What is undermining climate change mitigation: How fossil-fuelled practices challenge low-carbon transitions

by Raymond Murphy
Emeritus Professor
School of Sociology and Anthropology
University of Ottawa

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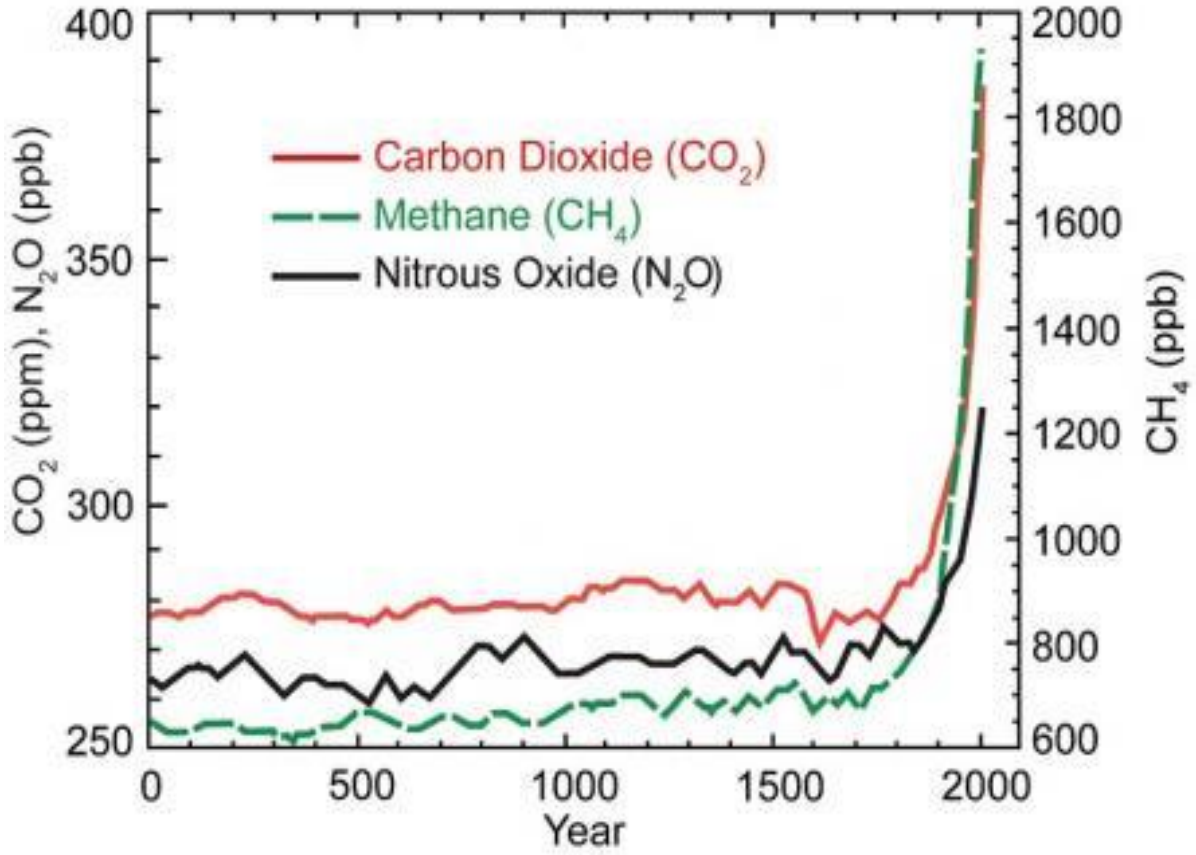
Human activities cause climate change. Which activities cause how much emissions, their scale, increasing or decreasing, by whom? Need to quantify the effects.

Figure 1. Evolution of heat-trapping gases in the atmosphere that result in the greenhouse effect



EPA 2017. 'Causes of Climate Change'. *United States Environmental Protection Agency*. https://19january2017snapshot.epa.gov/climate-change-science/causes-climate-change_.html (accessed 17 April 2020).

Recency of the accelerating treadmill of human-caused greenhouse-gas emissions

10,000 BC until 1740: minimal emissions and climate change because humans didn't have the capacity to dig, pump, and frack fossil fuels (carbon) and put it in the sky

CO_2 emissions

1750 – 1990 (240 years) = 804 Gt = slow acceleration of emissions

1990 – 2019 (30 years) = 872 Gt = rapid acceleration of emissions

Humans are emitting carbon into the atmosphere by technologically innovating vehicles, ships, planes, electricity-insatiable data centres, etc., resulting in the accelerating treadmill of fossil-fuelled activities (driving, flying, cruising, cryptocurrencies, AI, etc.).

CO_2 remains in the atmosphere more than a century and accumulates

Even if emissions decrease in 2024, human-caused climate change is being made worse not better because 2024 emissions are added to CO_2 emitted into the atmosphere in 2023, 2022, … and the last hundred years.

The scale of fossil-fuelled practices and emissions is enormous.

Global annual CO_2 emissions
1940: 4.85 billion metric tons
2022 after enormous advances in science showing dangers of emissions:
37.49 billion metric tons

Pielke (2010) calculated that the replacement of one-half of global fossil-fuel use and emissions by nuclear energy between 2010 and 2050 would require 12,000 additional regular-sized nuclear reactors, namely opening a new one every day. This would still leave humanity dependent on fossil fuels for the other half of energy demand.

Although wind and solar energy is developing, the accelerating treadmill of fossil-fuelled practices is so fast that fossil fuels still supply 80% of global energy, the same figure now at COP29 as it was four decades ago at COP1. Humans are running faster to implement low-carbon energy (wind, solar, etc.) just to hold the proportion of fossil fuel emissions constant thereby merely worsening climate change less quickly than would otherwise occur.

David Miller, President of the Big Cities Climate Leadership Group, argues that 'most people understand climate change, but they don't understand the connection between this existential crisis and their own actions. We have to bend the curve of needing more energy', i.e. reduce demand.

Premise 1: people lack a practical understanding of how their own fossil-fuelled practices are contributing to climate change and of the enormous scale of such practices.

Premise 2: Awareness of the harm caused by their own fossil-fuelled practices is a necessary condition to incite people to act and to support collective policies to remedy climate change.

Objective of this paper = provide documentation of how much carbon-polluting emissions result from common fossil-fuelled activities, what is their scale, are they increasing or decreasing, and how do they vary by social class.

Focussing solely on supplying clean energy to mitigate climate change has failed because demand for greenhouse-gas emitting fossil-fuelled practices is on an accelerating treadmill that overwhelms increased supply of clean energy.

And the greater the demand for fossil-fuelled activities, the more difficult mitigation and adaption.

Hence need to analyse demand for fossil-fueled social practices, which is the deep cause of climate change because it involves activities people enjoy.

Bill McGuire wrote that ‘as a climate scientist, it is my duty to tell you about what is happening to our world, whether it engenders fear or not. … A failure to do this will mean that the public is left ignorant of the true extent of the climate emergency, which in turn can only hinder engagement and action’.

McGuire’s argument also applies to social scientists. Our duty is also to inform people, which includes about dire and unpopular news, and not just tell them what they want to hear leaving them ignorant of the gravity of the problem.

Researchers need to go to the conclusion where the evidence and logic lead, no matter how unpleasant that is.

Another inconvenient truth

I = P * A * T

Affluence reduces birth rate and population

Affluence increases use of fossil-fuelled technologies

Affluence is driving emissions and climate change because it increases discretionary fossil-fuelled activities

China

1970 massive growing population, fertility 5.81, but poor, hence few fossil-fuelled practices, low greenhouse-gas emissions

2024 affluent, hence fertility fell to 1.30, population decreased, increasing use of fossil-fuelled technologies. Hence it has become the world's highest emitter despite decreasing population because of an accelerating treadmill of fossil-fuelled practices.

The treadmill of carbon-polluting practices is now accelerating faster

Two drivers explaining how affluence accelerates emissions

1) **The intensification of fossil-fuelled practices among the affluent**
2) **The transition to more affluence and fossil-fuelled practices in developing countries**

country	population
China	1.4 billion
India	1.4 billion
Indonesia	275 million
Pakistan	225 million
Brazil	215 million

Club of Rome: Limits of growth

Growth of what? Fossil-fuelled activities

Analysis needs to take into account emissions of both a small number of super wealthy enormous carbon polluters and an enormous number of merely affluent smaller polluters. The scale and proportionality of fossil-fuelled practices are the important issues.

The wealthiest 0.54 % of the global population, 40 million people, emitted 14 % of greenhouse gases.

The poorest 50%, 4 billion people, only emitted 10%.

The middle 49.46% emitted 76%, with the more affluent they were, the more they emitted.

Private jets of the wealthy

Small private jet (Elton John, Prince Harry)

Short return flight London – Nice

= 10 tonnes of emissions = 10,000 kgs

There were about 22,000 private jets, many big ones, in operation in 2020. One study found that 'the private jet market is currently undergoing unprecedented demand … both charter and ownership demand is soaring. … the average number of global daily private jet flights is around 11,500 flights per day' in 2021.

Carbon polluting practices of the super wealthy

In 2022, Elon Musk's Gulfstream G550ER plane produced

1,800 tons of CO_2 emissions = 1.8 million kgs.

Bigger private jets of other billionaires emit more:
the Airbus A380 of Prince Alwaleed bin Talal of Saudi Arabia;
the Airbus 340-300 of Russian oligarch Alisher Usmanov;
the Boeing 747-8 of Hong Kong real-estate tycoon Joseph Lau;
the Boeing 747-300 of the Sultan of Brunei;
the Boeing 767-33A ER of Russian businessman Roman Abramovich

Wilk and Barros (2021) calculated that 'a superyacht with a permanent crew, helicopter pad, submarines and pools emits about 7,020 tons of CO_2 a year . . . making it by the far worst asset to own from an environmental standpoint'

Carbon polluting practices of the merely affluent

Fossil-fuelled commercial aviation practices

Lifting an average 40,000-kilogram plane with a

20,000 kilogram load of passengers, cargo, and crew

and 18,000 kilograms of jet fuel and

powering it to fly at 800 kilometers per hour an average distance

and landing it

requires the combustion of that jet fuel

thereby emitting an enormous quantity of greenhouse gases.

Commercial flights per day = 110,000

Figure 4. Accelerating treadmill of commercial aviation

2009 = 4.5 trillion passenger-kilometres
2018 = 8.3 trillion passenger-kilometres

2019 = 106 billion gallons of jet fuel combusted
2050 = 230 billion gallons of jet fuel combusted

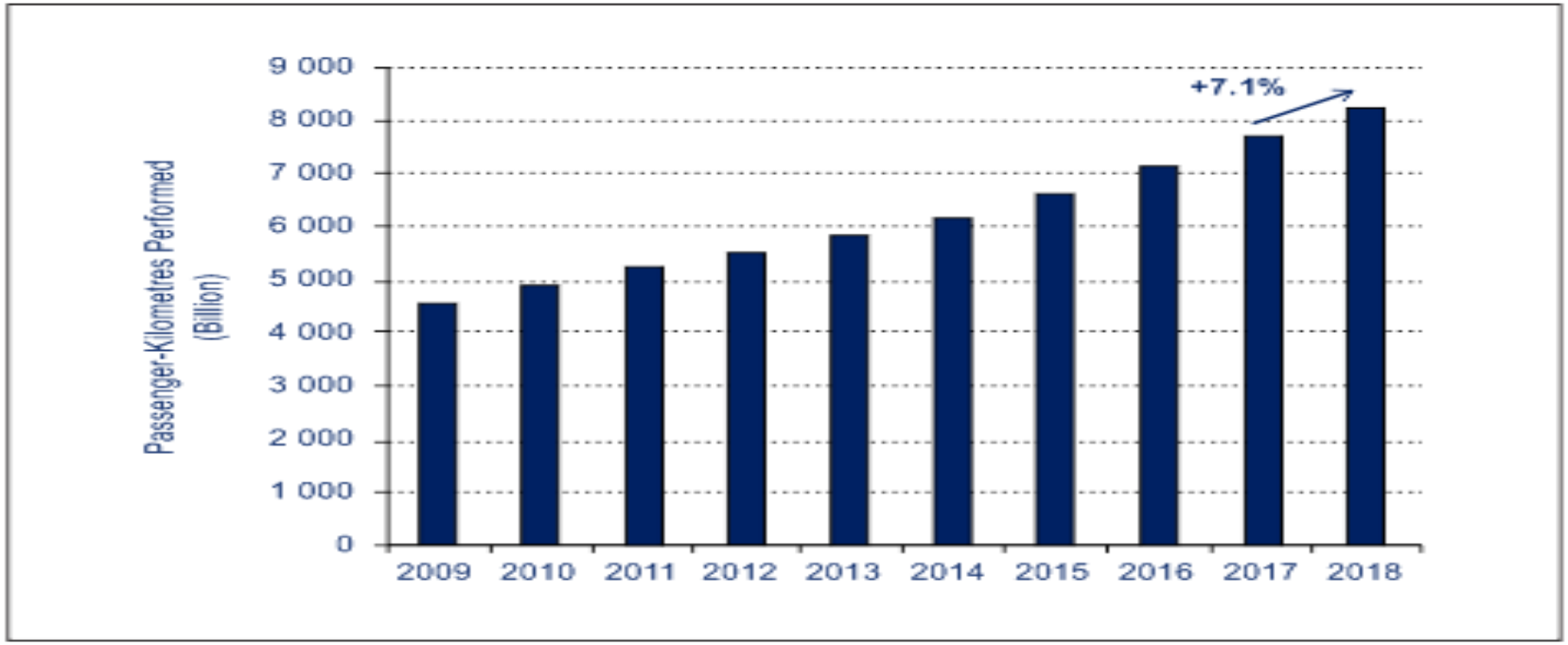


Figure 1. Passenger-Kilometres Performed
Total Scheduled Traffic, 2009-2018

80% of the world's population are excluded from ever flying because of cost. Aviation practices are monopolised by the remaining 20%, especially by frequent flyers. Nevertheless, 4.3 billion passengers fly annually increasing to 10 billion by 2040.

CO_2 emissions *per passenger* for a short return flight London – Nice
Economy class: 0.438 tonnes = 438 kgs = 5 times 90 kg. passenger weight
Business class: 0.568 tonnes = 568 kgs = 6 times passenger weight
First class: 1.1 tonnes = 1100 kgs = 12 times passenger weight
(Myclimate.org)

Conferences and Trade Shows

Emissions from a 6-day international conference of 5,000 participants compared to a virtual conference

In-person conference

7,188,027 kg of CO_2 equivalent to transport 5,000 people by plane, rail, or car (mainly from planes)

+ 523,878 kg of CO_2 from powering hotels, meals, and conference venue

= 7,711,905 kg of CO_2

= 1,542 kg of CO_2 per participant

= 17 times the weight of average 90 kg participant.

Virtual conference

124,416 kg of CO_2 from powering the virtual conference

= 25 kg. of CO_2 per participant

= ¼ the weight of an average 90 kg participant

Difference

= 7,587,489 kg more CO_2 emitted by holding an in-person rather than a virtual conference. And CO_2 from a 6-day conference stays in the atmosphere over a century.

In-person conferences are valuable and enjoyable but have a climate cost. Are they worth it when less harmful virtual alternatives are available?

Total greenhouse gas (GHG) emissions for previous COPs reported in COP 26 sustainability report

COP	Total GHG emissions tCO2e (per delegate / x delegate weight)		GHG emissions from delegate travel tCO2e (per delegate)	
COP15 – 2009 Copenhagen	72,374	(2.16 / 24)	66,374	(1.98 / 22))
COP21 – 2015 Paris	43,000	(0.64 / 7)	33,800	(0.50 / 6)
COP23 – 2017 Bonn	49,966	(2.26 / 25)	43,056	(1.95 / 22)
COP25 – 2019 Madrid	51,101	(2.21 / 25)	43,192	(1.85 / 21)
COP26 – 2021 Glasgow	131,556	(3.42 / 38)	103,955	(2.70 / 30)

Open Letter on COP reform from the Club of Rome

“COP meetings must be transformed into smaller, more frequent, solution-driven meetings.”

A clearly discretionary social practice: cruising

The accelerating treadmill of passengers cruising

1990 3,774,000

2023 28,837,000

2027 39,500,000 projected

Average cruise ship carries 2,500 passengers and combusts 80,000 gallons of highly polluting diesel or bunker fuel a day.

CO_2 emitted by all cruise ships in 2017

divided by number of passengers

= 820 kg per passenger

= ten times the average 90 kg. passenger weight.

+ jet fuel emissions flying to port of departure and from destination to home.

Global emissions of CO_2 from cars and vans

2010: 3.14 billion metric tons

2019: 3.61 billion metric tons

2020: 3.20 billion metric tons

2021: 3.48 billion metric tons

2022: 3.53 billion metric tons

Percentage of global vehicle sales in 2022

SUVs and pickup trucks = 46%

Electrical vehicles = 2%

Fossil-fuelled Vehicle Activities

William Nordhaus, 2018 Nobel laureate for economics, gives an example. Driving "100 miles consume 5 gallons of gas which emit 100 pounds of CO_2, which is imperceptible to the senses"
Average car is driven 10,000 miles annually
= 10,000 pounds of CO_2 emitted

Presently there are 1.5 billion cars in the world. The global number of cars is projected to increase to 2 billion by 2040.

Cars per hundred population: United States 90; Kenya 3.

The Military

The United States military is the world's biggest single institutional consumer of hydrocarbons, and therefore the largest institutional carbon polluter, with the air force surpassing the army and navy.

<u>Average combustion of fuel in gallons per US soldier per day:</u>

Second World War = 1

Vietnam War = 9

Iraq and Afghanistan Wars = 22

In 2015 the American agency responsible for military energy dealt with 14 million gallons of fuel <u>per day</u>.

China, Russia, NATO

Information and communications technology (ICT)
= networks, production, TVs, computers, mobile phones, data centres, cryptocurrencies, etc.

<u>Traffic to and from data centres</u>

1987 = 2×10^{12} bytes

2017 = 1.1×10^{21} bytes

ICT is responsible for 2% of emissions globally

Netflix fans watched 6 billion hours resulting in emissions equivalent to 1.8 billion kilometers driven in cars. YouTube had 1.4 billion users in 2016 emitting 11 million tonnes of CO_2 equivalent.

Cremation

Cremation = combusting 28 gallons of diesel to incinerate the corpse for two hours at 1000º C, emitting 540 pounds of invisible carbon dioxide. Only 5 – 8 pounds of ash are visible.

<u>USA</u>

1958, 4% of deceased Americans were cremated

2018, 50% of deceased Americans were cremated

<u>Canada</u>

In 2020, 74% of deceased Canadians were cremated

Cremations in Canada in 2020 = 244,200,

resulting in 132 million pounds of CO_2 emitted.

Aquamation = alkaline hydrolysis, Desmund Tutu

An Emerging New Dimension of Intergenerational Environmental Social Injustice

The atmosphere constitutes a commons everyone shares, including future generations. It is being appropriated by the affluent as a waste sink to dump long-lasting carbon. Being of limited size, the more fossil-fuel beneficiaries combust, the less carbon sink capacity (carbon budget) is left for latecomers (the poor and future generations) without causing climate change and costly disasters. The atmospheric commons is a medium carrying social relations of monopolisation and exclusion from risk makers to risk takers.

In space. Stern: "poor countries are least responsible for the existing stock of greenhouse gases, yet they are hit earliest and hardest by climate change".

In time. Beck: "issues of climate justice include the excluded non-living [future] generations, who are going to suffer most".

Humans closing off nature's resources to other species

The Anthropocene involves not just the impact of human activities, but more precisely monopolisation of the planet's resources by humans and their activities.

- **At the present 1^{o} C global warming, 50 % of species fail to cope, including those as different as coral and polar bears. And global warming will rise by at least 2^{o} C**
- **Total plant biomass (especially trees) declined by half**
- **Wild mammal biomass cut by 85%**
- **Domesticated cattle and pigs outweigh wild mammals by 14 to 1**
- **Domesticated foul (especially chickens) outweigh wild birds by 3 to 1**

The increase of fossil-fuelled practices is outpacing efficiency improvements

Annual airline fuel efficiency increase: 2000 to 2010 = 2.4%

2010 to 2019 = 1.9%

Annual increase in airline passengers: 2000 to 2019 = 5%

Global percentage of fuel for jets that is sustainable aviation fuel (SAF) = 0.1%.

Only way to mitigate harm to the climate from flying is to fly less.

Annual efficiency gains for Netflix and YouTube = 20%

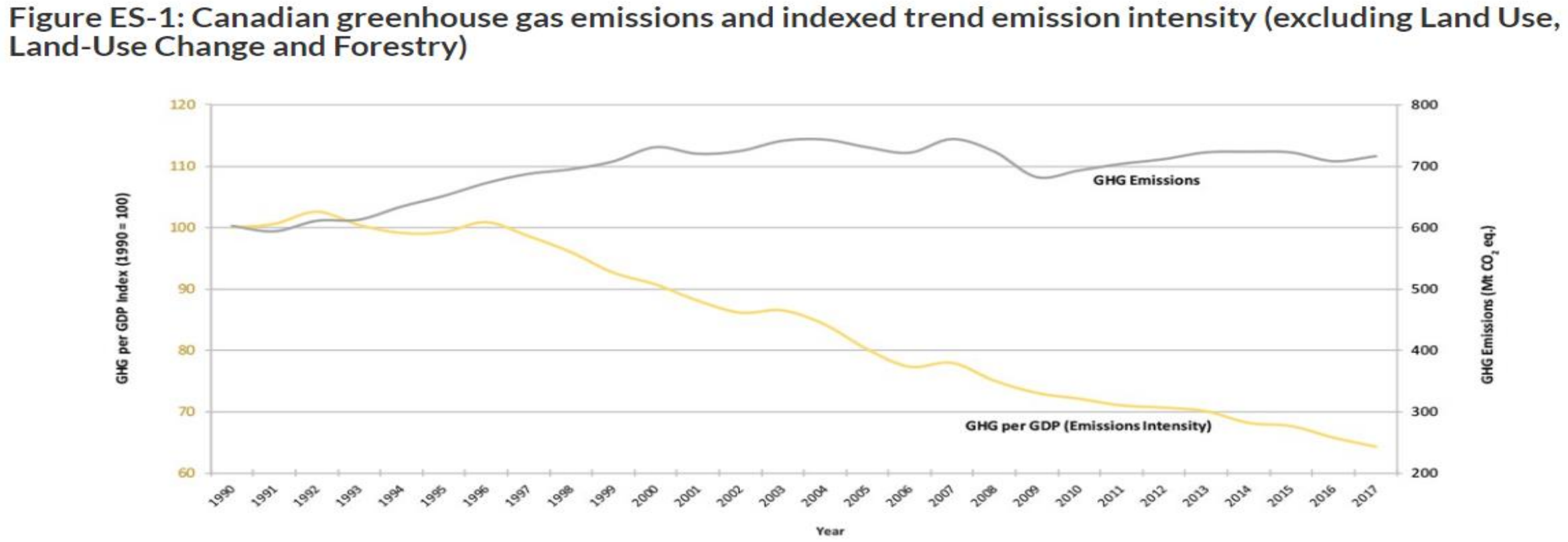
Annual growth in demand for Netflix and YouTube = 50%

Electricity consumption by data centres increased from 2014 to 2020 despite major improvements in efficiency.

The more efficient a technology, the more people use it.

Emissions are increasing despite falling emissions per GDP because GDP is growing faster

Figure 4. Canadian greenhouse gas emissions and indexed trend emission intensity (excluding Land Use, Land-Use Change and Forestry)



Government of Canada. 2019. *Greenhouse Gas Sources and Sinks: Executive Summary 2019.* Ottawa: Government of Canada. https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/sources-sinks-executive-summary-

What is undermining climate change mitigation and the low-carbon transition?

The accelerating demand for fossil-fuelled practices by the affluent and their monopolisation of the atmospheric commons as a carbon pollution sink cancels out efforts to reduce emissions and mitigate climate change, such as efficiency increases and the introduction of wind and solar energy, electrical vehicles, sustainable aviation fuel, etc. The net result leaves a carbon polluted atmosphere and a degraded biophysical environment for latecomers, namely future generations and the poor, who will have to suffer costly disasters.

How does the enormous demand for high-energy practices undermine mitigation and adaptation?

Wind and solar farms to replace fossil fuels would need to cover a huge space.

The scale of carbon capture and storage (CCS) and direct air capture (DAC) would need to be massive.

Growing seaweed on oceans to capture carbon would need to cover an ocean.

Replacing internal combustion engines with battery–powered electrical vehicles would necessitate a gigantic quantity of nickel, copper, cobalt, rare minerals, etc. Replacing fossil fuels with a colossal number of small modular nuclear reactors would require a huge quantity of uranium and produce a large amount of radioactive waste, etc.

Time: the more fossil-fuelled practices and emissions there are, the more time technological and socioeconomic transitions will take, hence the scale of fossil-fuelled practices impedes urgently needed remedies.

Some putative solutions may prove to be the displacement of problems, with the default energy option being old, reliable, polluting fossil fuels.

Who is responsible for greenhouse-gas pollution and who should pay for damage?

<u>E.g. for flying</u>

Is it the flying public?

Or the tourist industry promoting fossil-fuelled travelling?

Or the airline companies?

Or the jet fuel manufacturing companies and oil companies?

Or fossil fuel extracting and exporting countries?

Or all of the above and in what proportion?

It is not those who never or rarely fly, mainly poor people or future generations.

Limits to growth and degrowth

The finite capacity of atmospheric commons sink to absorb greenhouses gases without causing dangerous consequences constitutes a limit to the safe growth of fossil-fuelled activities.

The limit is not scarcity of fossil fuels, like peak oil, but paradoxically too much resulting in too much emissions. Rather than resulting in a dramatic collapse, the remaining safe storage capacity of the sink has been incrementally filling up and soon will be gone.

The carbon budget limiting the remaining amount of carbon emissions to be safe, and hence limiting growth of fossil fuelled activities and demand, even shrinking it, is a key concept.

Degrowth is needed for polluting activities (flying, cruising) whereas growth is needed for environmentally benign activities (cycling, canoeing).

Typically, degrowth has been involuntary. A degradation of the climate and of the environment caused by fossil-fuelled practices threatens to cause involuntary degrowth.

Will high-energy activities be restrained

a) temporarily and purposively by an understanding that fossil fuelled practices are causing long-term harm and cost or

b) permanently by an irreversibly degraded environment because people are unaware that their own fossil-fuelled activities and their scale are causing the damage?

Voluntary or mandatory solutions?

Ecological saints are rare, offer token payments, and the worst polluters don’t stop or even pay.

Voluntary offsetting doesn’t satisfy scale and proportionality.

If victims distant in time or space are forced to pay the environmental debt in terms of disasters, then cost is invisible to polluters, so they pollute freely and abundantly.

To correct this and create a disincentive for carbon pollution and human-caused global warming, mandatory offsetting and carbon taxes must be paid upfront in proportion to pollution.

Living in society requires controlling activities that harm others, such as emitting greenhouse gases.

Why is there resistance to mitigating climate change?

1) **The harmful consequences of climate change result from the energy-intensive activities and affluence people enjoy.**
2) **There is a time lag and delayed-action effect between enjoyable cause and harmful consequences, and similarly between mitigation action and its benefits.**
3) **There is a lack of a practical understanding of the harmful environmental consequences of high-energy practices people enjoy. This impedes the development of needed foresight to anticipate future harms. The climate crisis is a crisis of foresight, a failure to see how near-term fossil-fuelled pleasures are causing long-term harm.**

Homer-Dixon: "If hope is to be a motivator and not a crutch, it needs to be honest and not false. It needs to be anchored in a realistic, evidence-based understanding of the dangers we face and a clear vision of how to get past those dangers to a good future".

Two hypotheses

1) **People do not know in understandable units the amount of long-lasting emissions from their own fossil-fuelled practices nor their scale and increase. If flying, cruising, and the like are assumed harmless, why not do them because they are enjoyable? Hence disclosure of climate consequences of common practices is crucial for fostering an informed citizenry.**
2) **This translation of the science of climate change into a practical understanding of the consequences of one's own fossil-fuelled practices is a <u>necessary</u> condition for prompting mitigation of the climate crisis. If the translation is not done, then the low-carbon transition will be exceedingly difficult and perhaps will fail.**

- **Murphy, Raymond. 2024. "What is undermining climate change mitigation? How fossil-fuelled practices challenge low-carbon transitions". *Energy Research and Social Science* Vol. 108, February 2024. https://doi.org/10.1016/j.erss.2023.103390**

- **Murphy, Raymond. 2021. *The Fossil-fuelled Climate Crisis: Foresight or Discounting Danger?* London: Palgrave Macmillan Springer Nature, 2021.**

Open Letter on COP reform from the Club of Rome

“Global emissions continue to increase, carbon sinks are being degraded and we can no longer exclude the possibility of surpassing 2.9ºC of warming by 2100. Our first encounter with 1.5ºC was accompanied by unprecedented human impacts coupled with enormous climate costs running into the hundreds of billions in 2023. Science tells us that global greenhouse gas emissions must be reduced by 7.5% annually to have any chance of staying within the 1.5ºC threshold, a prerequisite for the stability of our planet and a livable future for much of humanity. In 2024, the task is unequivocal: global greenhouse gas emissions must be reduced by 4 billion tonnes. … A record number of 2,456 fossil fuel lobbyists were granted access at COP28. … All this is what compels our call for a fundamental overhaul of the COP. We need a shift from negotiation to implementation, enabling the COP to deliver on agreed commitments and ensure the urgent energy transition and phase-out of fossil energy. COP meetings must be transformed into smaller, more frequent, solution-driven meetings.”

UN Climate Change Conference UK 2021 “COP26 Sustainability Report”. Glasgow.

https://webarchive.nationalarchives.gov.uk/ukgwa/20230313121406/https://ukcop26.org/cop26-sustainability-report/

There were 40,000 delegates at COP26 in Glasgow

- **Short-term cheap gas (“axe the carbon tax”) will result in throwing fuel on long-run unaffordable forest fires.**

A Materialist Sociology of Climate Change

Material properties of the planet

a) **Greenhouse gases remain in the atmosphere a century and accumulate.**
b) **Atmosphere has limited capacity to store carbon without causing dangerous greenhouse effects of global warming.**
c) **CO_2 is imperceptible to the senses even though it is four times the weight of the gasoline whose combustion caused it.**
d) **Climate change is irreversible in human time frames because of the biophysical difficulty of transferring carbon from the atmosphere back into safe storage in the ground.**

Consequence:
the interaction of these material properties with the accelerating treadmill of fossil-fuelled practices monopolised primarily by the affluent is causing disastrous climate change and excluding latecomers from a benign biosphere.