014	723	164
2015	723	163
2016	707	161
2017	716	158
2018	728	163
2019	730	163

Table 2: Total Carbon Dioxide Equivalent Emissions for Canada and Ontario since 2005.[87]

[86] Ibid.
[87] Government of Canada, "National Inventory Report, 1990-2010: Greenhouse Gas Sources and Sinks in Canada – Part 3" (2012) En81-4-2010-3-eng.pdf

56. In 2019, Ontario produced 163.2 megatonnes equivalent of CO_2 or 22% of Canada's total of 730 megatonnes. Ontario was the only province to show a sizable decrease from 205.7 megatonnes produced in 2005. This decrease resulted from its closure of coal burning electric generating plants. In the 2 years prior to the coronavirus pandemic, global CO_2 production increased from 35.93 billion tons in 2017 to 36.70 billion tons in 2019 corresponding to an average increase of 385 megatonnes per year. This is more than double Ontario's total annual CO_2 equivalent production.

57. Table 2 shows Ontario's emissions have been stable since 2014.

58. The contribution of Ontario to global warming in 2019 is given in Table 3 using the climate sensitivity values $S = 1$ and $S = 3$ ºC. The latter value is recommended by the 2021 IPCC. As discussed previously, this sensitivity value is the product of global climate models that have projected increased greenhouse gas concentrations to produce much more warming in recent decades than has actually occurred as shown in Figures 10 and 11. Canada produces 1.6% of the

(publications.gc.ca) at p. 13 (Canada Emissions) and p. 61 (Ontario Emissions), attached to this affidavit as **Exhibit "11"**; Government of Canada, "National Inventory Report, 1990-2013: Greenhouse Gas Sources and Sinks in Canada – Part 3" (2015) En81-4-2013-3-eng.pdf (publications.gc.ca) at p. 17 (Canada Emissions) and p. 54 (Ontario Emissions), attached to this affidavit as **Exhibit "12"**; Government of Canada, "National Inventory Report, 1990-2019: Greenhouse Gas Sources and Sinks in Canada – Part 3" (2021) En81-4-2019-3-eng.pdf (publications.gc.ca) at p. 5 (Canada Emissions) and p. 25 (Ontario Emissions), attached to this affidavit as **Exhibit "13"**. In Table 2, the equivalent emissions totals for the years 2005 and 2014-2019 are taken from the 2021 National Inventory Report. The equivalent emissions totals for the years 2009-2013 are taken from the 2015 National Inventory Report. The equivalent emissions totals for the years 2006-2008 are taken from the 2010 National Inventory Report.

world's CO_2 and Ontario produces 22% of Canada's CO_2 or 0.35% of the world's total. For the last 5 years (2016 to 2020), the average annual mean growth rate of CO_2 observed at Mauna Loa, Hawaii, has been 2.5 ppm/year.[88] Hence, Ontario is responsible for 0.35% x 2.5 ppm/year = 0.0088 ppm/year (or 8.8 ppb/year) of the global CO_2 increase. Using equation (1) one finds the amount of global warming caused by Ontario given in Table 3.

Region	Atmospheric CO_2 Increase (ppm/year)	Warming (ºC/year)	
		S = 1 ºC	*S =3* ºC
World	2.5	0.0087	0.026
Canada	0.040	0.00014	0.00042
Ontario	0.0088	0.000031	0.000092

Table 3: Contribution to Atmospheric CO_2 Increase and Global Warming by Canada and Ontario. The warming was computed using equation (1) and the observed 2021 carbon dioxide concentration of 2021, C_o = 415 ppm, as well as the observed rate of annual CO_2 increase as described in the text.

G. Applying global climate models, what is the predicted impact on global warming of reducing or eliminating greenhouse gas emissions in Ontario?

59. The effect of proposed cuts in Ontario's greenhouse emissions on global warming is shown in Table 4 for climate sensitivities *S=1* and *S=3* ºC. Note the contribution to atmospheric CO_2 increase is in units of ppb/year which is parts per billion/year.

[88] NOAA Global Monitoring Laboratory, Earth System Research Laboratories, "Trends in Atmospheric Carbon Dioxide", https://gml.noaa.gov/ccgg/trends/gl_gr.html, accessed Feb. 19, 2022, attached to this affidavit as **Exhibit "14"**.

Ontario Percentage Reduction of Greenhouse Gas Emissions from 2019 Levels	Ontario Contribution to Atmospheric CO_2 Increase (ppb/year)	Ontario Contribution to Global Warming (°C/year)	
		S = 1 °C	*S = 3* °C
0	8.8	0.000031	0.000092
10	7.9	0.000028	0.000084
20	7.0	0.000025	0.000074
30	6.2	0.000022	0.000065
40	5.3	0.000019	0.000056
50	4.4	0.000015	0.000046
60	3.5	0.000012	0.000037
70	2.6	0.000009	0.000028
80	1.8	0.000006	0.000019
90	0.9	0.000003	0.000009
100	0	0	0

Table 4: Effect of Ontario Reduction of Greenhouse Gas Emissions on Ontario's Contribution to Global Warming. The warmings were calculated in the same way as those listed in Table 3.

H. How long would it take for Ontario's contribution to greenhouse gas emissions to have a measurable effect on temperature?

60. The time for Ontario's greenhouse gas emissions to affect the global temperature by a given amount is shown in Table 5 for climate sensitivities *S=1* and *S=3* °C. This calculation used equation (1) and assumed Ontario would continue to emit greenhouse gases at the rate of 8.8 ppb/year as described previously. A temperature increase of only 0.1 °C is difficult to observe using a mercury thermometer. A global warming of 0.1 °C is less than observed natural variations of the mean temperature by several tenths of a degree Centigrade as shown in Fig. 9 which occur on time scales of years to decades. Hence, a measurable effect of Ontario's greenhouse gas emissions on global temperature that exceeds natural fluctuations would take thousands of years. A prediction of temperature change

on such long time scales would require consideration of other effects such as changes to the Earth's orbit due to Milankovitch cycles and changes in solar radiation.

Global Temperature Increase in ºC due to Ontario's Greenhouse Gas Emissions at 2019 Levels	Years after 2021	
	S = 1 ºC	*S = 3* ºC
0.05	1,663	548
0.1	3,385	1,102
0.2	7,012	2,230
0.3	10,901	3,385
0.4	15,068	4566
0.5	19,534	5,775

Table 5: Time for Ontario Greenhouse Gas Emissions to Change Global Temperature. The calculation assumed greenhouse gas emissions would not decrease from the observed rate of 8.8 ppb/year. The attribution of a global temperature increase to Ontario greenhouse gas emissions would be complicated by natural variations of the global mean temperature by several tenths of a degree Centigrade on time scales of years to decades as is discussed in the text.

I. Do greenhouse gases emitted in Ontario cause or contribute to extreme weather events or other harmful environmental phenomena in Ontario?

61. IPCC reports suggest global warming will increase the frequency of extreme events such as hurricanes but do not give any quantitative predictions because the science is very uncertain. Global observations shown in Figures 15 and 16 do not show any increase in the frequency of extreme events such as hurricanes or tornadoes. Moreover, Fig. 17 shows no increase in the frequency of tornadoes in Ontario. Observations shown in Figures 14 and 18 also do not show any evidence of an increase of other extreme events in Ontario such as droughts or forest fires. Finally, given Ontario's greenhouse gas emissions only comprise 0.35% of the global total, it is scientifically implausible to claim that Ontario's greenhouse gas emissions are or will be responsible for extreme weather or harmful environmental phenomena.

SWORN BEFORE ME remotely by William van Wijngaarden and stated as being located in the City of Princeton in the State of New Jersey, USA before me at the City of Toronto in the Province of Ontario, on February 25, 2022 in accordance with O Reg 431/20, Administering Oath or Declaration Remotely	
D. Murczek	W. van Wijngaarden
Commissioner for the Taking of Affidavits	DR. WILLIAM VAN WIJNGAARDEN
DAYNA MURCZEK (LSO#82824Q)	

This is Exhibit "C" to the Affidavit of Ephry Mudryk,
sworn May 4 , 2022.

____

A Commissioner, etc.

Court File No. CV-19-00631627-0000

ONTARIO
SUPERIOR COURT OF JUSTICE

B E T W E E N:

SOPHIA MATHUR, a minor by her litigation guardian CATHERINE ORLANDO, ZOE KEARY-MATZNER, a minor by her litigation guardian ANNE KEARY, SHAELYN HOFFMAN-MENARD, SHELBY GAGNON, ALEXANDRA NEUFELDT and LINDSAY GRAY

Applicants

- and -

HER MAJESTY THE QUEEN IN RIGHT OF ONTARIO

Respondent

AFFIDAVIT OF PHILIP CROSS

Sworn February 28, 2022

I, PHILIP CROSS, of the City of Ottawa, in the Province of Ontario, MAKE OATH AND SAY:

1. I live in Ottawa, Ontario. I worked at Statistics Canada for 36 years, including as Chief Economic Analyst from 2010 to 2012. Since leaving Statistics Canada, I have worked for a variety of think tanks and universities, as well as providing peer review for both academic publications and the journal *Policy Options* (produced by the Institute for Research on Public Policy). I am a Senior Fellow at the Macdonald-Laurier Institute and the Fraser Institute, and an Executive Fellow at the University of Calgary's School

of Public Policy. My specialty is macroeconomics and the determinants of economic growth, notably the role of innovation and natural resources. I am a member of the C.D. Howe's Business Cycle Dating Committee, which determines when Canada's economy is in recession.

2. I have written several papers on the impact of environmental policies – notably a carbon tax – on economic growth. These include a 2019 study of carbon taxes for the Macdonald-Laurier Institute titled "The Case For a Carbon Tax: What Went Wrong?"[1] I participated in a panel discussion of carbon pricing at the annual CAMPUT Regulatory Forum hosted by Canada's Energy and Utility Regulators and Natural Resources Canada along with Professor Pierre-Olivier Pineau of HEC Montreal (the University of Montreal) on June 2, 2019. I studied the importance of the oil sands to Canada's economy in 2021.[2] I conducted an in-depth study of establishing national goals for both economic growth and greenhouse gas emissions in 2021, "Doubling GDP by 2050".[3]

3. My papers on macroeconomics include the 2016 paper on "The Limits of Economic 'Stimulus'" for the Macdonald-Laurier Institute; "Alberta's Future: The Role of Entrepreneurship and Innovation" in April 2021 for the University of Calgary School of Public Policy; "Turning Points: Business Cycles in Canada since 1926" for the C.D.

[1] https://macdonaldlaurier.ca/files/pdf/20190621_MLI_COMMENTARY_Carbon_Tax_Cross_Fweb.pdf.
[2] *Ibid*.
[3] https://macdonaldlaurier.ca/files/pdf/202110_Doubling_GDP_by_2050_Cross_PAPER_FWeb.pdf.

Howe Institute in 2012;[4] and "Does Canada Need a Wealth Tax?" for the Fraser Institute in 2021.[5]

4. As Chief Economic Analyst at Statistics Canada, my responsibilities included writing Statistics Canada's monthly assessment of economic conditions as well as reviewing all the major economic data releases before publication to ensure both their statistical accuracy and that they were presented in a neutral manner. This requires ensuring that what is stated in the press release is backed up by facts and does not reflect the values or policy preferences of the author(s). Separating facts from narratives is essential in the often politically-charged debates on climate change.

5. As such, I have knowledge of the matters set out in this affidavit.[6]

6. I have been asked to provide evidence about: the countries that produce the most greenhouse gas emissions and the drivers of emissions in those countries; Ontario's contribution to greenhouse gas emissions; past compliance with greenhouse gas emissions reductions targets in other countries; and the economic consequences of greenhouse gas emissions reductions. Specifically, I was asked to answer the following questions:

    a. Which of the world's economies are the largest producers of greenhouse gases? What are Ontario's emissions relative to those other jurisdictions?

[4] https://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed/Commentary_366_0.pdf.
[5] https://www.fraserinstitute.org/sites/default/files/does-canada-need-a-wealth-tax.pdf.
[6] A copy of my *curriculum vitae* is attached to this affidavit as **Exhibit "1"**.

b. What are the drivers of greenhouse gas emissions in the countries with the highest emissions, with particular focus on those countries' energy needs, their economy, and their demographic makeup?

c. Please describe the greenhouse gas emissions reduction targets in other jurisdictions and comment on past compliance with those targets.

d. What are some of the complexities associated with reducing greenhouse gas emissions?

7. I understand that my role is to provide opinion evidence that is fair, objective and non-partisan, related only to matters that are within my area of expertise and to provide additional assistance as the court may require.[7] Where I have cited a source in the footnotes to this affidavit, I have relied on that source in forming my opinion and I believe it to be true.

8. My opinion can be summarized as follows:

   a. The largest emitters of greenhouse gases in the world are China, the United States, the European Union and India. Canada is the tenth largest emitter. Ontario accounts for 22% of Canada's emissions and approximately 0.33% of global emissions. The combined annual emissions of the top four economies (roughly 25,000 megatonnes) are dramatically larger than Ontario's annual emissions (163.2 megatonnes).

   b. The drivers of greenhouse gas emissions among the large emitters are economic growth and population growth. This is especially true of China and India. There is

[7] My signed Acknowledgement of Expert's Duty is attached to this affidavit as **Exhibit "2"**.

a very strong correlation between energy consumption and per capita gross domestic product. China and India have seen recent increases in economic growth and population with resultant increases in emissions. Other emerging economies like Indonesia and Iran, whose population and economies continue to grow, have increased their emissions enough to overtake Canada's emissions in recent years. The population and economies of China and India are projected to continue growing between now and 2030, with the result that their greenhouse gas emissions can be expected to grow by amounts that vastly exceed Ontario's total emissions.

c. Few countries have fully implemented their previous commitments to reduce greenhouse gas emissions. None of the major emitting nations are considered to be on track to meet their targets under the Paris Agreement. Emissions from Ontario do not have a decisive impact on whether Canada will meet any of the three greenhouse gas reduction targets that have been adopted by the Canadian government (30%,[8] 36%[9] and 40-45%[10] below the 2005 baseline by 2030). Even an immediate and total cessation of all greenhouse gas emissions in Ontario, which is impossible, would not achieve the federal government's reductions targets because Ontario only accounts for 22% of Canadian greenhouse gas emissions.

[8] "Pan-Canadian Framework on Clean Growth and Climate Change", Exhibit "GGG" to the Affidavit of Charlotte Ireland, affirmed January 15, 2021, Application Record ("AR"), Vol. 2, p. 5356.
[9] Government of Canada, "Budget 2021" dated April 19, 2021 attached to this affidavit as **Exhibit "3"**.
[10] Government of Canada, "Canada's Climate Actions: For a Healthy Environment and a Healthy Environment", dated July 2021 and attached to this affidavit as **Exhibit "4".**

d. Energy transitions typically take decades and are highly complex, involving new technologies, long lead times, a reconfiguration of a wide range of infrastructure, enormous investment, avoidance of supply shortfalls, and trade-offs and balancing with respect to the economy and the environment.

A. Which of the world's economies are the largest producers of greenhouse gases? What are Ontario's emissions relative to those other jurisdictions?

9. According to an April 2021 report by Environment and Climate Change Canada (ECCC),[11] global greenhouse gas emissions in 2018 totalled 47,552 megatonnes (mt). Table A.1 from Annex A of that report is reproduced below:

[11] Environment and Climate Change Canada, "Global Greenhouse Gas Emissions", April 2021, available at https://www.canada.ca/content/dam/eccc/documents/pdf/cesindicators/global-ghg-emissions/2021/global-greehouse-gas-emissions-en.pdf, attached to this affidavit as **Exhibit "5"**.

Annex A. Data table for the figure presented in this document

Table A.1. Data for Figure 1. Greenhouse gas emissions for the world and the top 10 emitting countries and regions, 2005 and 2018

Country or region	2005 greenhouse gas emissions (megatonnes of carbon dioxide equivalent)	Share of global greenhouse gas emissions in 2005 (percent)	2018 greenhouse gas emissions (megatonnes of carbon dioxide equivalent)	Share of global greenhouse gas emissions in 2018 (percent)	2005 to 2018 percent change in national emissions
China	7 194	18.6	12 355	26.0	71.7
United States	6 802	17.6	6 024	12.7	-11.4
European Union (27)[A]	4 288	11.1	3 567	7.5	-16.8
India	1 970	5.1	3 375	7.1	71.3
Russian Federation	2 373	6.1	2 543	5.3	7.2
Japan	1 284	3.3	1 187	2.5	-7.6
Brazil	889	2.3	1 033	2.2	16.
Indonesia	703	1.8	970	2.0	37.9
Iran	613	1.6	828	1.7	35.1
Canada	705	1.8	725	1.5	2.8
Rest of the world[B]	11 847	30.6	14 946	31.4	26.2
World	38 669	100.0	47 552	100.0	23.0

Note: Totals may not add up due to rounding. Greenhouse gas emissions for each country and region presented in this comparison were calculated by the World Resources Institute. For certain countries, including Canada, these values differ from the official estimates of greenhouse gas emissions submitted to the United Nations Framework Convention on Climate Change. For more information, please consult the Caveats and limitation section.
[A] European Union (27) includes: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.
[B] "Rest of the world" includes international bunkers.
Source: World Resources Institute (2021) Climate Watch Country Historical Greenhouse Gas Emissions.

10. China produced the most emissions in 2018 of 12,355 mt, or 26.0 percent of total global emissions. The US was next at 6,024 mt, or 12.7 percent. The EU and India followed with 3,567 mt and 3,375 mt respectively (equivalent to 7.5 and 7.1 percent). Russia was next at 2,543 mt (equal to 5.3 percent), followed by Japan with 1,187 mt (equal to 2.5 percent). Also ahead of Canada were Brazil at 1,033 mt (2.2 percent), Indonesia at 970 mt (2.0 percent) and Iran with 828 mt (1.7 percent). Canada was in tenth place with 725 mt, or 1.5 percent of global emissions. The nine nations ahead of Canada collectively accounted for 31,882 mt or 67.0 percent of global emissions.

11. These data from ECCC are very close to the estimates found in the Application Record[12] and provided by the Office of the Ontario Auditor General for 2019. The data from the Auditor General's report is sourced from the Potsdam Institute for Climate Impact Research, the World Bank, Environment and Climate Change Canada, and Statistics Canada.[13] Figure 10 in the Auditor General's report, reproduced below, shows global emissions in 2016 totalled 47,200 mt.

[12] Exhibit "III" to the Affidavit of Charlotte Ireland, affirmed January 15, 2021, at p. 134, Application Record ("AR"), Vol. 2, Tab 9, p. 5537. The United Nations has established two complementary frameworks for reporting greenhouse gas emissions. These two approaches can lead to minor discrepancies in reported emissions. See https://www150.statcan.gc.ca/n1/en/pub/38-20-0001/382000012020001-eng.pdf?st=Kf12ks9o, attached to this affidavit as **Exhibit "6".**

[13] Office of the Auditor General of Ontario, *Annual Report 2019*, Vol. 2, Chapter 3 at 134, available at https://www.auditor.on.ca/en/content/annualreports/arreports/en19/v2_300en19.pdf, attached to this affidavit as **Exhibit "7"**. There are minor discrepancies in reported emissions in the various reports setting out global and national greenhouse gas emissions. As noted in the Caveats and limitations from Environment and Climate Change Canada cited in Table A.1 above, these differences reflect "that many member countries, including Canada, now report emissions using revised methodology and global warming potential guidelines" and that "emissions from international bunker fuels (which are estimated based on the location of marine and aviation refueling) are not reflected in reported countries and regions emissions totals. However, they are included in the total world emissions…" See **Exhibit "5"** at 7-8.

Figure 10: Comparison of Greenhouse Gas Emissions by Jurisdiction

Sources of data: Potsdam Institute For Climate Impact Research, World Bank, Environment and Climate Change Canada, and Statistics Canada

	Population (000)	Emissions per Capita (t)	Total Emissions (Mt)
World	7,426,103	6	47,200
G20 Members			
China	1,378,665	9	12,700
United States	323,071	20	6,570
European Union	511,219	9	4,353
India	1,324,510	2	2,870
Russia	144,342	18	2,670
Japan	126,995	10	1,310
Brazil	206,163	5	1,050
Germany	82,349	11	918
South Korea	51,246	14	732
Mexico	123,333	6	718
Canada	**36,109**	**20**	**716**

12. China was the leading emitter in 2016 at 12,700 mt, followed by the US at 6,570 mt, the EU (excluding Germany) at 4,353 mt, India at 2,870 mt, Russia 2,670 mt, Japan 1,310 mt, Brazil at 1,050 mt and Germany at 918 mt. However, the next two nations in 2016 were South Korea with 732 mt and Mexico at 718 mt, who were replaced by Indonesia and Iran in 2018. Canada remained tenth with 716 mt, equivalent to 1.5 percent of global emissions (the same as in 2018). According to this data source, the nine jurisdictions with emissions greater than Canada accounted for 71.8 percent of global emissions.

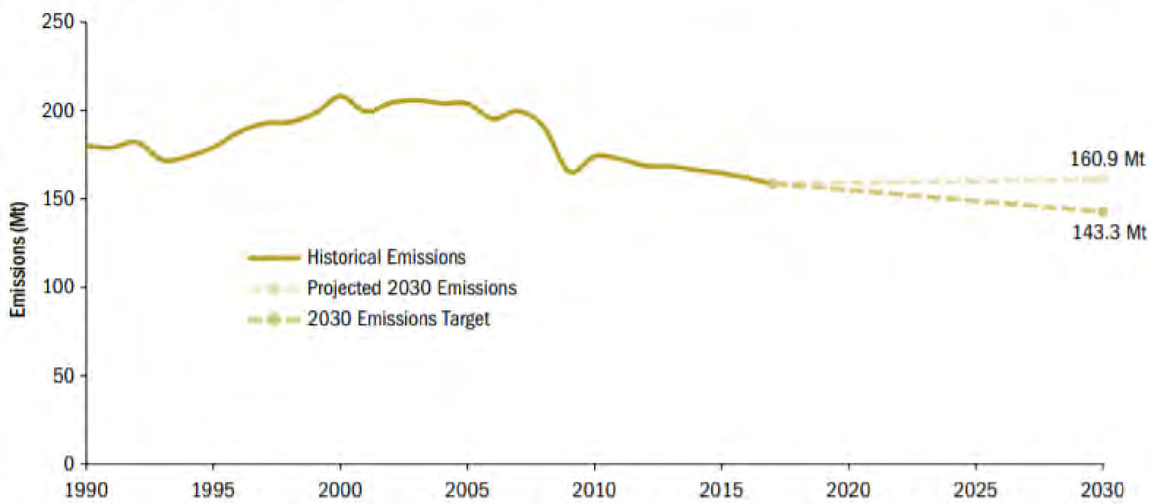
13. The decline in the share of the nine largest emitters in the next two years ending in 2018 reflects how formerly low-emitting developing nations saw emissions rise rapidly as their populations and economies grew. Notably, Indonesia increased from 674 mt to 970 mt, vaulting into eighth place, while Iran's emissions soared from less than 334 mt to 828 mt. India also saw emissions rise from 2,870 mt to 3,567 mt, although its ranking

remained unchanged as the fourth largest emitter. Brazil was an exception among emerging markets, as its emissions dipped 1.7 percent from 1,050 mt to 1,033 mt.

14. The same table from the Ontario Auditor General's 2019 report stated that "Ontario produces 22.2% of Canada's emissions and 0.3% of global emissions."[14] Figure 1 of that report, reproduced below, shows Ontario's emissions as reported by the Ontario Auditor General in 2016.

Figure 1: Ontario's Historical Greenhouse Gas Emissions, Projected Greenhouse Gas Emissions, and 2030 Target

Prepared by the Office of the Auditor General of Ontario



15. In absolute terms, Ontario's emissions peaked at 208 megatonnes in 2000, and then fell to 159 megatonnes in 2017. However, the Ontario Auditor General's 2019 Annual Report notes that there is uncertainty about how to account for emissions reductions that Ontario residents purchased internationally from California, since the US government has to agree to that transfer and neither the previous nor the current US

[14] Exhibit "III" to the Affidavit of Charlotte Ireland, affirmed January 15, 2021, at p. 121, AR, Vol. 2, Tab 9, p. 5537.

administration has been willing to agree.[15] This is one of several reasons why estimates of emissions can vary slightly over time.

16. Ontario's low contribution to global emissions explains why, despite a drop in Ontario's emissions between 2000 and 2010, that drop did not make a significant impact on global emissions. Global greenhouse gas emissions rose at a pace of 2.2 percent a year between 2000 and 2010, up from 1.3 percent a year during the period from 1970 to 2000, despite the decline in Ontario.[16]

B. What are the drivers of greenhouse gas emissions in the countries with the highest emissions, with particular focus on those countries' energy needs, their economy, and their demographic makeup?

17. The drivers of global greenhouse gas emissions are economic growth and population increase. This is particularly true of China and India, whose economic growth and population increase in recent years have resulted in increases to greenhouse gas emissions that are vastly larger than Ontario's comparatively tiny and decreasing emissions. This trend will only continue as the populations of China and India continue to grow between now and the year 2030 and as those countries continue to develop and grow economically.

18. There is abundant literature about the primordial importance of energy for long-term economic growth. Vaclav Smil, a renowned Canadian academic specializing in energy, the environment and population changes, writes emphatically that "To talk about energy *and* the economy is a tautology: every economic activity is fundamentally

[15] Exhibit "F" to the Affidavit of Charlotte Ireland, affirmed January 15, 2021 at p. 35, AR, Vol. 2, Tab 9, p. 872.
[16] Exhibit "F1" to the Affidavit of Dr. Robert McLeman, affirmed February 5, 2021 at p. 5, AR, Vol. 5, Tab 25, p. 9295.

nothing but a conversion of one kind of energy to another, and monies are just a convenient (and often rather unrepresentative) proxy for valuing the energy flows."[17] Professor Kenneth Friesen of Fresno Pacific University states bluntly that "The history of today's industrialized world is the history of fossil fuel energy."[18] Roger Fouquet, a Professor at the London School of Economics who studies the relationship of economic development, energy use, and the environment, agrees and wrote that "there is a close relationship between energy consumption and economic development."[19] This close relationship is reflected in the finding that "in developing nations a lack of modern energy services is a principal cause of low levels of economic and social development. Access to electricity promotes social development and improved welfare by allowing greater access to information via computer, radio and television, cleaner means of storing and preparing food, and the attainment of heating and cooling services."[20]

19. Describing the history of energy in Canada, University of Toronto historian Ruth Sandwell writes that "it was the massive nineteenth-century shift to fossil fuels and

[17] Smil, Vaclav, *Energy and Civilization: A History*, The MIT Press, 2017 at 344. By unrepresentative, Smil means that the low cost of energy does not reflect its critical role in our society and economy; this is evident every time there is a major electrical blackout, which causes massive disruption such as in Ontario in 2003 or Texas in 2021. Smil went out to write that "All natural processes and all human actions are, in the most fundamental physical sense, transformations of energy. Civilization's advances can be seen as a quest for higher energy use required to produce increased food harvests, to mobilize a greater output and variety of materials, to produce more, and more diverse, goods, to enable higher mobility, and to create access to a virtually unlimited amount of information.": Smil at 385.
[18] Friesen, Kenneth Martens, *Energy, Economics, and Ethics: The Promise and Peril of a Global Energy Transition*, Rowman & Littlefield, 2020 at 11.
[19] Fouquet, Roger, *A brief history of energy. International Handbook on the Economics of Energy*, Joanne Evans and Lecter C. Hunt (eds), Edward Elgar, 200 at 1.
[20] Medlock III, Kenneth B. *Energy demand theory. International Handbook on the Economics of Energy* Joanne Evans and Lecter C. Hunt (eds), Edward Elgar, 2009 at 89.

electricity that, unbeknownst to economic theorists of the time, would eventually transform almost every aspect of life and work, and in ways that would dramatically increase opportunities for economic growth for the first time in history."[21]

20. The dependence of economic growth on energy goes back centuries. The famed economic historian Carlo Cipolla attributed both the Agricultural Revolution thousands of years ago and the Industrial Revolution in the late 18th century to people harnessing new energy sources. The Industrial Revolution "can be regarded as the process whereby the large-scale exploitation of new sources of energy by means of inanimate converters was set on foot".[22] Fossil fuels played a negligible role in supplying energy until the Industrial Revolution. In 1850, fossil fuels accounted for only 5 percent of energy. Today they represent 87 percent of global energy supply, the same as a decade ago.[23]

21. Fossil fuels proved especially efficient and convenient in meeting the energy demands of industrialization. Coal was the first widespread source of inanimate energy. This began a cumulative process, where a rising supply of energy stimulated more economic growth, which boosted education that led to the discovery of new sources of energy, notably other fossil fuels. The International Energy Agency (IEA) foresees fossil fuels continuing to supply 75% of all the world's energy in 2030, down "only slightly from

[21] Sandwell, R.W. *An Introduction to Canada's Energy History. In Powering Up Canada: A History of Power, Fuel, and Energy from 1600*, McGill-Queen's University Press, 2016 at 8.
[22] Cipolla, Carlo M. 1978. *The Economic History of World Population*, Barnes and Noble Books at 54.
[23] Yergin, Daniel. 2011. *The Quest: Energy, Security, and the Remaking of the Modern World*, Penguin Press at 3.

79% today."[24] The importance of energy to economic growth is reflected in how Emerging Market countries like Indonesia and Iran have moved into the top 10 emitters of greenhouse gas emissions, joining China, India, and Brazil by 2018.

22. The key role of energy in the economy is confirmed by the very high correlations (over 0.9) between average per capita GDP and energy consumption across all countries.[25] The importance of energy in raising incomes explains why it has proven difficult to get developing countries to sign up for and then deliver on emissions reduction targets. In practice, the difficulty of lowering energy consumption and emissions in developing countries is consistent with Smil's observation that "a decoupling of economic growth and energy consumption during early stages of modern economic development would defy the laws of thermodynamics."[26]

23. The correlation between energy consumption and the stage of a nation's economic development does not mean there are not differences within homogeneous groups of countries. As Smil observes, "to become rich requires a substantial increase in energy use, but the relative energy consumption increase among affluent societies, whether measured per GDP unit or per capita, varies widely."[27] Making the transition out of poverty requires a considerable amount of energy, but staying richer is consistent with some variation in energy consumption, as long as energy consumption remains substantial.

[24] International Energy Agency, "World Economic Outlook 2021", 182. Available at https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf, attached to this affidavit as **Exhibit "8"**.
[25] Smil, Vaclav, *Energy and Civilization: A History*, The MIT Press, 2017 at 347.
[26] *Ibid* at 350.
[27] *Ibid* at 347.

24. A complicating factor is that rich nations now have the option of "offshoring" their energy consumption and therefore their greenhouse gas emissions by importing energy-intensive manufactured goods from Asia, especially China. This "carbon leakage" lowers measured emissions in North America or Europe while doing nothing to reduce global emissions as energy consumption simply shifts to Asian nations.[28] As Helm noted, "unless carbon leakage is addressed, the US and others are unlikely to join in appropriate action. It is at the heart of the international problem. There is little point in taxing carbon in the home market only for production to shift overseas. In fact, such carbon shifting tends to make matters worse, since the goods and services need to be transported and are often produced in less efficient and more polluting ways. Shipping and aviation are carbon-intensive methods of transport, and the coal-fired power stations and steel mills in China typically have lower thermal efficiency and fewer controls of the various emissions."[29]

25. The importance of energy to the growth of developing nations is reflected in their rising emissions in recent decades. The greenhouse gas emissions of developing nations will continue to grow. According to the IEA, developing nations plan to build over 215 GW of coal-fired power plants, or 200 GW even if they implement their announced climate

[28] For further information on the concept of carbon leakage and how it is applied to a specific industry, see International Energy Agency. Climate Policy and Carbon Leakage: Impacts of the European Emissions Trading Scheme on Aluminium. Available at https://iea.blob.core.windows.net/assets/c9ab1b11-51a2-4930-abe1-7463a9978b09/Aluminium_EU_ETS.pdf.
[29] Dieter Helm, The Carbon Crunch: How We're Getting Climate Change Wrong—And How to Fix It, Yale University Press, 2012, at 191.

plans.[30] The IEA estimates that every 200 GW of new coal-fired power plants increases annual emissions by 800 megatonnes a year[31] or over 20,000 megatonnes over the projected life span of these plants.[32]

26. The reason Asian nations are continuing to build coal-fired power plants is because, as the IEA notes, "the closure or repurposing of coal mines and power plants could have significant economic and social consequences."[33] An additional complication is that closing existing power plants in emerging markets means "there are concerns over the potential exposure of the banking system to stranded assets."[34] For example, in India "the presence of over 50 GW of financially stressed coal assets has created strains in the banking system."[35]

27. University of Guelph Professor Ross McKitrick shows the difficulty of reducing emissions in a growing society where both GDP and population are expanding.[36]

[30] International Energy Agency, "World Economic Outlook 2021", 57. Available at https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf, **Exhibit 8**.
[31] International Energy Agency, "World Economic Outlook 2021", 129. Available at https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf, **Exhibit 8**.
[32] International Energy Agency, "World Economic Outlook 2021", 58. Available at https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf, **Exhibit 8**.
[33] International Energy Agency, "World Economic Outlook 2021", 58. Available at https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf, **Exhibit 8**.
[34] International Energy Agency, "World Economic Outlook 2021", 61. Available at https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf, **Exhibit 8**.
[35] International Energy Agency, "World Economic Outlook 2021", 61. Available at https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf, **Exhibit 8**.
[36] Ross McKitrick. "Trudeau can have carbon cuts, income growth or high immigration—but not all three", *Financial Post*, November 16, 2016. Available at https://financialpost

Overall emissions of greenhouse gas emissions (GHG) are a function of the carbon intensity of our economy (GHG emissions per dollar of GDP), real income (GDP per capita) and population (Pop). This can be expressed as:

GHG = GHG/GDP x GDP/Pop x Pop

28. Real GDP and population growth by themselves raise carbon consumption, which makes it more difficult to meet emissions targets. This equation concisely demonstrates the difficulty for developing countries to lower emissions: Asia's emissions are being driven higher by economic growth as its population slows (with the notable exception of India), while Africa's emissions are rising as it has the fastest growing population of any continent, even as its economic growth lags Asia.

29. The equation shows that greenhouse gas emissions are a function of all three components; real income per capita; the emissions intensity of creating that income; and population levels. Focusing on just one term to the exclusion of the others, as occurs when only emissions intensity is highlighted, means other sources of emissions growth are ignored. The equation can also be shortened to GHG = GHG/POP x POP, which means total greenhouse gas emissions are a function of the size of the population and greenhouse gas emissions intensity per person.

30. Population is a major driver of greenhouse gas emissions, even in the absence of economic growth that also raises emissions. Population growth is projected by the

.com/opinion/ross-mckitrick-the-liberals-will-have-to-choose-between-immigration-income-and-climate, attached to this affidavit as **Exhibit "9"**.

United Nations to continue in major countries such as China and India.[37] The United Nations projects that by 2030, China's population will grow by 30,565,000 people or 2.1 percent from its 2018 level, and India's population will expand by 137,224,000 or 10.0 percent from 2018.

31. Even if the greenhouse gas emissions per person in China and India remain unchanged,[38] then by 2030 emissions in China will grow to 12,618 megatonnes (its projected population in 2030 of 1,464,340,000 multiplied by per capita emissions intensity of 0.008617) and India's to 3,714 megatonnes (a population of 1,503,642,000 times emissions intensity of 0.00247). Population growth alone, even assuming no increase in emissions intensity per person that normally accompanies economic growth, means that China's total emissions will rise by 263 megatonnes per year (from 12,355 in 2018 to 12,618 in 2030) and India's by 339 megatonnes per year (from 3,375 in 2018 to 3,714 in 2030).

32. These projected increases in emissions by China and India, which are strictly due to projected population growth in those countries, greatly exceed all of Ontario's current greenhouse gas emissions (159 megatonnes in 2017). Focusing on emissions in Ontario, while ignoring the enormous difficulty of lowering emissions in developing countries as their population and incomes expand, ignores the largest source of global greenhouse gas emissions growth in the world. Even lowering emissions in Ontario to

[37] United Nations Department of Economic and Social Affairs, "World Population Prospects 2019. Volume 1: Comprehensive Tables, Table A.9, 26-27". Available at https://population.un.org/wpp/Publications/Files/WPP2019_Volume-I_Comprehensive-Tables.pdf, attached to this affidavit as **Exhibit "10"**.

[38] Using the data from Table 1 of this report, China's emissions totalled 12,355 megatonnes, or 0.008617 per person, while India's emissions of 3,375 megatonnes in 2019 represents 0.00247 per person.

zero by 2030 would only offset 26.4 percent of the projected *increase* in emissions from China and India that are solely due to population growth, even assuming that their emissions intensities stay unchanged as their economies continue to grow.

33. To see how McKitrick's equation helps analysis, it shows that for Canada to achieve a 36 percent minimum cut in emissions by 2030 from its 2005 baseline would require an average annual decline of 3.8 percent in emissions from their actual level in 2019. McKitrick's key insight is that if the population and real GDP per capita increases – as they normally do in a healthy, growing society – then carbon intensity needs to fall even faster than total emissions to meet reduction targets.

34. For example, if the population continues to expand by about 1.0 percent a year (which is Statistics Canada's long-term projection)[39] and real GDP per capita grows by 1.5 percent,[40] then emissions intensity has to fall by an annual average of 5.5 percent through 2030 in order to achieve a total decline in Canadian greenhouse gas emissions of 46.4 percent between 2019 and 2030.[41] Such a large decline in emissions intensity in a short period is unrealistic without drastic economic impacts. Unless technology

[39] See https://www150.statcan.gc.ca/n1/en/pub/91-520-x/91-520-x2019001-eng.pdf?st=_qIfV9bV attached to this affidavit as **Exhibit "11"**.
[40] The 1.5 percent comes from my MLI paper on doubling GDP; https://macdonaldlaurier.ca/mli-files/pdf/202110_Doubling_GDP_by_2050_Cross_PAPER_FWeb.pdf.
[41] Ross McKitrick. "Trudeau can have carbon cuts, income growth or high immigration—but not all three", *Financial Post*, November 16, 2016. Available at https://financialpost.com/opinion/ross-mckitrick-the-liberals-will-have-to-choose-between-immigration-income-and-climate, **Exhibit "9"**. For example, for emissions to recede 36 percent from their 2005 level, they must reach 473 megatonnes in 2030; if GDP rises by 2.5 percent a year for the rest of this decade it will total $2,546 billion in 2030. Dividing 473 by 2,546 gives a carbon intensity of 0.186 in 2030, 46.4 percent below its 2019 level of 0.347.

changes rapidly, the economic cost of emissions reductions will be too much to sustain the growth of population and the economy.

35. Further complicating matters is that national goals under the Paris Agreement target the absolute level of emissions and not the carbon intensity of GDP. Automatically, a high rate of population growth or any increase in GDP requires more than simply offsetting reduction in carbon intensity to lower emissions in absolute terms. For example, although Canada has the highest population growth in the G7 at 5.2 percent between 2016 and 2021,[42] Canada's carbon intensity did decline by 22.9 percent between 2005 and 2019, an impressive achievement on its own. This decline, however, was almost entirely because of a 28 percent gain in GDP, and not lower emissions. Hitting Canada's target under the Paris Agreement requires an outright decline in emissions (not just emissions intensity) which will be made more difficult by an expanding population and economic growth.

C. Please describe the greenhouse gas emissions reduction targets in other jurisdictions and comment on compliance with those targets.

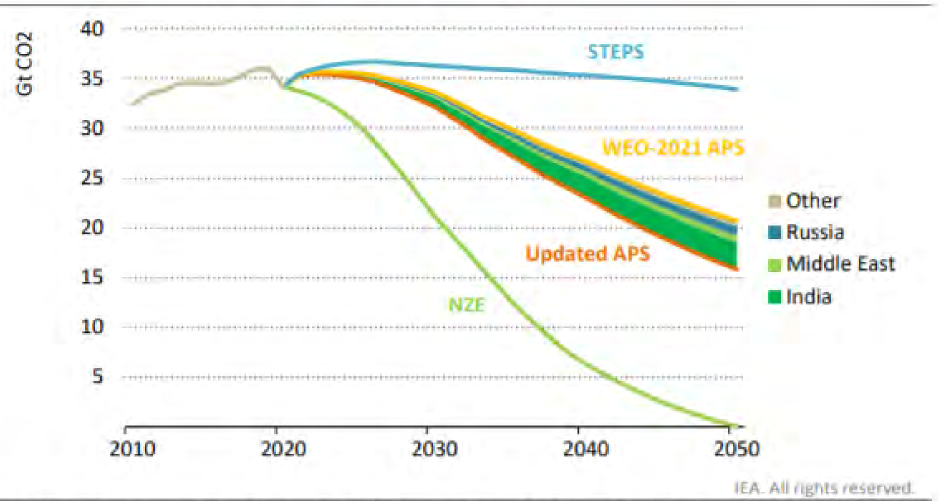
36. None of the major emitting nations are on track to meet their announced targets for reducing greenhouse gas emissions. Without widespread international adherence to these targets, Ontario's actions will have no meaningful impact on the amount of anthropogenic greenhouse gas emissions.

[42] "Canada tops G7 growth despite COVID", Statistics Canada, The Daily, February 17, 2022. Available at https://www150.statcan.gc.ca/n1/daily-quotidien/220209/dq220209a-eng.htm, attached to this affidavit as **Exhibit "12"**.

I. Global emissions

37. The International Energy Agency (IEA) provides a global assessment of how all nations are progressing towards their national targets under the Paris Agreement, in terms of both actual steps taken and promises made for future action. The IEA updated this assessment for promises made in November 2021 at the COP26 Conference in Scotland. The results are presented in Figure 1.1, reproduced below.

Figure 1.1 ▷ CO_2 emissions in the WEO-2021 scenarios and emissions reductions from recent pledges



Note: Other = net zero pledge by Australia and commitment to the Global Coal to Clean Power Transition Statement by Indonesia. Middle East = net zero pledges by Saudi Arabia and the United Arab Emirates.

38. The line labelled STEPS shows the projected course of emissions under the status quo (STEPS stands for State Policies Scenario). More specifically, STEPS is "based on an assessment of existing policies and measures and those that are under development. The STEPS scenario explores where the energy system might go without a major additional steer from policy makers."[43]

[43] International Energy Agency, "World Energy Outlook 2021: Technical note on the emissions and temperature impactions of COP26 pledges" at 2. Available at https://iea.blob.core.windows.net/assets/aa17bd09-2ad0-4d0a-b5aa-ee418900c4af/

39. The two lines labelled APS represent the Announced Pledges Scenario, which "takes account of all the climate commitments made by governments around the world" both before and after COP26 and "assumes that they will be met in full and on time." For example, India's pledge to reach net-zero in 2070 is accepted at face value, even though the track record shows few countries have fully implemented their climate commitments on time or in full and there is little reason to expect a dramatic change with the COP26 agreement. Even more problematic is Russia's pledge at COP26 to be carbon net zero by 2060, since Russia's track record and stated plan argue that it is not seriously committed to net zero (Russia's emissions are explored in more detail below).

40. The Net Zero Emissions by 2050 Scenario (NZE) shows the pathway needed to achieve the goal of net zero emissions by 2050. The IEA calls the difference between the NZE line and the APS curve the "'ambition gap' that needs to be bridged for pledges to align with the temperature goal included in the Paris Agreement."[44] As Figure 1.1 shows, this "ambition gap" between government plans or pledges and the ultimate goal of net zero emissions represents almost half of total emissions in 2020. Put another way, governments have failed to articulate how they imagine (let alone realistically plan) to eliminate nearly half of current emissions.

41. It is also worth noting that even in a Net Zero scenario for 2050, the IEA projects that oil demand will remain substantial at 24 million barrels per day, the equivalent of 21.7

Theimpactsofnewemissionspledgesonlongtermtemperatures.pdf, attached to this affidavit as **Exhibit "13"**.

[44] *Ibid* at 3.

percent of global energy consumption.[45] A Net Zero world does not mean ceasing to consume fossil fuels and keeping all oil and gas in the ground. This reflects that net zero includes oil and gas production whose emissions are captured and removed before entering the atmosphere.

II. Emissions by country

42. For compliance by country, I use the Climate Action Tracker (CAT), which is an independent analysis of government climate action and measures compared with the Paris target of limiting warming to below 2ºC. The CAT is a collaboration of Climate Analytics (a climate science and policy institute based in Berlin) and the NewClimate Institute, using a model developed by the Potsdam Institute for Climate Impact Research (whose work is cited in the report by the Ontario Auditor General at paragraph 11 above). Funding for CAT is provided by governments, notably the German Ministry for Environment, and foundations including the European Climate Foundation. The CAT grades nations on a five-point scale, moving from Paris Agreement Compatible (the top), to Almost Sufficient, to Insufficient, to Highly Insufficient, and then Critically Insufficient (the worst).

43. I present the CAT evaluation of compliance with the Paris Agreement in the same order as the national ranking in total global emissions in 2018. None of the major emitting nations were graded as on track to meet their national Paris targets.

44. China, the world's largest emitter of greenhouse gas emissions, is graded as "Highly Insufficient." CAT found that China's newly proposed carbon intensity targets remain

[45] BP Energy Outlook 2020 at 66. Available at https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2020.pdf, attached to this affidavit as **Exhibit "14"**.

"highly insufficient" for both non-fossil and renewable capacity, leaving the country dependent on coal for too much of its power needs. China commissioned 38.4 GW of power from new coal plants in 2020, "representing 76% of the world's total commissioned coal plants, signaling another year where China held back the rest of the world's progress in declining plants."[46] Using the IEA's estimate that every GW of coal power generates 4 megatonnes of emissions annually,[47] China's commitment to 38.4 GW of coal power in 2020 will increase its emissions by 153.6 megatonnes a year.[48] China's new plan also covers only CO_2 emissions and not other greenhouse gases.

45. China in 2009 made "the world's largest commitment to renewable sources of energy."[49] However, Lomborg notes that while China has invested more in renewable energy, its energy needs have risen so much that the share of renewables in its energy consumption has fallen from "almost 20 percent in 2000 to about 10 percent in 2020 (although it was even lower at 7.5 percent in 2011)."[50] China's power generation rose from 947 GW in 2010 to 1,625 GW in 2016 and is expected to double again to 3,188

[46] https://climateactiontracker.org/countries/china/, attached to this affidavit as **Exhibit "15"**.
[47] International Energy Agency, "World Economic Outlook 2021", 129. Available at https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf, **Exhibit 8.**
[48] International Energy Agency, "World Economic Outlook, 2021" at 129, https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf, **Exhibit 8**.
[49] Friesen, Kenneth Martens, *Energy, Economics, and Ethics: The Promise and Peril of a Global Energy Transition*, Rowman & Littlefield, 2020 at 82.
[50] Lomborg, Bjorn, *False Alarm: How Climate Change Panic Costs Us Trillions, Hurts the Poor, and Fails to Fix the Planet*, Basic Books, 2020 at 27.

GW by 2040.[51] China's huge energy needs explain why it is investing heavily in renewables, nuclear power, and fossil fuels, notably coal.

46. The USA, the second largest emitter, is graded as "Insufficient." The US has made progress in reducing its use of coal-fired power plants by switching to natural gas, but completely decarbonising its power sector by 2035 as the Biden administration proposes requires approval by a reluctant Congress. The Biden target for half of all vehicles sold in 2030 to be zero-emissions is also not enough to reach the Paris target for the USA.[52] Finally, US contributions to finance international climate programs is rated "Critically insufficient."[53]

47. The EU, the third largest emitter, is graded as "Insufficient." While the EU has lowered its emissions, it still does "not have a coal phase-out plan by 2030."[54] While sales of electrical-charged vehicles are rising, most are hybrids "which still often use a combustion engine, while at the same time benefitting from generous state support."[55] The EU is also marked for insufficient funding of international climate programs.

48. India, the fourth largest emitter, is graded as "Highly Insufficient." Most of the shortfall reflects that "India is continuing to expand its coal capacity, as a number of projects are under construction and several others have been announced, despite the utilisation

[51] Friesen, Kenneth Martens, Energy, Economics, and Ethics: The Promise and Peril of a Global Energy Transition, Rowman & Littlefield, 2020 at 82.
[52] https://climateactiontracker.org/countries/usa/policies-action/, attached to this affidavit as **Exhibit "16"**.
[53] https://climateactiontracker.org/countries/usa/, attached to this affidavit as **Exhibit "17".**
[54] https://climateactiontracker.org/countries/eu/, attached to this affidavit as **Exhibit "18"**.
[55] *Ibid*.

rate of coal power plants falling."[56] Subsidies for coal consumption are "approximately 35% higher than for renewable energy."[57]

49. Russia, the fifth largest emitter, is graded as "Critically Insufficient." Russia continues to boost fossil fuel production, consumption and exports. It lacks "any substantial contribution to international climate finance goals."[58] Russia's goal of renewables generating 4.5% of all its power is "very modest."[59] It violates UN guidelines on accounting for negative emissions from its forests.

50. Canada, the tenth largest emitter, is graded "Highly Insufficient." Some of the shortfall reflects Canada having to follow the Trump administration's rollback of fuel efficiency standards for vehicles, since most vehicles sold in Canada are manufactured in the United States. This rollback is now being reversed by the Biden administration, an example of how not all emissions are controlled by national or sub-national governments.[60] Canada also was marked down for expanding pipeline capacity to transport fossil fuels, while lowering the cost for the oil and gas sector to comply with methane regulations during the pandemic. It is notable that no mention was made of either Ontario's emissions or policies in this report.

[56] https://climateactiontracker.org/countries/india/, attached to this affidavit as **Exhibit "19"**.
[57] *Ibid*.
[58] https://climateactiontracker.org/countries/russian-federation/, attached to this affidavit as **Exhibit "20"**.
[59] https://climateactiontracker.org/countries/russian-federation/policies-action/, attached to this affidavit as **Exhibit "21"**.
[60] https://climateactiontracker.org/countries/canada/, attached to this affidavit as **Exhibit "22"**.

51. Friesen concludes that the four largest economies (China, the US, India and Germany) “will largely determine how long the world will be carbon dependent and when global temperatures will peak.”[61] Recall that Table 2 from this affidavit showed that China, the USA, the EU and India accounted for 48.9 percent of global greenhouse gas emissions in 2016. The actions of Ontario will not be a significant factor, particularly as none of the world’s largest emitters is on track or even has a plan to achieve their targets for a substantial reduction in emissions.

52. Emissions from Ontario do not have a decisive impact on Canada’s total emissions. Statistics Canada data shows that in 2019 (the latest year available; 2011 is the first year for which Statistics Canada compiled this data) Ontario accounted for 22.0 percent of Canada’s emissions at 170,001 kilotonnes (a kilotonne, which is the unit Statistics Canada uses to measure emissions, equals 0.001 megatonnes). This is about 109,000 kilotonnes less than Alberta’s total, which represents 36.1 percent of Canada’s emissions. Put another way, even if Ontario immediately reduced its emissions to zero, this would only lower Canada’s total emissions to 601.8 mt, just an 18.6 percent reduction from the 2005 benchmark of 730 mt. The Canadian government has announced that “Canada is committed to reducing its emissions by 40 to 45% below 2005 levels by 2030.”[62]

[61] Friesen, Kenneth Martens. *Energy, Economics, and Ethics: The Promise and Peril of a Global Energy Transition*. Rowman & Littlefield, 2020 at 24.

[62] “Canada’s Climate Actions For A Healthy Environment and a Healthy Economy”, available online at https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/actions-healthy-environment-economy.html, **Exhibit 4**.

Geography	Canada (map)	Quebec (map)	Ontario (map)	Alberta (map)	British Columbia (map)
Reference period	Total, industries and households	Total, industries and households	Total, industries and households	Total, industries and households	Total, industries and households
	Kilotonnes				
2009	730,373	94,100	171,420	241,249	76,039
2010	739,377	89,709	179,582	247,471	77,862
2011	752,619	91,487	180,018	257,744	77,711
2012	751,717	89,423	172,864	265,411	78,276
2013	762,820	89,109	173,173	275,172	79,503
2014	763,567	87,706	169,856	280,193	80,256
2015	766,744	90,142	168,636	278,925	80,171
2016	741,903	88,569	165,764	261,747	80,291
2017	756,590	90,580	164,381	271,617	81,521
2018	771,446	91,805	169,954	276,347	83,054
2019	771,813	92,857	170,001	278,980	83,628

Source: Statistics Canada. Table 38-10-0097-01. Physical flow account for greenhouse gas emissions. Available at https://doi.org/10.25318/3810009701-eng, attached to this affidavit as **Exhibit "23"**.

53. It is also evident from the table above that Ontario is the only major province to have made progress in reducing emissions from their peak (Canada's four largest provinces account for 81.0 percent of its total emissions). Emissions in Ontario peaked in 2011 at 180,018 kilotonnes and thereafter fell 5.6 percent to 170,001 kilotonnes in 2019. By comparison, over the same period emissions rose 8.2 percent in Alberta, 7.6 percent in BC, and 1.5 percent in Quebec. The increases in BC and Quebec are notable because the increases occurred despite these provinces adopting carbon pricing schemes (a carbon tax in BC and a cap and trade system in Quebec). Even when emissions in Ontario fell over an extended period, Canada's total emissions rose 2.6 percent from 2011 to 2019, showing that Ontario by itself is not enough to

determine the national trend of emissions. The decline in Ontario's total emissions is even greater on a per capita basis, which fell 14.5 percent from a peak of 13.671 tonnes in 2010 to 11.688 tonnes in 2019. This drop is the result of a 5.3 percent decline in the absolute level of emissions while Ontario's population increased by 10.7 percent between 2010 and 2019.[63]

54. This conclusion is even more true on an international scale: Ontario's actions in lowering its emissions since 2005 have not impacted global trends. This reflects that Ontario is an insignificant portion of global emissions, and its actions have no impact on the behaviour of nations such as China and India. It is the latter that is determinant for global emissions. For example, the IEA estimates that stopping construction of all new investments in coal-fired power plants, mostly in Asia, would lower emissions in 2030 by 800,000 kilotonnes, or 800 megatonnes.[64] The annual emissions from these new coal-fired power plants alone will vastly exceed Ontario's total contribution to global greenhouse gas emissions.

D. What are some of the complexities associated with reducing greenhouse gas emissions?

55. There is extensive literature on the difficulty of making the transition from one dominant energy source to another, even when a lower cost of the new energy source gives an incentive to make the transition. We know this because the world has made several transitions to new primary energy sources over the past two centuries, including

[63] Population data are from Statistics Canada. Table 17-10-0005-01. Population estimates on July 1st, by age and sex. Available at https://doi.org/10.25318/1710000501-eng.
[64] International Energy Agency, "World Economic Outlook, 2021" at 129, https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf, **Exhibit 8**.

from wood to coal to petroleum to natural gas.[65] After reviewing these shifts in the world's primary energy consumption, one researcher observed that "all of the Industrial Age energy sources follow a similar trend when entering the market. It takes 40 to 50 years for an energy source to go from 1% to 10% of market share, and an energy source that eventually comes to occupy half of the market will take almost a century to do so."[66] Smil concludes that a global energy transition "takes two or three generations, or 50-75 years, for a new resource to capture a large share of the energy market."[67]

56. Canada has made similar transitions, resulting in a "shift from reliance on wood, to coal, electricity (created first by coal and then hydro and then nuclear energy), oil, and then natural gas."[68] One example of how slowly this transition occurs over time is coal, which provided just 7.3 percent of Canada's total energy consumption in 1871, rising to 41 percent thirty years later in 1902, and then an all-time high of 66 percent in 1918.[69]

57. The transition from fossil fuels to new energy sources will take time. Energy transitions take time for a number of reasons, reflecting what Yergin calls "the law of long lead times."[70] One is it takes time to learn how to make and use new energy sources: for example, "filling stations need gasoline, gasoline comes from oil, oil had to be

[65] Fouquet, Roger, *A brief history of energy. International Handbook on the Economics of Energy*, Joanne Evans and Lecter C. Hunt (eds). Edward Elgar, 2009 at 11.
[66] de Sousa, quoted in Rhodes, Richard, *Energy: A Human History*, Simon & Schuster, 2018 at 339.
[67] Smil, Vaclav. *Energy and Civilization: A History*, The MIT Press, 2017 at 395.
[68] Sandwell, R.W. "An Introduction to Canada's Energy History" In *Powering Up Canada: A History of Power, Fuel, and Energy from 1600*, McGill-Queen's University Press, 2016 at 16.
[69] Watson, Andrew, *Coal in Canada. In Powering Up Canada: A History of Power, Fuel, and Energy from 1600*, McGill-Queen's University Press, 2016 at 21.
[70] *Ibid.*

discovered, refineries had to process it, pipelines had to deliver the oil to the refineries and the gasoline to the cities where the cars were driven."[71]

58. Weaning our society off fossil fuels will be a much more difficult process than many imagine, reflecting the considerable capital embedded in the existing energy infrastructure built upon fossil fuels. Energy transitions involve "the prerequisites for enormous infrastructure investment and the inertia of massively embedded energy systems."[72] Commercial buildings, industrial plants and homes are constructed with a 60-year planning horizon. Power plants are also planned on the basis of a life span of several decades, while a new oil field may require a decade between exploration and first production. The automobile fleet changes very slowly, with two decades required to replace Canada's existing stock of 33 million vehicles on the road.

59. More broadly, our high-energy civilization requires a reconfiguration of a wide range of infrastructure, including "mines, oil and gas fields, thermal power stations, hydroelectric dams, pipeline networks, ports, refineries, iron and steel mills, aluminum smelters, fertilizer plants, railroads, multilane highways, airports, skyscraper-dominated downtowns, an extensive suburbia."[73] Yergin concludes that "history demonstrates that energy transition takes a long time. It took almost a century before oil overtook coal as the number one energy source."[74] The reality is that fossil fuels will be part of our economy for decades to come.

[71] Rhodes, Richard, *Energy: A Human History*, Simon & Schuster, 2018 at 339.
[72] Smil, Vaclav, *Energy and Civilization: A History*, The MIT Press, 2017 at 397.
[73] Smil, Vaclav, *Energy and Civilization: A History*, The MIT Press, 2017 at 422.
[74] Yergin, Daniel, *The Quest: Energy, Security, and the Remaking of the Modern World*. Penguin Press, 2011 at 715.

60. The goal of net zero emissions by 2050 requires compressing the transition to new energy sources that normally occurs over several decades into less than three decades by 2050. Making the transition more difficult is that, while past transitions were facilitated and incentivized by lower costs, the transition to renewable energy sources or capturing the carbon from existing fossil fuel sources typically raises costs. Neither of these mean that the transition cannot or should not occur, but they imply that the transition has to be managed skillfully to not cause energy prices to escalate too rapidly or create shortfalls of supply. Every policy decision involves trade-offs, and this is especially true of energy choices which have different impacts on the environment and the economy.

SWORN BEFORE ME remotely by Philip Cross and stated as being located in the City of Ottawa in the Province of Ontario before me at the City of Toronto in the Province of Ontario, on February 28, 2022 in accordance with O Reg 431/20, Administering Oath or Declaration Remotely

....

Commissioner for the Taking of Affidavits

DAYNA MURCZEK (LSO#82824Q)

....

PHILIP CROSS

SOPHIA MATHUR, et al. Applicants and THE QUEEN Respondent Court File No. CV-19-00631627-0000

ONTARIO
SUPERIOR COURT OF JUSTICE
Proceeding commenced at TORONTO

RESPONDING RECORD
(Motions to Intervene)

ECOJUSTICE
777 Bay Street
Suite 1910, PO Box 106
Toronto ON M5G 2C8

Fraser Andrew Thomson
fthomson@ecojustice.ca

Danielle Gallant
dgallant@ecojustice.ca

Tel: 416-368-7533
Fax: 416-363-2746

Counsel for the Applicants
(Responding Party)

STOCKWOODS LLP
Toronto-Dominion Centre
TD North Tower, Box 140
77 King St W, Suite 4130
Toronto ON M5K 1H1

Nader R. Hasan (54693W)
Tel: 416-593-1668
naderh@stockwoods.ca

Justin Safayeni (58427U)
Tel: 416-593-3494
justins@stockwoods.ca

Spencer Bass (75881S)
Tel: 416-593-1657
spencerb@stockwoods.ca

Tel: 416-593-7200
Fax: 416-593-9345

Lawyers for theApplicants
(Responding Party)