

# Magical Thinking

Why Net Zero is Neither Possible nor Desirable

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# Magical Thinking

## EXECUTIVE SUMMARY Why “Net Zero” Is Neither Possible nor Desirable

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Several western governments have committed their countries to have “net zero” greenhouse gas emissions in future. In this note, I explain why achieving net zero for an entire economy would face insuperable technical and cost barriers and demand unacceptable political changes for democratic societies. Today, 84% of the primary energy needs of the world are met by oil, natural gas and coal. Five per cent is met by renewable energy sources. Net zero means increasing the uses of renewable energy entirely to replace the 84% of energy supplied by oil, natural gas and coal, and doing this in less than 30 years.

### *Many of the Technologies Needed are Not Available*

The following are examples of technologies that would be needed to meet the “net zero” goals, but are not ready yet:

- Cellulosic ethanol as vehicle fuels
- Electrification of long-distance trucks (“semis”)
- Electrification of commercial aircraft
- Grid-scale electricity storage in batteries
- Hydrogen produced from renewables
- Large-scale tidal power
- Production of petrochemical products without hydrocarbon feedstocks
- Recovery of carbon dioxide from the atmosphere

No one can predict when, or even if, the technologies listed above will reach the stage of commercial viability, let alone wide-scale commercial acceptance.

### *The Costs to Consumers and the Economy would be Unacceptably High*

Surprisingly, we do not know the likely full financial and economic costs of reducing emissions or of foregoing the economic benefits of continued reliance on the use of affordable and plentiful energy sources. All we have is anecdotal evidence about the costs of the measures drawn from a wide range of sources. The largest of these costs so far in Canada has been the loss in value of the energy and mining projects cancelled due directly and indirectly to climate policies - \$196 billion over the 2014 to 2019 period.

The industries most likely to be affected in future are in petroleum, petrochemicals, mining, metal refining and fabrication, cement, steel, pulp and paper, and vehicle and parts manufacture. In other words, **climate policies threaten to accelerate the**

**deindustrialization of the Canadian economy and eliminate our most productive and economically viable resource industries, imposing great harm on the regions now dependent on them.**

*The World Cannot Produce the Materials Needed for Such a Transition in the Timeframes Proposed*

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In May 2021 the International Energy Agency (IEA) issued a report on “*The Role of Critical Minerals in Clean Energy Transitions*”. The IEA projected that the demand for key minerals such as lithium, graphite, nickel and rare-earth minerals would explode, rising by 4200 percent, 2,500 percent, 1,900 percent and 700 percent respectively, by 2040. The world does not have the capacity to meet such demand and there are no plans to fund and build the necessary mines and refineries.

*The Costs and Changes in Standards of Living Involved Would not be Accepted by Western Countries under Democratic Systems of Government*

There are no precedents for governments of democratic countries imposing on their citizens costs as high as those that would be entailed in net zero policies. Even in countries governed by totalitarian regimes, as in the former Soviet Union, Nazi Germany and today’s China, where governments imposed central planning and absolute state control, no country has sought to force the implementation of comprehensive changes where the results of the changes were known from the outset to sharply diminish the incomes and standards of living of the people governed.

*The Non-OECD Countries Will Continue to Place their Economic Development Objectives Ahead of Emissions Reduction*

By 2050, the world population is projected to grow by more than two billion people. Almost all of that growth will occur in Asia and Africa which, by 2050, will hold 80% of the world’s population. Emerging markets (E7) could grow around twice as fast as advanced economies on average. The billions of people living in those regions cannot, and will not, be constrained from making sensible economic choices by the climate policy preferences of those in the west who already enjoy high incomes and living standards. The global dog will not be wagged by the ever smaller G7 tail.

## **Conclusion**

The political impetus behind the net zero emissions goal in western countries must contend, sooner or later, with the combined economic, technological and political barriers to global decarbonization. The western world can proceed on a path by which it progressively reduces its industrial capacity and incomes, transferring economic activity and emissions to the countries of Asia and elsewhere. It cannot, even by the most drastic and authoritarian measures, unilaterally end the growth in fossil fuel use or emissions. One can only wonder what will happen when the majority of people in western countries comes to realize this.

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## Why “Net Zero” is Neither Possible nor Desirable

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### What Does “Net Zero” Greenhouse Gas Emissions Mean?

Several western governments have committed their countries to have “net zero” greenhouse gas emissions in future. The deadline for meeting this arbitrary target is often the year 2050, but other target years have been used. The term is sometimes applied to the emissions from only electricity generation and sometimes to emissions from all parts of the economy. “Decarbonizing” an entire economy would mean virtually eliminating the use of all oil, natural gas and coal used to provide energy services like heat, light, motive power, and all the thousands of uses of electricity. Where these fuels continue to be used, the resulting emissions would theoretically be “netted out” through purchasing various “offsets” bought from low-emission sources elsewhere. In some cases, countries envisage the building of projects that involve the capture and geological storage of carbon dioxide or projects that withdraw carbon dioxide from the atmosphere.



*Climate activists and many policymakers or citizens have not considered how difficult it will be to achieve NetZero.  
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### The Barriers

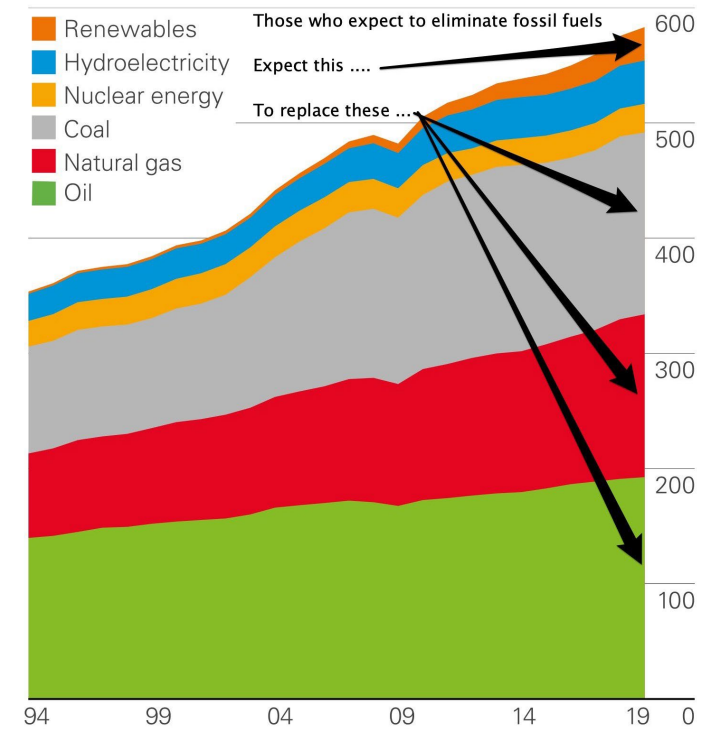
In this note, I will explain why achieving net zero for an entire economy would face insuperable technical and cost barriers and demand unacceptable political changes for democratic societies.

As context, one should be aware that, according to the British Petroleum Statistical Review of World Energy 2020, 84% of the primary energy needs of the world are now met by oil, natural gas and coal.<sup>1</sup> These energy sources have the combined advantages of having relatively high levels of energy density by volume and being affordable, accessible, and easy to transport and store. This is why they have been the basis of economic prosperity since the beginning of the industrial revolution and especially since the early 20<sup>th</sup> century. Most of the 16% of the world’s energy needs not supplied by fossil fuels are met by nuclear and

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<sup>1</sup> <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2020-full-report.pdf>

hydroelectric energy sources. Five per cent are met by 'renewable' energy – 3% from biomass and 2% from wind and solar energy. Net zero, as defined by its proponents, involves no expansion of nuclear energy, but instead increasing the uses of renewable energy entirely to replace the 84% of energy supplied by oil, natural gas and coal, and doing this in less than 30 years.



### *Many of the Technologies Needed are Not Available*

Technologies develop through a series of stages that start with initial research, discovery of the basic science and of the means of applying it in practice, testing and demonstration, initial commercial applications, marketing, and widespread commercialization based upon consumer acceptance. Each of these steps involve risks and there is no certainty that a new idea, once proven in the laboratory, will be successfully applied and marketed given the competition from other ideas in the marketplace. Governments can try to “pick winners”; indeed, there is a long history of government trying, and failing, to do so at great taxpayer expense.<sup>2</sup> The following are examples of technologies that would be needed to meet the “net zero” goals, but are not ready yet:

- Cellulosic ethanol as vehicle fuels<sup>3</sup>
- Electrification of long-distance trucks (“semis”)
- Electrification of commercial aircraft<sup>4</sup>

<sup>2</sup> <https://www.fraserinstitute.org/article/let-market-not-government-pick-winners-and-losers>

<sup>3</sup> <https://www.scientificamerican.com/article/how-a-government-program-to-get-ethanol-from-plants-failed/>

<sup>4</sup> <https://www.smithsonianmag.com/innovation/why-arent-there-electric-airplanes-yet-it-comes-down-batteries-180970909/>



- Grid-scale electricity storage in batteries<sup>5</sup>
- Hydrogen produced from renewables<sup>6</sup>
- Large-scale tidal power<sup>7</sup>
- Production of petrochemical products without hydrocarbon feedstocks
- Recovery of carbon dioxide from the atmosphere<sup>8</sup>

No one can predict when, or even if, the technologies listed above will reach the stage of commercial viability, let alone wide-scale commercial acceptance.

### *The Costs to Consumers and the Economy would be Unacceptably High*

The proponents of net zero policies often pay little attention to the financial and economic costs of reducing emissions or of foregoing the economic benefits of continued reliance on the use of affordable and plentiful energy sources. In fact, surprisingly, we do not know either the actual costs or the likely future costs, only that they will be very high. The most comprehensive list of programs now implemented by the federal and provincial governments in Canada is the one published in the federal government's biennial report to the United Nations.<sup>9</sup> That report, however, offers only a short description of the measures and an estimate of how much they will all reduce emissions by 2030. It does not include the costs of the measures, any evidence as to their cost-effectiveness or any indication of the degree of duplication and overlap among them. The result is that all we have is anecdotal evidence about the costs of the measures drawn from a wide range of sources.



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I can illustrate some of the costs that have already been incurred in Canada, even though Canadians have in many respects only yet experienced a small portion of the costs that would be required to reach net zero:

<sup>5</sup> <https://www.thegwpf.org/content/uploads/2019/02/GridStorageWeb-1.pdf>

<sup>6</sup> <https://www.thegwpf.org/green-haste-will-trash-the-promise-of-hydrogen/>

<sup>7</sup> [https://e360.yale.edu/features/will\\_tidal\\_and\\_wave\\_energy\\_ever\\_live\\_up\\_to\\_their\\_potential](https://e360.yale.edu/features/will_tidal_and_wave_energy_ever_live_up_to_their_potential)

<sup>8</sup> <https://privatebank.jpmorgan.com/content/dam/jpm-wm-aem/global/cwm/en/insights/eye-on-the-market/future-shock-jpmwm.pdf>

<sup>9</sup> <https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/fourth-biennial-report-climate-change.html>

- Costs to taxpayers of over 300 existing federal and provincial government programs to reduce emissions, including contributions for mass transit infrastructure – never officially costed, but at least \$10 billion per year
- Costs to consumers of carbon dioxide taxes - \$6.6 billion in 2021-2022, rising to at least \$28 billion per year in 2030, and more after that
- Costs of ratepayer subsidies to renewable energy for power generation – not costed across Canada, but \$4 billion per year in Ontario<sup>10</sup> and due to rise sharply in Alberta and Saskatchewan
- Cost of pipeline restrictions on market access for Canadian oil producers - \$14 billion<sup>11</sup>
- Cost of energy and mining projects cancelled due directly and indirectly to climate policies - \$196 billion over the 2014 to 2019 period<sup>12</sup>
- Cost of foregone investment in Canadian hydrocarbons industry due to climate policy – no authoritative estimate, but probably in range of \$100 billion per year

The combined effect of increasing carbon dioxide taxes, the Clean Fuel Standard, and various emissions ceilings and credit trading programs are high and escalating over time. Past studies by several economic think tanks have pointed out that these costs will increasingly expose firms operating in the emissions-intensive and trade-exposed sectors to competitive pressures that will undermine their viability and lead many to close and/or move their operations to other jurisdictions.<sup>13</sup> The industries most likely to be affected are in petroleum, petrochemicals, mining, metal refining and fabrication, cement, steel, pulp and paper, and vehicle and parts manufacture. In other words, climate policies threaten to accelerate the deindustrialization of the Canadian economy and eliminate our most productive and economically viable resource industries, imposing great harm on the regions now dependent on them.

Almost half of Canada's GHG emissions arise from economic activity in Alberta and Saskatchewan. The petroleum industry, largely centred in those provinces, provided \$500 billion in revenues to federal, provincial and municipal governments over the period 2000-2018, with the provincial governments being the principal beneficiaries.<sup>14</sup> This does not include the incomes and taxes paid by people employed in the petroleum industry. According to some estimates, the "deadweight loss" of halting forever production from the oil sands industry would be about \$9 trillion. The loss of the petroleum industry would undeniably deal a devastating blow to the western Canadian and Newfoundland economies and create conditions in which it would be increasingly difficult to attract investment for newer industries. The loss of emissions-intensive and trade-exposed firms across Canada would similarly have seriously negative effects, especially in rural areas where there are many one-industry towns.<sup>15</sup>

<sup>10</sup> <https://coldair.luftonline.net/2020/05/consequences-of-ontarios-green-energy.html>

<sup>11</sup> <https://context.capp.ca/articles/2021/feature-high-cost-of-no-pipelines/>

<sup>12</sup> <https://www.secondstreet.org/2019/06/04/new-report-shows-billions-in-missed-natural-resource-opportunities/>

<sup>13</sup> <https://www.conferenceboard.ca/e-library/abstract.aspx?did=10485>

<sup>14</sup> <https://energy-information.canada.ca/en/subjects/energy-and-economy>

<sup>15</sup> <https://blog.friendsofscience.org/wp-content/uploads/2019/12/CLIMATE-POLICY-AND-RURAL-CANADA-Final-Dec-15-2019.pdf>



The costs to individual households would also be very high. Prohibiting the sale of internal combustion engine vehicles would raise the cost of vehicle ownership by at least \$10,000 per unit, not counting the cost of purchasing and installing home rechargers. It would also make it very difficult for many people living in multi-unit buildings to have access to a recharger. Full electrification of the light duty vehicle fleet would require the addition of up to 10,000 megawatts of additional electricity generation capacity (probably impossible) and thus sharply raise the cost of electricity to fuel vehicles.<sup>16</sup> Much increased reliance on wind and solar generation sources without thermal generation backup would require much increased use of battery storage at rates up to ten times those experienced today, and with much reduced security and reliability of supply. The implementation of a mandatory net zero building code by 2030 could add up to \$100,000 to the cost of constructing a new house, and the effects of such a code would be worsened if governments attempt to impose it through retrofits to existing buildings. If governments seek to force the electrification of all transportation modes, the elevated costs of freight movement (at least double current levels) would make food and other goods far more expensive. Through requiring airlines to purchase offset credits and to use scarce biofuels, governments will drive the costs of air freight and passenger flights to unprecedented levels and make it prohibitively expensive for many to travel internationally. The list of products and services whose cost will increase is endless.



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The above cost estimates are almost certainly conservative. Canada is on the same path in terms of climate policy measures as the European Union (EU), but not so far along. The cost of EU climate policies is now more than two percent of the EU's economy, or about US \$400 billion per year; indeed, about 20% of the EU budget is now being spent on climate policies.<sup>17</sup> If the European Union maintains its current climate promises for 2050, it alone could end up paying more than US \$2.5 trillion per year in climate policy costs, 10% of its entire GDP. This is more than all of the EU's current spending on education, health, environment, housing, defence, police and courts.<sup>18</sup>

### *The World Cannot Produce the Materials Needed for Such a Transition in the Timeframes Proposed*

Mark Mills of the Manhattan Institute has written a series of brilliant articles in which he has examined the physics of fueling society, including the potential for wind, solar and

<sup>16</sup> <https://blog.friendsofscience.org/wp-content/uploads/2019/05/ELECTRIC-VEHICLE-CONSIDERATIONS-4.pdf>

<sup>17</sup> Bjorn Lomborg, *False Alarm*, Hachette Book Group, Inc. New York, 2020

<sup>18</sup> Ibid

biomass energy sources to meet the energy requirements now met by conventional energy sources. One of his best articles<sup>19</sup> elaborated in considerable detail on the material realities of green energy:

- *“Building wind turbines and solar panels to generate electricity, as well as batteries to fuel electric vehicles requires, on average, more than 10 times the quantity of materials, compared with building machines using hydrocarbons to deliver the same amount of energy to society.*
- *A single electric car contains more cobalt than 1,000 smartphone batteries; the blades on a single wind turbine have more plastic than 5 million smartphones; and a solar array that can power one data center uses more glass than 50 million phones.*
- *Replacing hydrocarbons with green machines under current plans – never mind aspirations for greater expansion – will vastly increase the mining of various critical minerals around the world. For example, a single electric car battery weighing 1,000 pounds requires extracting and processing some 500,000 pounds of materials. Averaged over a battery’s life, each mile of driving an electric car ‘consumes’ five pounds of earth. Using an internal combustion engine consumes about 0.2 pounds of liquids per mile.*
- *Oil, natural gas and coal are needed to produce the concrete, steel, plastic and purified minerals used to build green machines. The energy equivalent of 100 barrels of oil is used in the processes to fabricate a single battery that can store the equivalent of one barrel of oil.”*

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In May 2021 the International Energy Agency (IEA) issued a report on *“The Role of Critical Minerals in Clean Energy Transitions”*.<sup>20</sup> While offering a somewhat optimistic account of the long-term availability of minerals to accommodate the “transition”, it provided evidence of how extremely difficult and problematic it will be to attain the needed materials in the timeframes envisaged by advocates of net zero.

The IEA projected that the demand for key minerals such as lithium, graphite, nickel and rare-earth minerals would explode, rising by 4200 percent, 2,500 percent, 1,900 percent and 700 percent respectively, by 2040. The world does not have the capacity to meet such demand and there are no plans to fund and build the necessary mines and refineries. In addition, sharp increases in demand for these metals will raise commodity prices, which in turn will raise the prices of many other goods and accelerate inflation. It takes over 16 years for mining projects to go from discovery to first production (assuming environmental assessment processes and environmentalists’ legal challenges do not halt them along the way). If countries started tomorrow, new production for these materials might begin after 2035. This places into context the claims by the governments that they will have carbon-dioxide-free electricity by 2035. In fact, unless there are major increases in the discovery and development of new mineral resources, it appears highly unlikely that the materials requirement associated with currently-identified alternatives to fossil fuel use, can be met in the foreseeable future.

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<sup>19</sup> Mark Mills, *Mines, Mineral, and “Green” Energy: A Reality Check*, July 9, 2020

<sup>20</sup> <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions>

The Institute for Energy Research, in commenting on the IEA report, noted that the production of “green” energy materials is energy intensive, and that trend is increasing.

*“In recent years, ore quality has fallen across a range of commodities. For example, the average copper ore grade in Chile declined by 30 percent over the past 15 years. Extracting metal content from lower-grade ores requires more energy, high production costs, and more greenhouse gas emissions and waste volumes. The IEA data show that, depending on the location and nature of future mines, the emissions from obtaining these materials could wipe out much or most of the emissions saved by driving electric cars.”<sup>21</sup>*

*The Costs and Changes in Standards of Living Involved Would not be Accepted by Western Countries under Democratic Systems of Government*

There are no precedents for governments of democratic countries imposing on their citizens costs as high as those that would be entailed in net zero policies. Even in countries governed by totalitarian regimes, as in the former Soviet Union, Nazi Germany and today’s China, where governments imposed central planning and absolute state control, no country has sought to force the implementation of comprehensive changes where the results of the changes were known from the outset to sharply diminish the incomes and standards of living of the people governed.

Some climate action proponents, like former Bank of Canada Governor Mark Carney, celebrate that recent events have laid the groundwork for extensive government controls. In response to the COVID-19 virus, governments in western countries have been able to impose major restrictions on people’s lives. While the virus is real and dangerous, it might be argued that a calculated exploitation of people’s fears has been effective in persuading free people to accept restrictions on their lives that would have seemed impossible only a few years ago. Whatever lessons aspiring autocrats may draw from the COVID experience, it would be far more difficult to control a population if the prospect were for sacrifices to be endured for the foreseeable future.

Public opinion surveys consistently show that, while at least half the population in western countries believe that humans emissions have some role in causing climate change and that the results may be harmful, the vast majority are unwilling to pay more than \$100 per year to avoid those changes. The reality, of course, is that in most western countries, and certainly in Canada, the average person is already paying far more than \$100 per year in costs and lost income due to climate policies. The questions, therefore, are how high the costs will have to rise, how much individual freedom and choices will have to be compromised, and how visible these changes must be before the adverse political reaction forces a change in the current movement towards central planning.

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<sup>21</sup> [http://www.wsj.com/articles/bidens-not-so-clean-transition-11620752282?mod=opinion\\_lead\\_pos5](http://www.wsj.com/articles/bidens-not-so-clean-transition-11620752282?mod=opinion_lead_pos5)

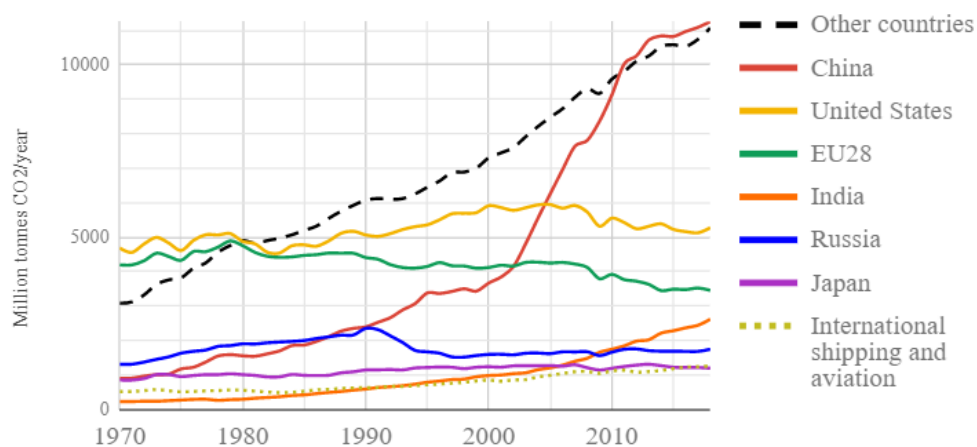
## *The Non-OECD Countries Will Continue to Place their Economic Development Objectives Ahead of Emissions Reduction*

Of all the reasons why global net zero emissions goals cannot be met, this is the most irrefutable.

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According to the British Petroleum Statistical Review of World Energy 2020, global carbon dioxide emissions rose from 29.7 billion tonnes in 2009 to 34.2 billion tonnes in 2019, a 15% increase. The countries of the Organization for Economic Cooperation and Development (OECD) reduced their emissions. However, by 2019, the non-OECD region produced 65% of the world's emissions. Non-OECD emissions growth over the last 11 years was almost 10 times the reduction in emissions achieved at great cost by the OECD countries. The Asia/Pacific region as a whole is clearly the "leader" in determining emissions trends; the United States, with less than 15% of global emissions, is at best a bystander, as is Europe, with only 12% of global emissions.

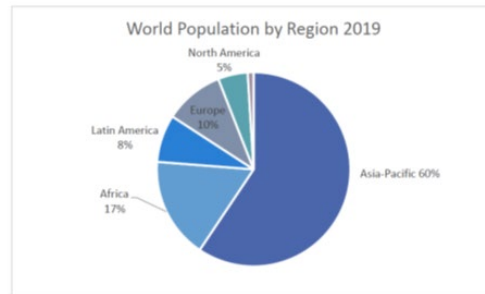
World fossil carbon dioxide emission 1970-2018



[https://commons.wikimedia.org/wiki/File:World\\_fossil\\_carbon\\_dioxide\\_emissions\\_six\\_top\\_countries\\_and\\_confederations.png](https://commons.wikimedia.org/wiki/File:World_fossil_carbon_dioxide_emissions_six_top_countries_and_confederations.png)  
Tomastvivlaren, CC BY-SA 4.0 <<https://creativecommons.org/licenses/by-sa/4.0/>>, via Wikimedia Commons

Many people, especially in Europe and North America, may not be aware that their combined populations are only 15% of the world's total, that the population of Africa exceeds that combined total and that the population of Asia is four times that large. Based on the analysis of the United Nations population agency, the regional populations and their differences are about to change considerably during the early adulthood of a child born today. By 2050, the world population is projected to grow by more than two billion people. Almost all of that growth will occur in Asia and Africa which, by 2050, will hold 80% of the world's population.

The population of Europe is projected to decline by about 37 million, largely due to depressed birth rates. In fact, the combined population of Europe and North America will be only 11% of the world total.



Many people, especially in Europe and North America, may not be aware that their combined populations are only 15% of the world's total, that the population of Africa exceeds that combined total and that the population of Asia is four times that large.

There will be similar trends in economic growth. In a 2017 report, Price Waterhouse Cooper offered some insights into how the global economy might change by 2050.<sup>22</sup> The report was based on growth projections for 32 of the largest economies in the world, accounting for 85% of world GDP. Notably, the world economy could more than double in size by 2050, far outstripping population growth, due to continued technology-driven productivity improvements. Emerging markets (E7) could grow around twice as fast as advanced economies on average. (The E7 countries are China, India, Brazil, Russia, Indonesia, Mexico and Turkey. The G7 countries are the United States, Germany, Japan, the United Kingdom, France, Italy and Canada.) As a result, six of the seven largest economies in the world are projected to be emerging economies in 2050 led by China, India and Indonesia.

The enormous growth anticipated will mean that there will be a demand for all sources of energy supply. In many cases, but especially in most of Asia, the Middle East and Africa, that means continued and increased use of coal, oil and natural gas. The billions of people now living in those regions and the billions more who will be born there in the next 30 years cannot, and will not, be constrained from making sensible economic choices by the climate policy preferences of those in the west who already enjoy high incomes and living standards. The global dog will not be waged by the ever smaller G7 tail.

The advocates of net zero were pleased when the COVID-19 pandemic, and governments' response to it, so depressed the world economy that there was a 6% reduction in GHG emissions in 2020. They felt confident that, through their proposals to "build back better" (i.e., according to their vision), global energy use and emissions would continue to shrink. In fact, according to the May 2021 reports of both the International Energy Agency and the US Energy Information Administration, global oil consumption is forecast to rise by 5.4 million barrels per day (mb/d) in 2021. Further, global oil demand will "soar" from 93.1 mb/d in the first quarter of 2021 to 99.6 mb/d by year end and reach 101.4 mb/d in 2022. Global natural gas demand, which declined in 2020, is expected to recover in 2021, and rise to 1.3% above 2019 levels. Coal, the most carbon-intensive of the major fuels, is rebounding strongly in 2021, with global demand projected to rise 4.5%, and return to

<sup>22</sup> *The Long View: How will the global economic order change by 2050?*, PC, February 2017



2019 levels. The global trends clearly are being driven by economic development in the non-OECD countries, ignoring the policy preoccupations of elites in western countries.

## Conclusion

There is no question that political elites in many western countries are committed to imposing ever-more-expensive and intrusive measures to reduce GHG emissions, and that this commitment is aided and supported by the mainstream media and powerful, well-funded business and environmental organizations. To the general public in Canada, the political impetus behind the net zero goal seems like an irresistible force. Yet, as I hope I have shown here, that force must contend, sooner or later, with the combined economic, technological, and political barriers to global decarbonization. The western world can proceed on a path by which it progressively reduces its industrial capacity and incomes, transferring economic activity and emissions to the countries of Asia and elsewhere. It cannot, even by the most drastic and authoritarian measures, unilaterally end the growth in fossil fuel use or emissions. One can only wonder what will happen when the majority of people in western countries comes to realize this.

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## About The Author

**ROBERT LYMAN** is an economist with 27 years' experience as an analyst, policy advisor and manager in the Canadian federal government, primarily in the areas of energy, transportation, and environmental policy. He was also a diplomat for 10 years. Subsequently he has worked as a private consultant conducting policy research and analysis on energy and transportation issues as a principal for Entrans Policy Research Group. He is a frequent contributor of articles and reports for Friends of Science, a Calgary-based independent organization concerned about climate change-related issues. He resides in Ottawa, Canada. [Full bio.](#)

## About Friends of Science Society

Friends of Science Society is an independent group of earth, atmospheric and solar scientists, engineers, and citizens that is celebrating its 19th year of offering climate science insights. After a thorough review of a broad spectrum of literature on climate change, Friends of Science Society has concluded that the sun is the main driver of climate change, not carbon dioxide (CO<sub>2</sub>).

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