Clean Electricity Standard

Delusion vs Reality

4/15/22

Contents

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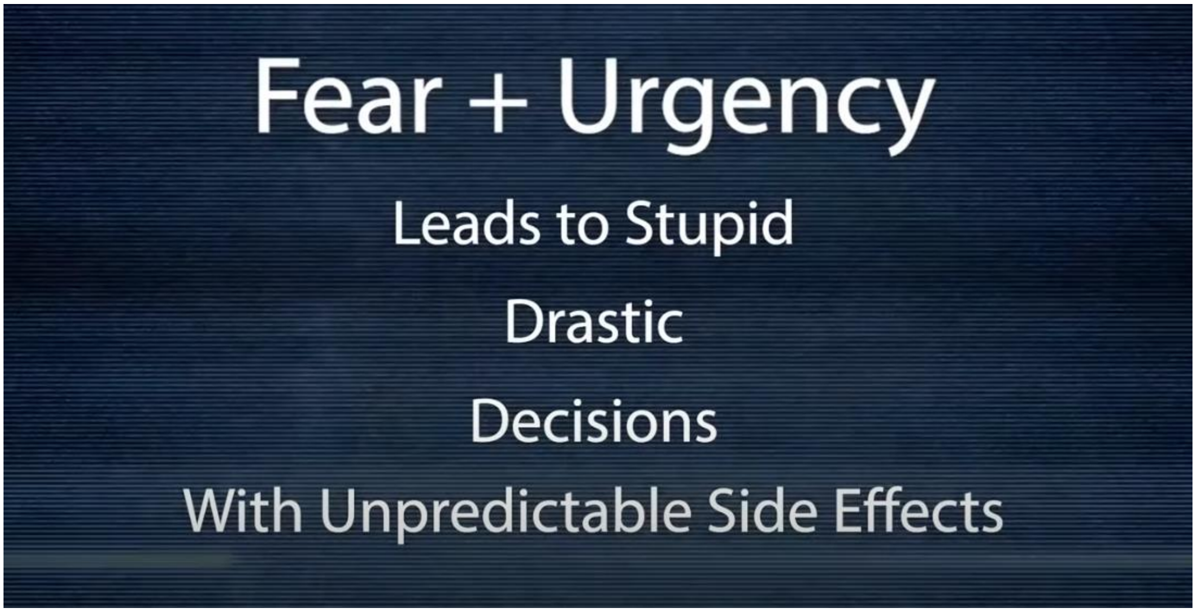
Reality vs Delusion

Net Zero 2030 Clean Electricity Standard



Hans Rosling. Factfulness.

The Government of Canada proposes drastic changes in Canada's electricity generation to meet NetZero 2030 targets. The basis for the short time frame and urgent push comes from the Intergovernmental Panel on Climate Change (IPCC) Special Report on 1.5 degree warming (IPCC SR1.5), published in 2018.

Indeed, at the time of publication of IPCC SR1.5, various climate activists began claiming that the world only had 12 years left before a climate catastrophe ensued, despite the fact that co-chair of the report and various other scientists and scholars stated that this was not the case and the panel "did not say we have 12 years left to save the world."

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from the work of hundreds of scientists, uses 2030 as a prominent benchmark because signatories to the Paris agreement have pledged emission cuts by then. But it's not a last chance, hard deadline for action, as it has been interpreted in some quarters.

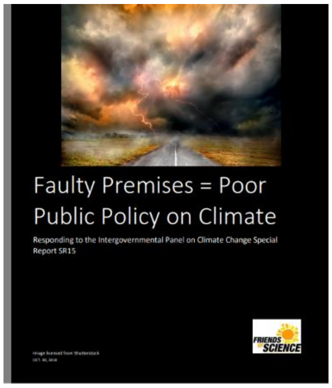
"Glad to clear this up," James Skea, co-chairman of the report and professor of sustainable energy at Imperial College London, told The Associated Press. The panel "did not say we have 12 years left to save the world."

He added: "The hotter it gets, the worse it gets, but there is no cliff edge."

"This has been a persistent source of confusion," agreed Kristie L. Ebi, director of the Center for Health and the Global Environment at the University of Washington in Seattle. "The report never said we only have 12 years left."

Consequently, before turning Canada's electrical power grids upside down, perhaps we should review the differences in findings of the IPCC SR1.5 report of 2018, and the most recent IPCC AR6 Working Group I (Physical Sciences) report of the summer of 2021, which has surprisingly good news.

Faulty Premises = Poor Public Policy on Climate – Overview



In response to the IPCC SR1.5 report, Friends of Science Society issued "Faulty Premises = Poor Public Policy on Climate".

Video overview: https://youtu.be/dITM8ufTItU

Climate science is a complex blend of chaotic, dynamic systems. The recent Intergovernmental Panel on Climate Change (IPCC) Summary Report 15 (SR15) attempts to predict the implications of a 1.5°Celsius (C) rise in Global Surface Mean Temperatures (GSMT) over the temperature of the pre-industrial era. The focus of the report is on the influence of human industrial emissions of carbon dioxide as the assumed driver of climate change and recent warming. Despite the number of scientists involved, science can go astray for no other reason than a singular focus through 'the same lens.'

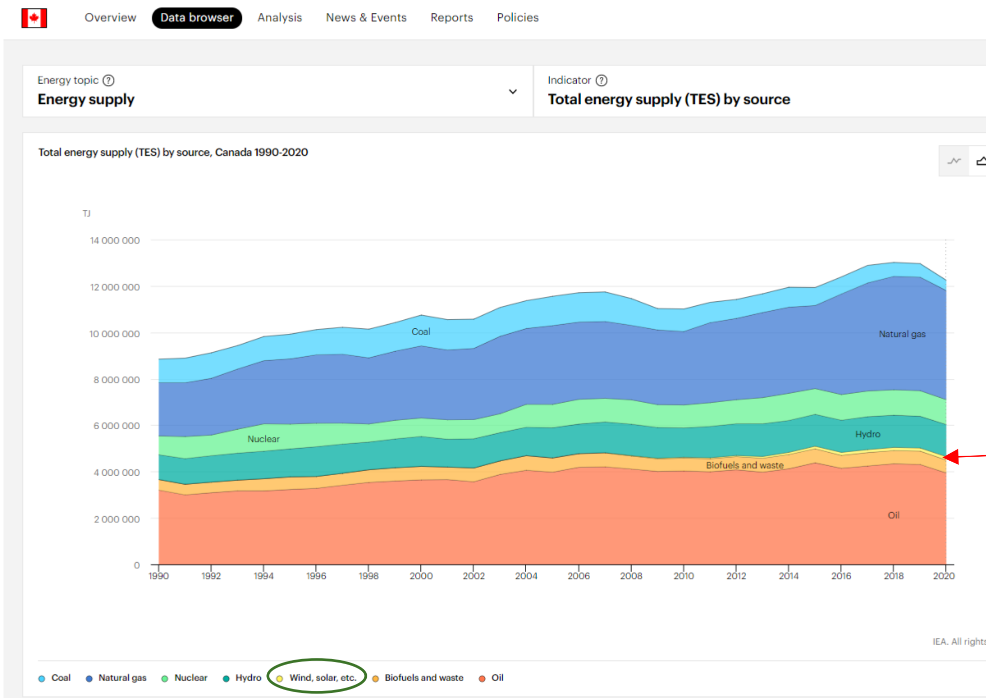
Friends of Science Society is critical of the IPCC SR15 report, pointing out the following:

1. We are in the Meghalayan, not the Anthropocene. The IPCC SR15 report claims to view climate change through "the lens of the Anthropocene." This term is popularly used to describe a modern geological period wherein humans are assumed to have a larger impact on the world than nature. On July 13, 2018, the International Union of Geological Sciences (IUGS) issued a statement that the earth is now in the Meghalayan, a period that began 4,200 years ago. In response to questions as to why the term "Anthropocene" had not been included, at least for the past 50 years of presumed human influence, the IUGS responded that the term "Anthropocene" has not even been submitted for consideration and that the term has only sociological, not scientific relevance. The IPCC should not use this 'lens.'
2. All climate models (simulations) used by the IPCC run 'too hot' versus observations. The computer simulations project future warming (thus being the rationale for global warming climate policies) show significantly higher temperatures than what is being observed. Only the Russian climate model and satellite/weather balloon data closely match present temperatures in the lower troposphere. This suggests that most climate models ascribe too great an effect of warming (climate sensitivity) to carbon dioxide. This means the climate models should not be used to set public policy.
3. No temperature can be accurately measured to a precision of less than ±0.1°C. Global temperature data is a metric of averaged and adjusted data from many sources, suggesting that a 0.5°C difference in temperature is moot and an arbitrary figure. It does not reference an actual measurement of earth's temperature; people are being misled.
4. The IPCC claims, in its founding principles, to be policy neutral. However, the IPCC SR15 makes many recommendations regarding Carbon Dioxide Removal Systems (CDRS), most of which are untested and unvetted and proposed with no cost-benefit analysis. Such recommendations are contrary to the purpose of the IPCC and should be disregarded by policymakers. The IPCC should simply report on scientific findings.

5. Rapid decarbonization is impossible and unrealistic as proposed by the IPCC. The world runs on more than 80% fossil fuels for energy; all other forms of power generation, including hydro, nuclear, wind and solar are completely reliant on fossil fuels for their creation. Millions of people would die if rapid decarbonization was implemented. There is no suitable, equitable alternative to fossil fuel energy for modern society. Any official, international body of scientists who are recommending a course of action leading to mass deaths should be disbanded.
6. There is no clear evidence that the changes or warming since the mid-1800s are caused by human use of fossil fuels (86%+ of human emissions have occurred after 1950) – though indeed there has been some warming and various perceptible changes in some natural features. Indeed, the range of climate change discussed falls well within natural variation since 1850. Likewise, global temperature records are incomplete, inconsistent, methods/placement of monitoring stations have changed, and temperatures are not monitored at equidistant places at the same time. The validity of the Global Average Surface Temperature is imprecise.
7. The proposed remedies of wind and solar increase carbon dioxide and cause warming. Rather than reduce fossil fuel use or aid in carbon dioxide reduction, wind and solar in fact require vast quantities of fossil fuels for production, installation, and natural gas back-up – resulting in an increase in carbon dioxide. Wind and solar are ineffective, expensive and cause power grids to destabilize, putting society at risk, harming industry, jobs, and consumers through heat-or-eat poverty. The devices are made of bonded materials and are largely unrecyclable. Wind and solar are contrary to sustainability and environmental goals.
8. Extreme weather events are an integral part of climate. The IPCC's AR5 report and their SREX special report on extreme weather both make it clear that human effects on climate are not deemed to increase extreme weather events; neither is an increase of carbon dioxide. The IPCC should clarify this with the media rather than allowing the press to engage in terrifying hyperbole.
9. Extremely disproportionate cost-benefit ratio should dissuade policy makers and citizens from following IPCC SR15 recommendations on carbon pricing. The cost of emissions reduction in 2030 is about 95 times the benefit assuming the climate sensitivity to CO2 from the climate models. When using the Lewis and Curry 2015 climate sensitivity estimate determined from measurements, the cost of emissions reduction in 2030 is about 210 times the benefit, however this estimate doesn't account for natural climate change. Using the best economic model that includes benefits of warming and CO2 fertilization of crops, and accounting for the natural warming from 1850, each $880 spent on mitigating a tonne of CO2 would prevent a net benefit of $8, increasing the loss to $888 per tonne of CO2 mitigation. Indeed, Dr. Judith Curry notes that carbon reduction efforts to 'stabilize climate' may be futile in the face of natural climate change.
10. The science is not settled. Anderegg et al (2010)[1] revealed that 34% of IPCC contributing authors disagreed with the IPCC declaration on human influence on climate. Hundreds of other scientists have disputed IPCC findings on human-causation in peer-reviewed papers, books, blogs and videos. There is inadequate scientific review by the IPCC of the Nongovernmental International Panel Climate Change reports. There is limited review of natural forces of the sun and planetary dynamics, and natural internal variability like ocean currents, volcanic eruptions and tectonic activity and its correlation to earth's magnetism (and thus solar influence). Reducing carbon dioxide from human industrial activity is a futile response to the continuous climate changes on earth; adaptation and investment in resilient infrastructure and response is a better use of public funds.

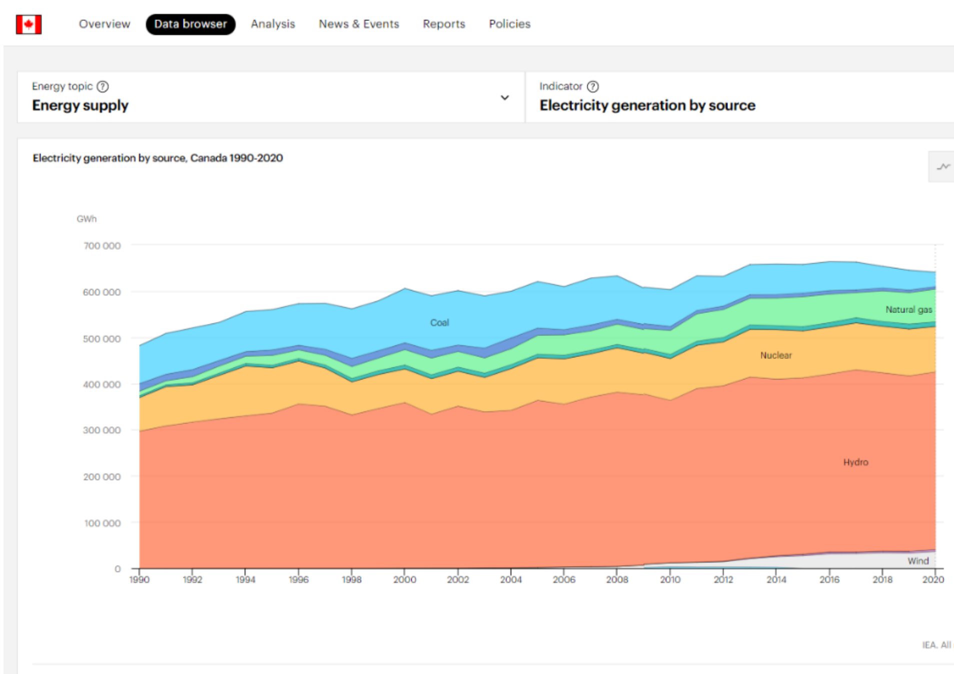
Science is a process of progressive knowledge and insights into how things work. What begins with well-intentioned agreement on aspects of scientific understanding, expands and changes over time with new insights.

Canada’s Total Energy Supply by Source - IEA



Wind, solar, etc.

Canada’s Electricity Supply by Source - IEA



2019
Wind 32,657.0 GWh
Solar PV 4,079.0 GWh
Tide 1.0 GWh

Interactive charts here: https://www.iea.org/countries/canada

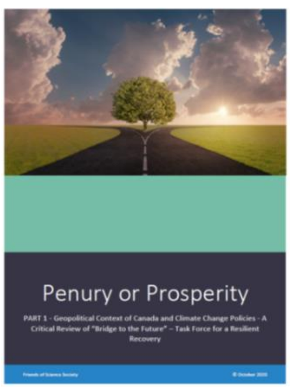
The stated objective of the Clean Electricity Standard, as outlined in the Clean Electricity Standard Discussion Paper is:

"The purpose of this discussion paper is to send a clear signal that the Government of Canada intends to move forward with regulations to achieve a net-zero electricity system by 2035; to outline considerations related to this objective; and to solicit comments from Canadians regarding the scope and design of the CES. While the main objective of this document is to inform and collect feedback regarding the CES, it also welcomes input on other relevant measures that would support the net-zero 2035 target. The treatment of electricity under the current Output Based Pricing System Regulations (OBPSR) will also be reviewed as part of this process."

Based on the evidence in the two charts above, it is clear that a net-zero electricity system is not attainable by 2035, and as will be shown in subsequent materials about renewables (see *"Carmangay Solar Project – Good for Carmangay….Terrible for the Rest of Us")* using carbon pricing, incentives and regulation will distort markets and impoverish the public for no measurable climate or greenhouse gas reduction benefit.

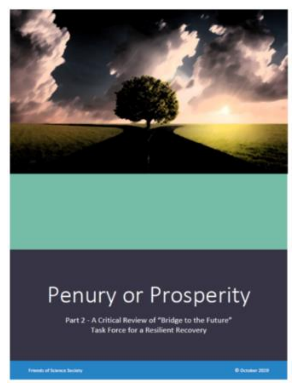
The following materials have been written by Friends of Science Society's team of Professional Engineers and Professional Geoscientists who have working knowledge of the complexities of the electrical power generation industry and the complexities of geothermal. Additional policy insights are offered by energy economist Robert Lyman, a former federal public servant of 27 years, 10 years a diplomat.

Hydrogen – The New Silver Bullet



https://blog.friendsofscience.org/wp-content/uploads/2020/10/Penury-or-Prosperity-Part-2-Critical-Review-Bridge-to-the-Future-Oct-11-2020-Final.pdf

"This is the dream: clean electricity producing clean energy which only produces water when it is consumed, and which will allow diversification with the electric vehicle in case this other illusion does not last long either!" - Prof. Samuel Furfari



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Mark Carney's many blithe public comments on hydrogen as the new NetZero solution have driven a flurry of projects around the world. Hydrogen, when consumed as fuel, leaves only water when consumed. Thus, some see hydrogen fuel cells as the Net Zero replacement for vehicle gasoline and diesel or even aviation fuel; others see hydrogen electrolysis as the ideal method to use wind energy to create energy 'storage' in the form of hydrogen (an extremely energy dense, indeed, highly explosive gas).

Hydrogen does not exist naturally in any quantity in the atmosphere; therefore, it must be 'made' from chemical/fracking or electrolytic processes. These require the use of energy, thus diminishing the energy value of the end product. Hydrogen is difficult to capture and must be stored under extremely high pressure, requiring very specialized metal structures that are also resistant to the metal corroding/embrittling qualities of hydrogen when it reacts with certain metals.

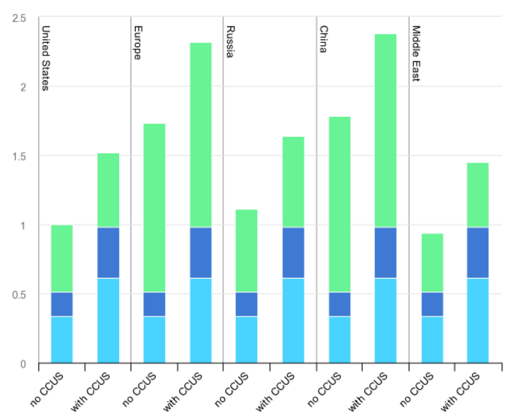
This Dutch engineer's video explains why wind and hydrogen are not the match 'made in heaven' that renewables advocates claim it is to create 'green' hydrogen (as a means of storing wind energy).

Jørgen Henningsen, formerly part of the EU Commission explains the problem of trying to convert wind power into hydrogen as ‘storage’ for later energy use:

“The explanation is quite simple: conversion of electricity, green or not, into hydrogen implies a loss of +/- 30 percent of the energy content of electricity; and whatever subsequent step taken in making the hydrogen into practical use will imply another 30 percent loss (of the 70 percent energy remaining in the hydrogen), altogether leaving us with +/- half the energy in the original electricity being available for useful purposes.”[1]

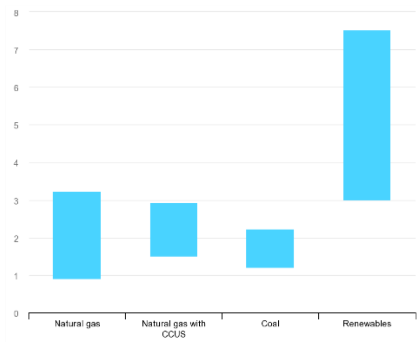
Prof. Samuele Furfari, author of “L'utopie hydrogène” (English version: Hydrogen Illusion) says that: *“Of course, some EU industries will benefit from the windfall of the hydrogen strategy – understand the manipulation of the market by politics – as others did in the biofuels era; they will benefit from guaranteed prices and a green image, of course, at the expense of taxpayers/consumers. It is therefore not surprising that on March 10 this year they entered an alliance with the European Commission, as others did for batteries and biofuels. Moreover, hydrogen is essential for the petrochemistry, but it is not for energy use especially since the subsidised hydrogen is produced from energy. Therefore – unless you want to create a vast smuggling market – hydrogen will be used in chemistry and not as a fuel because – obviously – it has a much higher value as a chemical feedstock than as a fuel. Burning hydrogen to generate energy when hydrogen has been produced by energy is like keeping oneself warm burning Louis Vuitton handbags. Inevitably, any hydrogen produced will end up in chemistry and not in a motor vehicle*.”[2]

In a separate article, Prof. Furfari explains, there is a much more important use for hydrogen – the making of fertilizer for agriculture, so that we can eat. “*Hydrogen is a chemical produced from natural gas in a common and worldwide process called “steam cracking”. This molecule is used extensively by the petrochemical industry and all the chemistry that results from it, mainly for the production of fertilizers. With growing global demographics, the demand for hydrogen for the production of agricultural fertilizers will keep pace with food necessities. This basic molecule, already highly sought after, will become more and more so. Thanks to this real surprise in the geopolitics of energy that is natural gas, its global market is more and more competitive and fluid, which will result in a reduction in its price on international markets.*”



Hydrogen production costs using natural gas 2018 (IEA) (CCUS = Carbon Capture Utilization Storage)

[1] https://euobserver.com/opinion/149089?utm_source=euobs&utm_medium=email
[2] https://www.latribune.fr/opinions/hydrogene-enieme-utopie-de-l-ue-ou-comment-se-chauffer-en-brulant-des-sacs-louis-vuitton-853316.html



Hydrogen production costs by production source (2018) (IEA) Based on the foregoing graphs, it does not look like hydrogen production from renewables will be cost competitive.

On a specific note for the Clean Electricity Standards, while it is *possible* to convert natural gas-fired power generation turbines to use a mix of hydrogen, the costs are astronomical, at 2 to 10 times that of conventional power.

CHALLENGING HYDROGEN ECONOMY

- Low carbon hydrogen fuel costs are trending lower, but are expected to remain 2–10X more expensive than natural gas at least through the end of the decade.
- Carbon taxes or other incentives may improve the economics of hydrogen compared to fossil fuels, but we anticipate that hydrogen will be used in long-haul transportation, maritime shipping, and industry before it is broadly adopted in the power sector.

https://www.ge.com/content/dam/gepower-new/global/en_US/downloads/gas-new-site/future-of-energy/hydrogen-overview.pdf

National East-West Hydro-Wind Grid

Power Generation Information on Difficulties of Instituting the Proposed Wind-Hydro National Grid Network in "Acting on Climate Change"

Technical

Generation Perspective

In "Acting on Climate Change"[3] – a McGill Trottier report issued in spring of 2015, there was a proposal for a Canadian national wind-hydro grid and the McGill Trottier authors claimed it could be implemented by 2035. Friends of Science Society asked the Alberta power generation experts for a discussion of whether or not that would be possible and at what cost. One of the papers cited in support of the east-west grid proposal by Harvey et al.[4] focused on Alberta as a significant wind resource. Here follows the technical discussion.

[3] https://www.mcgill.ca/tispp/files/tispp/acting_on_climate_change.pdf
[4] https://faculty.geog.utoronto.ca/Harvey/Harvey/papers/Harvey%20(2013,%20Wind).pdf

Even if we take it as a given that there is enough wind potential, there are major technical issues with using a national wind/hydro hybrid system to supply all of Canada's power. The biggest problem with wind is that it doesn't respond to demand. In fact, in Alberta it is negatively correlated to peak demand. Our winter peak occurs when there is extreme cold and in these situations, there is ALWAYS an absence of wind. Ontario may be similar but no research on this area has been included in this commentary.

The AESO publishes Long Term Adequacy Metrics to monitor the long term supply of electricity in Alberta. In the adequacy calculations, wind is excluded for the reason mentioned above.
See ww.aeso.ca/downloads/Division_202_-_Section_202-6_Adequacy_of_Supply_(Oct_1_2014).pdf section

4(2)(b)(v) and 4(2)(c)(v) on page 3 for the detail. The methodology "excludes wind" from the calculations.

Currently in Alberta, we consume about 80,000 GWh of electricity per year and wind generation in the province has a capacity factor of around 30%. See pages 19 and 10 here

http://www.aeso.ca/downloads/2014_Annual_Market_Stats_WEB.pdf. In theory, if Alberta were to be self-sufficient on an energy basis, we would need to install over 30 GW of wind turbines. Even with 30 GW of wind capacity, there would be times when wind contributes ZERO to the supply. In these cases we would need to import 100% of our power from other provinces. When the wind is blowing, we would be producing over 3 times as much power as we're consuming. This would mean that we would need to export or spill up to 20 GW of power. "Spill" (lack of use) is a definite possibility as there is no guarantee there would be demand for that much power.

In the Harvey paper, they talk about installing between 18.4 and 25.8 GW of wind in Alberta. This is 31% and 28% respectively of total wind capacity in their plan. This shows how heavily they rely on our province.

Ontario is the other major contributor to their plan with between 45% and 48% of total wind capacity. They also use a capacity factor of 40% for Alberta when in reality it is only 30%. This paper does not review other regions in Canada but they quote higher capacity factors than Alberta, above 50% in some provinces. A few internet searches show that these values may be overly optimistic by at least 10%.

The Harvey paper relies mainly on wind from Alberta and Ontario. Although, as they mentioned, it is true that there are benefits of diversification for wind sources, both provinces experience similar patterns. Higher wind in the winter months and lower in the summer. This can be seen in the AESO Market Statistics above and here for Ontario http://coldaircurrents.luftonline.net/2013/01/monthly-capacity-factor-of-wind.html. It is a certainty that there will be periods when both Alberta and Ontario simultaneously have low or no wind output. In these situations, the vast majority of the country would be entirely dependent on Hydro. Hydro has some flexibility but would not be adequate. A large portion of hydro is run of river and it can't be turned on/off at will. Major blackouts would occur and the consequences would be severe at times of extreme hot or cold temperatures.

In the paper, Section 4.1 Future Research Steps, they talk about looking into wind correlations and hourly demand. The fact that they didn't do this before writing this paper is the fatal flaw. Perhaps if/when they finish their research, reality will set in.

Transmission Perspective

Given the low capacity factor for wind, two to three times as much transmission is needed when compared to conventional generation. In the Harvey paper, they plan on transmitting wind energy across the country using HVDC lines to nodes in major demand centres. They consider only the "HVDC portion of the transmission and distribution system." They ignore the integration of these HVDC lines into existing grids and they also don't consider any transmission reliability issues. Even if we assume that their math for the HVDC lines is correct, they are severely understating the true cost of transmission and distribution.

In Alberta, we spend around $1 million to integrate 1 MW of wind generation. See pages 61 and 62 of Review of the Cost Status of Major Transmission Projects in Alberta

http://www.ucahelps.alberta.ca/documents/ABE_TFCMC_Report_7_WEB_-_June_2014.pdf for

background and costs of "SOUTHERN ALBERTA TRANSMISSION REINFORCEMENT (SATR); PROJECT 787 – To accommodate wind generation in southern Alberta."

In summary, Alberta would need to integrate the 18.4 to 25.8 GW of wind generation in the Harvey paper. HVDC lines would also need to be built across the country and the provinces receiving the power would also need to reinforce their grids. Alberta would also need to reinforce the grid to receive power and get it to load centres when the local wind isn't blowing. The bottom line is Harvey considerably understated the transmission requirements.

Economics

Above it is mentioned how the whole plan is technically infeasible. But if we ignore that fact and pretend it could actually work, we can look at the economics.

The Harvey paper estimates their hybrid wind/hydro plan would be able to supply the entire country at a price of between 4.5 and 6.39 cents per kWh including transmission costs. This is less than the majority of the country pays just for electricity right now and begs the question, if wind energy is so inexpensive, why hasn't this plan already been implemented?

First, Harvey states that power from wind costs between 3.75 and 4.97 cents per kWh. This requires "government-backed utility financing" at 3%. Then he states that private financing is closer to 12% and would essentially double the delivered cost of wind power. The reality is there is no "government-backed utility financing" in Alberta and even Ontario wind is being developed by private investors.

Again, these are the two provinces where he expects most of the wind power to be developed. Also, as discussed above, the transmission costs are likely two to three times higher than he states. The bottom line here is that wind energy in his plan would cost at least double what he is claiming.

If we assume his cost of $2k per kW of wind and that transmission costs are around 35% of wind costs (estimated from Table 1) this would require a capital investment of around $160 to $200 billion. Then, if we actually use realistic transmission assumptions it would likely be around $240 to $380 billion. This is in addition to the existing perfectly good infrastructure that we already have. Where would this money come from?

Philosophical

Canadian society is generally based on free markets, voluntary transactions between people. Harvey's paper is anathema to free markets and describes a philosophy that would obligate society to pay $100's of billions for an energy plan that won't even keep the lights on. **There would also be $100's of billions of stranded generating assets and potentially bankrupt utilities. This would result in a huge loss of wealth to Canada and we would never realize all the positive benefits if the money was invested in productive assets rather than wasted on wind turbines.**

On wind versus conventional generation, the paper discusses how wind resources are vast and "a very small wind farm area in each sector would be sufficient to displace the entire current national fossil fuel-and nuclear-generated electricity." This may be true but it would still be a much, much larger area than conventional generation. Also, large corridors across the entire country would need to be draped in transmission lines. You don't have to read too far in to this website to understand how people really feel about transmission lines https://retasite.wordpress.com/.

The foregoing assessment was written in 2015.

Subsequently, Kent Zehr, Professional Engineer, prepared **"Design Considerations of a Real-World Interprovincial Energy Corridor Transmission Line"**[5]. Zehr assumes technical feasibility in his overview, which is not meant to be comprehensive, but he offers some insights on the potential outcomes and challenges of an east-west grid.

He writes in the introduction:

For more than a decade various proponents, for various reasons, have proposed that a defined energy corridor should be designated from eastern Canada to western Canada. Eastern proponents see this as an opportunity to replace coal fired electricity generation with their apparently abundant hydro and renewable based power. Western proponents see it as an opportunity to construct pipelines allowing oil and gas to be delivered to Eastern Canada.

While there are existing oil and gas pipelines delivering products at least as far east as Ontario, new pipelines farther east have been stymied by political objections for more than a decade now.

On the other hand, there are no, zero, power transmission lines connecting even Ontario to Saskatchewan or Alberta. Thus, no opportunities exist to use electricity sourced from renewables and non-fossil fueled sources in Quebec or Ontario to replace fossil fueled sources in Saskatchewan or Alberta.

This paper examines what such a power transmission line could look like, how it might be built, and some of the electrical characteristics that bear on its eventual utility. Also, important in the real-world sense, construction costs, construction duration, and operating and maintenance costs are estimated. Finally, some assessments of the net benefits of such a line are made.

Contrary to the previous commentator, Zehr sees the project as technically feasible, but **fraught with difficulties**, including rights-of-way, as the proposed corridor would cross several provinces and numerous First Nations reserves; powerline rights-of-way are always subject to long-term negotiations. **Likewise, the cost of such a project would outweigh the alleged benefits.**

*However, the limited capacity of the presented concept for a single transmission line, even though much better than the previously proposed lines, the probable lengthy schedule, and the **very high cost of power delivered, all make even the very idea unacceptable since the purported benefits to society do not outweigh the very significant costs.***

Neither the Harvey paper nor Zehr made any consideration of 'embedded emissions', but these should not be forgotten. If the ultimate goal is to reduce greenhouse gas emissions, any such project must not substantially **increase** embedded emissions in the process of implementing the 'new' method/system or operation, unless those embedded emissions have a nominal life value of one or two years. As an example of a GHG reduction project that outrageously expanded embedded emissions, let us refer to the Portland North Interstate line.

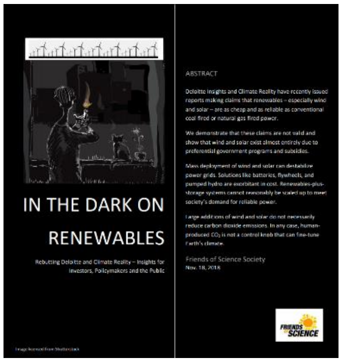
"Portland's North Interstate Rail light rail line is estimated to save about 23 billion British Thermal Units (BTU) per year, while its construction is estimated to have consumed 3.9 TRILLION BTU. It would take 172 years to offset the extra energy needed for construction."[6]

Not only would this exceed the lifespan of the line, but long before 172 years, automobiles are likely to be so energy efficient that light rail will offer no savings at all.

Embedded emissions must be accounted for in all proposals for a Clean Electricity Standard and a full cost-benefit analysis done by Professional Engineers with working experience in the power generation industry.

[5] https://blog.friendsofscience.org/wp-content/uploads/2020/11/Design-Considerations-of-a-Real-World-Interprovincial-Energy-Corridor-Power-Transmission-Line.pdf
[6] https://americandreamcoalition.org/pollution/RailEnergy&GHGs.pdf

In the Dark on Renewables



LINK TO REPORT: In the Dark on Renewables FINAL Nov 18 2018

Video overview: https://youtu.be/l7ZUiz-vQgA

Deloitte Insights and Climate Reality have issued reports (in 2018) making claims that renewables – especially wind and solar – are as cheap and as reliable as conventional coal-fired or natural-gas-fired power.

We demonstrate that these claims are not valid and show that wind and solar exist almost entirely due to preferential government programs and subsidies.

Mass deployment of wind and solar can destabilize power grids. Solutions like batteries, flywheels, and pumped hydro are exorbitant in cost. Renewables-plus-storage systems cannot reasonably be scaled up to meet society's demand for reliable power.

Large additions of wind and solar do not necessarily reduce carbon dioxide emissions. In any case, human-produced CO2 is not a control knob that can fine-tune Earth's climate.

Deloitte Insights, an imprint of Deloitte LLC, recently published a report entitled Global Renewable Energy Trends—solar and wind move from mainstream to preferred.[1] Shortly thereafter, Climate Reality issued an e-book entitled How Renewables Work: A Practical Guide to Wind, Solar and Geothermal.[2] According to Deloitte, wind and solar are now benefitting from three enablers:

The first enabler is that wind and solar are reaching price and performance parity on the grid and at the socket. Second, solar and wind can effectively help balance the grid. Third, new technologies are honing the competitive edge of wind and solar.

As this report "In the Dark on Renewables" shows, these claims are not valid.

The assertion that wind and solar are reaching performance parity on the grid and at the socket ignores the reality that they require nearly equal amounts of conventional power generation to back them up because the wind does not always blow and the sun sets every day. Since wind and solar power generation systems are paired with fossil fuel, nuclear, and/or hydro back-up generation, wind and solar are effectively redundant, which means consumers effectively have to pay for two sets of generators. And while the costs of wind turbines and solar panels may have dropped in recent years, successfully integrating those technologies requires transmission-system upgrades, energy storage systems, and certain technical upgrades that all come at an additional cost.

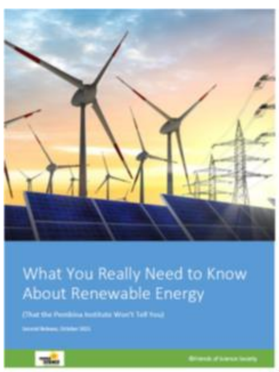
Regarding the claim that wind and solar can effectively help balance the grid, it is true that certain technical advancements can reduce the negative effects that wind and solar have traditionally had on system stability. However, no amount of technical wizardry will allow wind to contribute to system balancing when the wind is not blowing, and no amount of wizardry will allow solar to contribute to grid balancing at 3:00 a.m. local time.

The price parity claim, which is based on a value known as the levelized cost of energy (LCOE), is also invalid. Even if the LCOEs of wind and solar were lower than the LCOEs of conventional generation—a debatable proposition—that does not translate into lower overall costs for consumers. The problem with the LCOE as a cost metric is that it ignores all the peripheral costs of forcing wind and solar onto the grid that were just noted.

According to Climate Reality, the transition to 100% renewable energy systems will be helped along by geothermal energy for heating and cooling. This claim, too, is largely invalid. While geothermal is playing a role—and will continue to play a role—in the world's energy systems, it is simply not capable of replacing traditional heating and cooling systems in all situations or all locations.

The absurdity of the notion that it will now be easy and cheap to convert to 100% renewable energy systems is highlighted by the following chart, which comes from BP's Statistical Review of World Energy.[3] Renewables (excluding hydro), shown in dark orange, accounted for just 3.6% of world primary energy consumption in 2017. Consequently, renewables advocates are effectively suggesting that we can rebuild the world's entire energy system while maintaining the existing one as a backup, and that we can do so in a ludicrously short period while keeping costs low. This is simply not reality.

What You Really Need to Know about Renewable Energy (That the Pembina Institute Won't Tell You) Parts A and B



Unfortunately, climate activists who are not experienced power generation engineers have influenced public opinion and public policy. We offer these insights to help guide you in setting Clean Electricity Standards that will meet the objectives of the safe, reliable, affordable provision of electricity for Canadians.

What You Really Need to Know about Renewable Energy (That the Pembina Institute Won't Tell You) Parts A and B
https://blog.friendsofscience.org/wp-content/uploads/2021/10/Response-to-Pembinas-What-You-Need-to-Know-Parts-A-and-B-Oct-20-2021.pdf

Introduction and Overview

In August 2020, the Pembina Institute published a report titled *Renewable energy—what you need to know*. The report opens with the claim that "There are significant opportunities to supply the majority of Alberta households and industries with reliable, cheap, and clean electricity," and it goes on to say that, "With the falling costs of solar and wind energy, our electricity sector has entered a new reality where renewable generation is the most economical source of new electricity generation for the province." Pembina's so-called "new reality" is a fantasy, and a dangerous one at that. Jurisdictions that have shut down reliable fossil-fueled and/or nuclear generation in favour of wind and solar have seen skyrocketing electricity prices and have faced (or at the time of this writing are facing) severe energy shortages along with consequential economic losses and, sadly, loss of life.

The authors of Pembina's report prove the old adage that a little knowledge is a dangerous thing. Most of their statements contain a modicum of truth, so many Pembina readers may have become convinced that the authors understand the physical and market operations of Alberta's electric power system. Based on Renewable energy and a Pembina document referenced therein titled Baseload myths and why we need to change how we look at our grid, they clearly do not: their analyses ignore critical details, use cherry-picked data, fail to acknowledge the massive and ever-increasing implicit subsidies that Albertans are providing to wind and solar generators, and ignore the crucial role played by fossil-fueled generators—the very generators that many green-energy advocates love to hate—in allowing wind and solar generators to operate in the first place.

This rebuttal of *Renewable energy and Baseload myths* is considerably longer than those two documents. The reason is that refuting false or misleading statements often takes more time and ink than it takes to make the statements in the first place, and that is certainly the case here. The effort is necessary, however, because Pembina receives a large amount of taxpayer and private funding, it uses that funding to produce grossly misleading reports, and then it pushes for government policies based thereon. While Pembina proclaims on its website that "We provide our expertise to industry and government leaders, and we advocate for a strong, science-based approach to policy, regulation, environmental protection and energy development," science and expertise are nowhere to be found in Renewable energy or Baseload myths. Perhaps competent and objective analysis was too much to expect, given that the funders of Pembina's work were the Municipal Climate Change Action Centre, Energy Efficiency Alberta, and Environment and Climate Change Canada. These entities are almost certainly biased in favour of "climate action," and they probably have little or no understanding of what it takes to operate a safe and reliable electric power system.

In addition to being somewhat lengthy, this document makes extensive use of quantitative analysis. We are well aware that math was not everyone's favourite subject in school, but real-world data and sometimes-complex quantitative analyses are essential elements in the design, construction, and operation of modern energy systems. They are also critical inputs to public policy discussions, at least if we want those policies to be rational and to serve the public interest.

It is imperative that we not base public policy decisions on the sort of hand-waving arguments and inept analyses contained in Renewable energy and Baseload myths. We cannot run a modern society on energy systems that depend to a large extent on the whims of the wind and the sun, no matter how much green-energy zealots would like it to be otherwise. The economic and social well-being of our children and grandchildren, and maybe even their lives, depend on us getting this right.

This report consists of several parts. It will be updated when new parts become available. Please note that the final content of future parts may change a bit from what is set out here.

• In Part A, we discuss the serious flaws in Pembina's evaluation of solar energy. We explain why the number of Alberta homes that can be reliably served by solar energy alone is zero, we show that southern Alberta solar resources are not equivalent to those in Miami or Rio de Janeiro by any useful measure, and we show that paying for the energy storage needed to turn solar generation into a reliable electricity source using today's technology would put the purchase of electricity beyond the financial reach of most Alberta families.

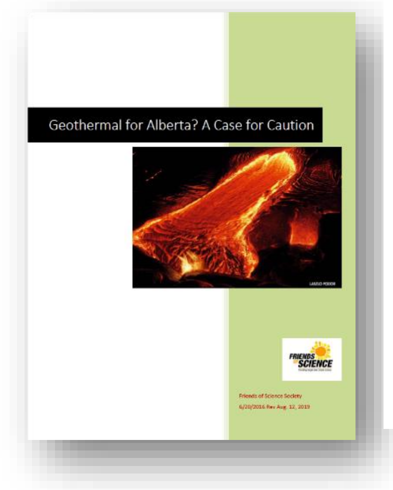
• In Part B, we discuss Pembina's inept analysis of the simple but critical concepts of "base load" and "baseload generation," and we show that renewable generation is the cause of—not the solution to—the increasing need for more flexible (and more expensive) generation in Alberta. We explain why Pembina's views on these topics are in direct conflict with sound engineering and economic principles. We briefly introduce Pembina's seriously flawed analysis of the roles of baseload generation and renewable generation in an energy emergency event that occurred in 2017.

• In Part C (to come), we will examine Pembina's analysis of the energy emergency event in more detail. We will also review the reliability-related characteristics of various types of generation. Finally, we will discuss how the energy market, the ancillary services market, various automatic control systems, and the system controller work together to ensure system reliability. Not surprisingly, Pembina gets this wrong, too.

• In Part D (also to come), we will examine how wind and solar generation negatively affect other generators and drive up costs for consumers. Contrary to Pembina's claims, wind and solar are not the most economic sources of new generation for Alberta, at least if we want the lights to come on when we flip the switch.

The overall conclusion of our analysis of Renewable energy and Baseload myths is that Pembina's reports are wholly unfit for educating readers on power-system operations and reliability. Basing significant public policy decisions on Pembina's so-called expertise will almost certainly have dire social, economic, and perhaps even life consequences for Alberta families and businesses.

Geothermal for Canada – A Case for Caution



Friends of Science Society has re-issued our 2016 report: "Geothermal for Alberta? A Case for Caution" to help inform the debate on the potential benefits and pitfalls of this novel form of heating and power generation for Canada. Though the document takes a specific look at Alberta, it includes a global overview of geothermal. This is a plain language document.

LINK TO FULL REPORT: Geothermal Alberta A Case for Caution Aug 12 2019 REV2

Video debate: https://youtu.be/sNhz1t7qMic

The Green Party "Mission Possible: The Green Climate Action Fund" platform advocates for the use of geothermal energy as a replacement for hydrocarbon/fossil fuel-based electricity and heat generation for Canada. The Green Party platform assumes that we can 'harness abandoned deep oil wells, wherever feasible, for geothermal energy, using workers who drilled the wells to manage the renewable energy generation.' On the surface, this appears to be a sensible 'repurposing' of similar drilling skills, by simply transferring these workers into geothermal as energy generation experts.

But things are not so simple when it comes to geothermal.

Like many forms of power generation, geothermal is location specific. To further confuse the public, geothermal is a term that is attached to two different forms of energy supply. One form is that of direct heat, where bore holes into the earth at a relatively nominal depth, capitalize on extant heat as a means of providing a stable heat source. This heat source can be best used with a system of electrical pumps, where the earth becomes a storehouse of hot and cold air, cycled by electrical pumps to act as an HVAC system. In some geographic locations, this set-up has benefits and, depending on the cost of electricity (to run the pumps that cycle the air) and depending on the stability and ambient temperature differential fluctuations, this can be a cost-efficient form of heating/cooling.

At first glance, parts of Alberta have excellent geothermal heating potential. However, a complicating factor is the often wildly fluctuating ambient temperatures due to Chinook winds, where temperatures can go from minus 20°C to plus 20°C in the space of a few hours. The response time of geothermal heating systems can be slow to keep up with this instability; likewise, the electrical energy required to pump the geothermal heat can be very expensive.

Another application for geothermal is that of electrical generation. Here, the Green Party 'makes hay' by claiming that using existing deep wells for geothermal would be an easy way to put lots of unemployed oil and gas workers back to work. The assumption is that these workers have similar skills used in drilling, that can easily be transferred to managing deep oil wells for geothermal electrical generation. This is a questionable assumption because electrical generation is quite different than oil well drilling – and to date, there is no assurance that such deep oil geothermal electricity generation potential exists anywhere but a few places in Alberta, BC and NWT, and some possible spots in Quebec. (Smart Prosperity just posted a blog on the first such initiative in Saskatchewan. A pilot project is in development at Swan Hills)

The Green Party's "Mission Possible" also states in point 7 that it will 'ban fracking' with no exceptions. However, deep well geothermal electrical generation relies on fracking in order to expose the 'hot rocks' to the cold water that is pumped down into the borehole. When the cold water hits the hot rocks, steam is produced, and this steam is pumped up to the surface to drive power generation turbines.

There is a new, untested, alternative method proposed by geothermal proponents in Canada – but the problem is that this form is untested. There is no large scale geothermal in operation in Canada at present and no pilot project of this alternative method. Therefore, it is not reasonable to set a nation's energy generation and employment policy based on something that does not exist, and that requires a process that the Green Party election platform strictly forbids, that being fracking.

Furthermore, as with many 'nature-driven' power generation proposals like wind and solar, proponents often say geothermal will tap into 'free' energy from the earth. A study by Majorowicz and Grasby (2019) indicates that geothermal energy simply cannot compete with the power generation provided by conventional fossil fuels, and the costs are exorbitant, except in certain unique geographic situations.

As with all forms of power and heat generation, there are potential applications for geothermal in Canada – but there are serious limitations as well. It is extremely unlikely that the mass of ~100,000 unemployed oil workers could be put back to work in a geothermal industry, nor do their skills directly transfer to geothermal power generation. Likewise, the temperature differentials in Canada make geothermal only a potential provider of supplementary power, not a main provider.

The real potential for geothermal based power production is only in the western and northwestern deep part of the Western Canada Sedimentary Basin (WCSB) basin where temperatures most suitable for that purpose can be found >150°C. [Temperatures of] >120°C can also be considered if very large flow rates are secured.

The difference [between geothermal and oil/gas] is in energy density and, in order to compare apples to apples, exergy (which is discussed in in our paper) is a couple orders of magnitude and therefore it will take several doublet geothermal well systems to replace one average producing oil and gas energy in the WCSB.

We also need to remember that pumping and reinjecting [to geothermal wells] all take large amounts of [electrical] power.

Also, thermal efficiency of geothermal power plants is some 10% +/- 4% depending on temperature of running fluid used.

It is at least 3 times that or more in coal power plants…."

(Wikipedia reports: Typical thermal efficiency for utility-scale electrical generators is around 37% for coal and oil-fired plants, and 56 – 60% (LEV) for combined-cycle gas-fired plants.)

Aside from these energy density and location issues, it is unclear how the Green Party can reconcile their absolute rejection of fracking with their demand for geothermal.

Geothermal experts like Dr. Jacek Majorowicz and Dr. Stephen E. Grasby offer expert insights on this complex topic. Their recent publication is: “Deep geothermal energy in Canadian sedimentary basins VS. Fossils based energy we try to replace – Exergy [KJ/KG] compared”

Unsustainable Subsidies – Public Con Job & Carbon Pricing Disaster

Carmangay Solar Project – Good for Carmangay….Terrible for the Rest of Us

Contributed by Jim Hunter and Ken Gregory, P. Eng. © 2021

Updated Mar. 31, 2021 to respond to an on-line comment regarding the use of the municipal borrowing rate of 2.5%. See Addendum.

As reported by Global News on Dec 10 [1], the Village of Carmangay, Alberta has completed “a solar farm project that will produce nearly 150 kW of power and is expected to save the Village more than $13,000 annually.” The project, which will produce more than enough electricity for the village (population 261), has been touted as producing “net zero” carbon dioxide emissions. This is a nice project for the people of Carmangay. Unfortunately, Global didn’t report the full picture. The rest of the story is that the project is heavily subsidized by the Alberta and federal governments—in other words, by taxpayers and all Alberta electricity consumers (“the Rest of Us”), and that the actual reduction in CO_2 emissions is small and comes at a high cost.

Carmangay’s solar energy is much more expensive than electricity from the grid. In a press release on December 8 [2], the Village of Carmangay stated that the total cost of the project was $380,000 and that it will produce 213,765 kilowatt-hours (kWh), or about 214 megawatt-hours (MWh), of direct current electricity per year for an expected project life of 25 years. “Direct Current” or “dc” energy is like the energy you get from a car battery. However, the power grid uses alternating current or “ac” energy like the power in your house. For energy from a solar farm to be compatible with use on the power grid, it must be converted to ac energy. Converting energy to ac energy produces energy losses in the order of 10 percent, so the output of the project is approximately 193 MWh ac. If we make the favourable-to-solar assumptions that there is no performance degradation, no downtime for maintenance, no fixed operating or maintenance costs and no variable operating costs for the life of the project, the total cost of Carmangay’s solar energy is equal to the $27,000 annual cost of a 25-year, $380,000 loan at 5%, divided by 193 MWh, or $140/MWh = 14.0 ¢/kWh. By comparison, the average wholesale price in Alberta’s competitive electricity market in 2020 was $46.72/MWh = 4.7 ¢/kWh. While this comparison is interesting, it does not tell the full story.

Wind and Solar must be 100% backed up by conventional generation. Alberta’s power system must be able to reliably supply customers at all times, and since the annual maximum demand for electricity across the province typically occurs after sunset on cold winter evenings when solar power is not available, we cannot eliminate any of the conventional generation that backstops solar generation. The same reasoning holds true for wind power, as the wind does not always blow during maximum demand periods.

The Carmangay solar project’s electricity is seven times more expensive than the gas-fired electricity it is displacing. The fact that wind and solar generation must be 100% backed up by conventional generation means that Carmangay’s solar project does not eliminate any of the fixed costs of conventional generation. Moreover, as we retire existing coal plants and add more intermittent and highly variable renewable generation to the grid, the need for flexible and efficient gas-fired generation will only grow. Therefore, the "full story" economic comparison is between the total costs (fixed plus variable) of the solar electricity and the variable costs (only) of the gas-fired electricity that we could be using instead. For example, based on data from the United States Energy Information Administration (EIA) [3], a modern gas-fired combined-cycle power plant (such as the recently completed Shepard plant on the east side of Calgary) burns 6.8 gigajoules (GJ) of natural gas per MWh of electricity produced. At the 2020 average delivered natural gas cost of $2.25/GJ [4], the fuel cost would be $15.30/MWh. Adding the EIA's $3.50/MWh for variable O&M costs, we get a total variable cost of $18.80/MWh or just under 2 ¢/kWh. Thus, solar energy from the Carmangay project at 14 ¢/kWh (see above) is about seven times more expensive than the electricity it is displacing. While proponents of green energy claim that wind and solar are now less expensive than conventional generation, this is simply not true when all costs are considered.

Stated another way, at current pricing, the total cost of power generation from a solar project in Alberta must be considerably less than 2 cents per kWh to be economic.

Wind and solar projects impose other costs on the grid not accounted for here. What about possible savings on transmission or distribution wires costs? No such savings are likely, for three main reasons. First, the cost of the existing wires is essentially fixed, so to the extent the Carmangay project allows the village to avoid wires costs, they must be paid by other Albertans. Renewable generation can sometimes reduce the need for wires, but only in very rare and well-controlled circumstances. Second, additional wires must be built to connect wind and solar projects to the provincial power grid. Third, the variable nature of renewable energy can impose costs on other generators on the grid. More detail on the fact that renewable generators like the Carmangay project will increase the cost of generation, transmission and distribution is a subject for a later post.

Carmangay's solar project is economic for the village because the rest of us are paying most of the cost. The Village's press release states that the solar power system is expected to produce an annual savings of about $13,400 based on 2019 electricity prices, and that grants from a number of federal and provincial sources made the project viable and have reduced the payback period for the Village to between 14 and 15 years. It also states that the payback period will be reduced further when electricity rates climb. But a saving of $13,400 per year for 15 years has a present value of only $139,000 (at a 5% discount rate), which comes nowhere near to covering the original cost of the plant. The remaining $241,000 of capital costs are paid for by the rest of us. Considering Carmangay has a population of 261, this comes to a subsidy of $920 per person. (A similar subsidy for all Albertans would cost $4 billion.) Regarding the notion that the payback period will be even lower when electricity rates climb, it is notable that the main driver of increased electricity rates in Alberta will be the forced integration of more renewable generation under federal and provincial cli-mate policies.

The cost of the CO2 emissions reduction far outweighs the environmental benefit. As noted above, the fuel gas saving resulting from the solar project is 6.8 GJ per MWh. The 193 MWh/yr generated by the project will therefore result in a fuel saving of 1,310 GJ per year. The emission rate from natural gas is very close to 0.05 tonnes per GJ [5], so the CO2 reduction resulting from this solar project amounts to 66 tonnes per year. At an amortized capital cost of $27,000 per year less the variable operating cost saving of the gas turbine ($18.80/MWh x 193 MWh/yr = $3,620 per year), the CO2 emissions reduction comes at a cost of $350 per tonne (($27,000 – $3,620)/66).

There are several measures of the benefit of reducing CO2 emissions. The benefit of removing a tonne of CO2 from the atmosphere is termed the Social Cost of Carbon (SCC). There have been many studies evaluating this benefit with a wide range of outcomes. The average SCC of peer reviewed studies is $39 per tonne [6]. Two other measures for the benefit of removing CO2 from the atmosphere are the Carbon Tax at $40/tonne (as of April 1, 2021) [7] and the market value of carbon offsets, which are currently trading for $24/tonne [8]. It appears that the cost of the Carmangay Solar Project far outweighs the environmental benefit. The CO_2 emissions and environmental damage resulting from the mining, manufacturing and eventual disposal of the solar panels for this project is significant and must also be considered when evaluating the merits of any solar project.

This is all a very high price to pay so that the Village of Carmangay can boast they are electrically net-zero. They could have made the same claim (and saved the rest of us a lot of money) just buying $24/tonne carbon offsets for a total price of only $1,580/yr, or $22,000 for the 25 year life of the project.

The Carmangay Solar Project makes no sense financially or environmentally. The December 8 press release states that the Village of Carmangay "has taken a major step forward in progressing as an environmentally and financially sustainable municipality." But as we have seen, financially, the solar plant produces electricity that is much more expensive than electricity produced by efficient gas-fired power plants and is only viable because of grants, subsidies, and other forms of taxpayer and ratepayer support. Environmentally, the benefit of Carmangay achieving an electrically net zero status is far outweighed by the cost, and is not in any way sustainable. So, while the project may appear to be environmentally and financially sustainable for the village, it is not sustainable for Albertans collectively.

The Carmangay solar project may be good for the people of Carmangay, but it is terrible for the rest of us. And these facts represent the rest of the story, which was not reported by the media.

Addendum:

In response to a comment which suggested using a Municipal Borrowing Rate to assess the Carmangay Solar Project, I agree that Municipal Government borrowing rates for existing debt are in the order of 2 to 2.5%, however it is incorrect to use this value as a discount rate for the project. Having said that, even if 2.5% discount rate is used, the Carmangay Solar Project would still no make sense financially or environmentally.

Municipal Government borrowing rates are low because the risk of government defaulting on their loans is small. Government borrowing is traditionally used for essential goods and services such as health care, police and roads which are not competing against other alternatives. Taxpayers have no option. They must use and pay for these services.

Government borrowing is typically not project specific and is funded with 100% debt and 0% equity. Carmangay probably did not borrow new money specifically for the Carmangay Solar Project therefore it is not possible to assign a specific cost of borrowing for this project. A riskier project investment, such as the Carmangay Solar Project, competing against, and at the same time, depending on, private sector power generation, levers off the lower existing government weighted average cost of capital (WACC). WACC addresses the risk of past projects and does not consider the future underlying risk of a new project. This future risk falls on the taxpayer. If the project does not perform as expected over the life of the project, taxes will increase. Private sector projects are funded with a combination of debt and equity with the equity holders taking the project risk/reward ahead of the lender. The taxpayer in a government project essentially takes the place of an equity holder in a private project. The hurdle rate which a company uses to evaluate the return required to justify the risk of proceeding with a new investment is called the discount rate.

Some of the risks the Carmangay Solar Project project faces are:

Capital cost risk. Although this cost is now known, it wasn't at the time of project approval.

Operations and maintenance risk. Risk that the electrical output of the project does not meet performance expectations, and/or the system requires more maintenance than assumed. This is assumed to be covered under the contractor's warranty, however there is the risk of default by the contractor.

Regulatory risk. Risk that power not consumed by Carmangay can no longer be sold to the grid on a priority basis and/or at the assumed price under current regulation.

Competitive risk. The project economics assume that power from the Carmangay Solar Project will be less expensive than from the grid (or other alternatives) over the life of the project.

Retirement obligations. The cost of disposal of the solar panels at the end of the project life.

These risks are not unlike the risks of large scale utility wind and solar power generation projects. The EIA (page 9) uses a discount rate of 5.9% with a 40% debt, 60% equity split in it's assessment of utility scale wind and solar projects in the US. This 5.9% discount rate is representative of the free market cost of capital for large scale utility power generation projects. A marginal discount rate of 5% was used in the Carmangay Solar Project analysis as a conservative reflection of the underlying risk of the project.

Marginal risk is the key concept. The Carmangay Solar Project is small and therefore it's impact on the electricity rates and taxes for Carmangay and Alberta will be small, but if Alberta proceeds with its plan for a large number of big solar (and wind) projects connected to the grid, the impact on Alberta electricity rates and taxes can be very large, as was the case with the Ontario Government's venture into wind and solar power which, according to the Auditor General of Ontario, from 2006 to 2014, Ontarians unwittingly subsidized their "green" energy plan to the tune of $37 billion from the Global Adjustment fees on their power bills.

Notwithstanding the reasoning for using a discount rate of 5%, the key messages from the Carmangay Solar Project analysis are not materially changed if a 2.5% borrowing rate is substituted for the 5%.

Carmangay's solar energy would be 2.3 times more expensive than electricity from the grid vs 3 times as stated in the analysis.

The Carmangay solar project would be 5.6 times more expensive than the grid generation it is replacing vs 7 times as stated in the analysis.

Carmangay's solar project would be economic for the village because the rest of us are paying such a large share of the cost – $165,000 of the $380,000 capital cost vs $241,000 of the $380,000 capital cost as stated in the analysis.

The cost of the CO2 emissions reduction far outweighs the environmental benefit. The cost would be $260 per tonne vs $350/tonne. The benefit of CO2 reduction would remain unchanged at somewhere in the range of $24 to $40 per tonne.

The use of the Municipal borrowing rate as a substitute for the discount rate would simply be another subsidy for the Carmangay Solar Project. No matter how you cut it, the Carmangay Solar Project makes no sense financially or environmentally.

SOURCES

[1] Global News Village of Carmangay the latest in Southern Alberta to harness solar power

[2] villageofcarmangay.ca Village of Carmangay Becomes Electrically Net Zero

[3] United States Energy Information Administration: Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2020, Table 1. Downloaded from https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf on January 4, 2021. The table cites a heat rate of 6431 Btu/kWh, which equals 6.8 GJ/MWh, for a single-shaft combined-cycle unit. It also cites US$2.54/MWh, or about C$3.50/MWh, as a variable O&M charge.

[4] GasAlbertaInc. Intra-Alberta Cost of Natural Gas – Wtd Avg for 2020. http://gasalberta.com/gas-market/gas-rates-in-alberta The delivered price of natural gas to an individual consumer in Alberta is a contractually negotiated price which will vary from this weighted average.

[5] United States Energy Information Administration: Cost and Performance Summary Table, Table 2 from the last column, row 8, 117 lb/mmBtu = 53.07kg/1.0551 GJ = 50.3 kg/GJ = 0.053 t/GJ The number depends on the exact

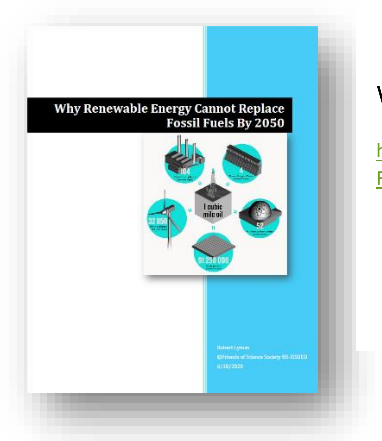
composition of the gas. For pure methane the value is 49.4 kg/GJ https://www.eia.gov/analysis/studies/powerplants/capitalcost/pdf/capital_cost_AEO2020.pdf

[6] Estimates of the Social Cost of Carbon: A Review Based on Meta-Analysis. In the Abstract – Main Findings point ii) The estimated SCC ranges from -$13.36 to $2,386$/tCO_2, with a mean value of 30.78$/t$CO_2$ with a PRTP at 3% in peer-reviewed studies. The mean value of $30.78 is in USD which converts to $39/tonne CDN at a conversion rate of 1.27. https://www.sciencedirect.com/science/article/abs/pii/S0959652618334589

[7] The Federal Government plan is to raise CO_2 taxes from the current $30/tonne to $40/tonne as of April 1, 2021 to $170/tonne by 2030. The Alberta Court of Appeal has declared the federal carbon tax unconstitutional and is awaiting a decision from the Supreme Court of Canada. Carbon Taxes and Rebates Explained

[8] A carbon offset is a credit for emissions reductions given to one party that can be sold to another party to compensate for its emissions. Carbon offsets are bought and sold through international brokers, online retailers and trading platforms. Less (https://www.less.ca/en-ca/flights.cfm?auid=ac) is one of these companies that provide CSA Standard-Certified Canadian Off-sets for $20.00/tonne, and the Gold Standard-Certified International Offsets for $24.00/tonne (Jan 5, 2021 pricing).

Why Renewable Energy Cannot Replace Fossil Fuels By 2050



Why Renewable Energy Cannot Replace Fossil Fuels By 2050

https://blog.friendsofscience.org/wp-content/uploads/2020/06/WHY-RENEWABLE-ENERGY-CANNOT-REPLACE-FOSSIL-FUELS-BY-2050-FINAL-2.pdf

Several prominent environmental groups in Canada and the federal New Democratic Party have endorsed the view that Canada should adopt the goal of "100% Clean and Renewable Wind, Water and Sunlight (WWS) by 2050". This view is shared by several environmental groups in other countries. Is this goal feasible? Studies by academics and think tanks in the United States and elsewhere have examined the potential for and costs of replacing fossil fuels. The most widely cited of these, and the probable bases for the view that 100% renewables is possible, are the reports done by Mark Jacobsen, Mark Delucci and others at Stanford University. Their studies examine both the United States and the global situation, using similar models and methodologies. Jacobson and Delucci also published a series of "all-sector energy roadmaps" that purport to show how each of 139 countries in the world could attain the WWS goal. The purpose of this paper is to examine the likely implication of the 100% renewables goal for countries like the United States and Canada. The WWS vision calls for converting all energy use for electricity, transportation, heating/cooling, industry, and agriculture/forestry/fishing, to be powered by wind, water and sunlight. It further seeks the closing of all energy production and consumption associated with fossil fuels (i.e. coal, oil and natural gas) and nuclear.

The Unstoppable Momentum of Outdated Climate Science[7]

Great News! The Extreme Scenario that IPCC Saw as Most Likely in 2013 is Now Judged Low Likelihood.

Though people around the world have been terrified by Greta Thunberg's earnest demand "I want you to panic" and "Our house is on fire" – these comments turn out to not be founded on science, and also to reference material in the IPCC SR1.5 report which is based on faulty premises. Likewise, press releases featuring UN Sec-Gen Antonio Guterres claiming "Code Red for humanity…an atlas of human suffering" turn out to be hyperbole, not reflected in the actual science reports of the IPCC.

As we have pointed out in our first reference "Faulty Premises = Poor Public Policy on Climate Change", that report referenced a scenario known as RCP 8.5 as if 'business-as-usual' regarding emissions, when it most certainly is not.

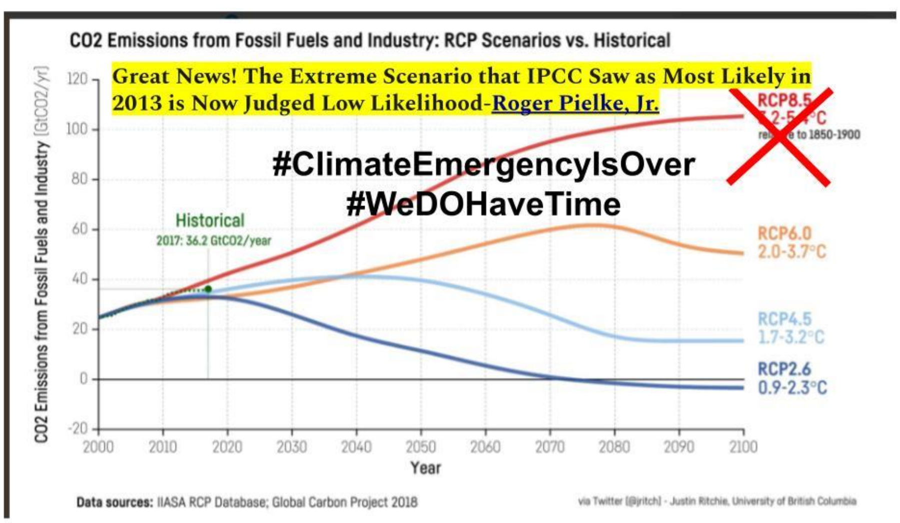
Roger Pielke, Jr. is a climate policy analyst who has worked with insurance agencies for ~25 years assessing extreme weather; he is a past contributor to and frequent commentator on IPCC reports.

Most recently, Pielke, Jr., and colleague Justin Ritchie of Canada have found that the claims of a 'Climate Emergency' stem from the misuse of the RCP8.5 scenario. In the most recent IPCC AR6 Working Group I – Physical Sciences report of August 2021, Pielke, Jr. reports that there is **good news.[8]**

For my technical readers, the scenarios judged unlikely by the IPCC are high emission ("such as RCP8.5 or SSP5-8.5") and the scenarios "in line" with current policies are intermediate scenarios ("RCP4.5, RCP6.0 and SSP2-4.5").

This is huge news. Fantastic in fact. Why? The extreme scenario RCP8.5 was in the most recent IPCC report identified as our most likely future. Now IPCC has completely reversed that, and it is now considered low likelihood. There could not be a more profound change in the scenario foundation of climate science.

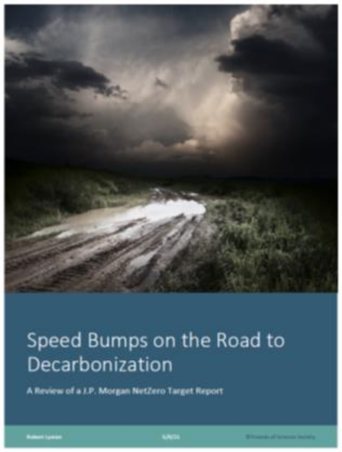
*Instead of apocalyptic warnings about "immediate risk" a top line message of this report should be: **Great News! The Extreme Scenario that IPCC Saw as Most Likely in 2013 is Now Judged Low Likelihood.** I am actually floored that this incredible change in such a short time apparently hasn't even been noticed, much less broadcast around the world.*



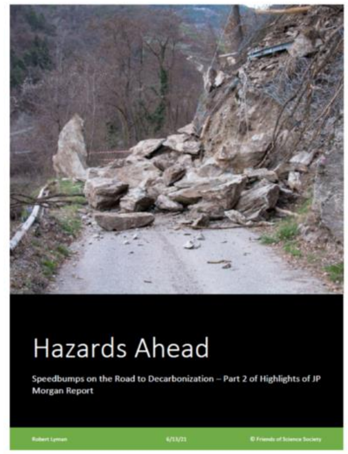
[7] https://rogerpielkejr.substack.com/p/the-unstoppable-momentum-of-outdated?s=r

[8] https://rogerpielkejr.substack.com/p/how-to-understand-the-new-ipcc-report?s=r

Consequently, there is no urgency attached to plans to decarbonize society. A calm, thoughtful and rational approach can be taken instead.



These two reports offer summarized insights on advanced proposals for decarbonization and electrification of existing fossil fueled processes and systems.



Speed Bumps on the Road to Decarbonization

The recent statements by several world leaders endorsing the political goal of reducing their countries' greenhouse gas emissions to zero by 2050, if not sooner, has been followed by the publication of several articles assessing the feasibility of this goal. One of the most interesting was the 2021 Annual Energy Paper published by the investment firm J.P. Morgan. J.P. Morgan is usually regarded as one of the most "woke" investment companies in the United States and one that supports the "decarbonization agenda". For that reason and others, the contents of the paper, written by Michael Cembalist, are very interesting.

Hazards Ahead

Electricity Storage

Utilities that have a large share of wind and solar energy in their generation mix must ensure that supply is available during the seasons when production from these sources in low. Without thermal power generation to call upon, proponents believe that grid-level electricity storage, in the form of pumped storage (from reservoirs) or batteries will solve this problem. Pumped storage provides about 97% of grid power storage in Canada and the United States. Expansion of pumped storage reservoirs and facilities is possible, but there are relatively few sites available that would be suitable for it. In 2018, grid-scale battery storage in the United States provided about 1 GW-hr of capacity.

Storage is expensive. Pumped storage costs about U.S. $2,000 per kilowatt and grid-scale battery storage costs about $2,500 per kilowatt for a discharge duration of two hours or more. The longer the storage is needed, the higher the cost. Roger Andrews, a geophysicist with world-wide experience in the energy and mining industries, has estimated the combined wind and solar levelized cost of electricity without storage to be US $50/MWh and at least US $700/MWh with it. His estimates are in a range similar to that of the Clean Air Task Force (a Boston-based energy think tank), as reported by the MIT Technology Review. Battery storage, in short, is not an option that will ensure an affordable energy future based on high levels of renewables generation.

Electrification of the Light Duty Vehicle Fleet

By 2019, battery electric vehicles (BEVs) constituted 0.77% of the global light duty vehicle fleet and only about 1% of vehicle sales. Ignoring the slow rate of EV market penetration, several countries and sub-national jurisdictions have publicly committed to eliminating sales of internal combustion light duty vehicles as early as 2035.

Recharging a BEV with a 64-kilowatt battery at home with a level II, 240-watt charger requires up to ten hours, which can be done overnight. Not everyone will have access to a home charger. Electric vehicle owners living in a town house, row house or an apartment without access to a level II charger would have to rely entirely on the public fast-charging network. The significant number of people who park their cars on the street would also be dependent on the public fast-charging network, which in most countries is quite immature.

At the end of 2019, the U.K. had around 100,000 BEVs, representing about 0.3% of the light duty vehicle fleet (Gautam Kalghatigi). These numbers would have to increase by at least 300-fold if the U.K. government is to replace all light duty vehicles. Further, if one were to assume a (very unlikely) 100-fold increase in BEV numbers to 2030 to 10 million, this would represent only 27% of the light duty vehicle fleet; 85% of U.K. transport would still rely on internal combustion vehicles. In 2019, 37,800 BEVs were sold in the U.K.; at this rate it would take 263 years to reach 10 million units.

The Electrification of Railways

The electrification of freight railways in the United States and Canada would require building and maintaining a high-voltage catenary system (an overhead system or wires along the railbed) that, within the United States alone, would span close to 140,000 miles in a wide variety of geographic locations. This probably would require delivering electricity through thousands of rail tunnels and rebuilding major bridges to provide clearance and support for the catenary wires.

Complete electrification would require conversion of 140,000 miles of rails, so the minimum direct capital cost would be in the order of $280 billion and the probable cost much higher. To that should be added the cost of replacing the more than 24,000 Class 1 locomotives in the existing fleet, which according to the Association of American Railways would be close to $100 billion. This does not include the cost of adding the electrical generation capacity that would be needed, for which no current estimates are available. If the cost of converting the present system to an electrified one were placed on the current industry, it would impose financial risks that many would be unwilling to accept. That means the conversion would have to be funded in part or in whole by governments, with the costs and risks largely borne by taxpayers.

The Electrification of Residential Heating and Cooling

The best studies of the probable costs of decarbonizing housing have been done in the United Kingdom. A major pilot project there concluded that emissions could be reduced by 60% for an average expenditure of 85,000 pounds (Cdn $146,000), and by 80% for an average expenditure of 135,000 pounds (Cdn $231,000). Assuming that these costs could be significantly reduced through a national effort, Professor Michael Kelly concluded that most existing U.K. residential housing stock could be retrofitted for a cost of about 70, 000 pounds each, or 2 trillion pounds (Cdn $3.43 trillion). In 2016, the Energy Technologies Institute estimated the cost of “deep retrofits” of the U.K. housing stock was more than 2 trillion pounds. In 2018, the Institute of Engineering and Technology published figures of 80,000 to 90,000 pounds per home. It is clear that only a small fraction of British households could afford such a cost. Taking into account the cost of adding electricity generation based on wind, and including heat pumps, the cost per house could rise to 150,000 pounds (CDN $257,000) or a national total approaching 4 trillion pounds (Cdn $6.85 trillion).

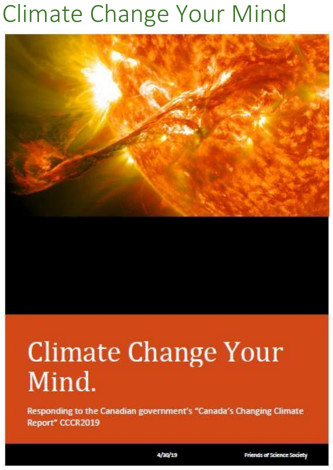
The Feasibility of Meeting the Mineral Supply Requirements

Mark Mills of the Manhattan Institute has examined the physics of fueling society, including the potential for wind, solar and biomass energy sources to meet the energy requirements now met by conventional energy sources. One of his key findings was that 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.

In May 2021, the International Energy Agency (IEA) issued a report on "The Role of Critical Minerals in Clean Energy Transitions". The report 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. It takes over 16 years for mining projects to go from discovery to first production. If countries started tomorrow, new production for these materials might begin after 2035. This places into context the claims by the governments of the United States, the United Kingdom and Germany that they will have carbon-dioxide-free electricity by 2035.

There are significant but often ignored security risks. The top three producers of three key "green" energy materials control more than 80 percent of global supply. China's share of refining is about 35 percent for nickel, 50 to 70 percent for lithium and cobalt, and almost 90 percent for rare earth elements. Russia is in a dominant position in the supply of natural gas to western Europe. By comparison, the top three oil producers, including the United States, account for less than half of world supply. The most important security risk of all resides in the possibility that, having completely electrified western economies and then achieved high levels of reliance on wind and solar energy for the needed generation, there might be major interruptions in power supply because of weather, the failure of transmission systems, cyber-attacks, or sabotage. The economies of western countries would be at risk of severe and prolonged blackouts, with no alternative capacity available.

Climate Change Your Mind



The Canadian government's report – "Canada's Changing Climate Report (CCCR2019)" – released a day after the national carbon tax was introduced, is filled with fearmongering and highly speculative projections says Friends of Science. "Climate Change Your Mind" is Friends of Science evidence-based rebuttal; they are calling for the government to retract CCCR2019.

LINK to Full Report; Climate Change Your Mind FINAL

The Sun Also Warms- Dr. Willie Soon
https://youtu.be/KazGXAqgkds

Executive Summary

Environment and Climate Change Canada issued a report entitled "Canada's Changing Climate Report 2019" (CCCR2019) on April 2, 2019 which sparked headlines world-wide claiming that Canada was warming 'twice as fast as the global average temperature.'[9] The report made predictions of increased weather extremes such as flooding, wildfires and heatwaves, unless drastic cuts to greenhouse gas emissions and the use of fossil fuels were implemented.

The report was issued a day after the very unpopular federal carbon tax policy was implemented and as a constitutional court case began over the validity of a federally imposed carbon tax on the provinces.

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9 https://www.theguardian.com/world/2019/apr/02/canada-climate-change-warming-twice-as-fast-report

Friends of Science Society disputes the claims of the CCCR2019 as summarized here:

1. **NASA GISS Dec. 2018 temperature dataset shows that global temperatures have dropped by 0.5°Celsius in the past three years**. The sun is presently entering a solar minimum, exhibiting very few sunspots. Historically, observations correlate this low solar activity to a time of cooling, such as that of the Little Ice Age (1250-1860AD).

2. **The risk of cooling** to Canadians and to Canadian agriculture presents a far more serious challenge than the risk of warming.

3. **Despite a significant rise in carbon dioxide concentration, temperatures have flatlined for the past 20 years.** The growing scientific consensus is that carbon dioxide is not the 'knob' that can fine tune climate, meaning carbon taxes and reduction measures will not fight climate change. Natural climate factors appear to be more influential.

4. **CCR2019 used a reference frame that began in a cooler solar minimum and ended in a higher temperature El Nino period** – this would give a distorted appearance of much higher warming. Page 6 of the Executive Summary refers to "Changes are relative to the 1986–2005 period."

5. **Computer models (simulations) are useful for understanding how climate works, but inadequate for accurately predicting future climate.** There are too many variables and unknowns. Physicist Freeman Dyson calls it 'science fiction' to use computer models for climate predictions. Climate models do not reflect the observations of satellite and weather balloon data and did not project the near 20-year hiatus in warming, with no statistically significant warming since 1997.

6. **Canada is a vast country of many regional climatic conditions; predicting climate change patterns 80 years from now is an exercise in magical thinking.** Climate change is measured in periods of 30, 50, 100 and millennial timescales. Climate and weather patterns are subject to changes in humidity, winds, precipitation, cloud cover, cosmic ray influx and more. Changing human influences like increased population density, land use (agriculture, paving/building up cities), large-scale water diversion (James Bay dam, Site C dam) and other emissions from daily human and industrial activity also affect regional climates. On a wider scale, there are natural factors like black carbon/ash/soot (which affect Arctic warming/albedo) and other aerosols from wildfires, ash, gases and aerosols from volcanic eruptions, decomposition of biomass, and atmospheric oscillations such as El Nino, La Nina, Pacific Decadal (PDO), geothermal activity (below sea level), and changes in ocean currents. These can have amplifying or modifying effects on large regions of Canada. Though some oscillations appear to have a regular cycle (PDO 60 years), others like El Nino, which can have global effects, are impossible to predict with any accuracy, nor can the length or scope of the impact be determined years in advance. A series of solar and cosmic cycles and planetary conjunctions also affect climate. How can carbon dioxide/greenhouse gas emissions be more influential than any one, or all of these?

7. **The Intergovernmental Panel on Climate Change (IPCC) Special Report on Extreme Weather in 2012 stated that there is little evidence to support the claim that human influence on climate will lead to more extremes.** It is curious that CCCR2019 comes to the opposite conclusion.

8. **Most expert scientists in the field of climate reject the use of the Representative Concentration Pathway 8.5 (RCP8.5) high end model assessment as being completely unrealistic** in terms of energy use. However, RCP 8.5 is used throughout the report, frequently with bright 'red-hot' visuals.

9. **Undue influence and content from contributors outside the field of physical sciences brings into question the quality of assessment.** Reliance on the IPCC AR5 report does not reflect the reality of Canada's unique geological and climatic conditions. Further, the AR5 report noted a then 15-year hiatus in global warming, which today reaches nearly 20 years. The AR5 report weakened the case for human causation of warming, as Dr. Judith

Curry testified to the US Senate on Jan. 16, 2014, also stating that the rapid rise in carbon dioxide (CO2) while temperatures flatlined indicated that:

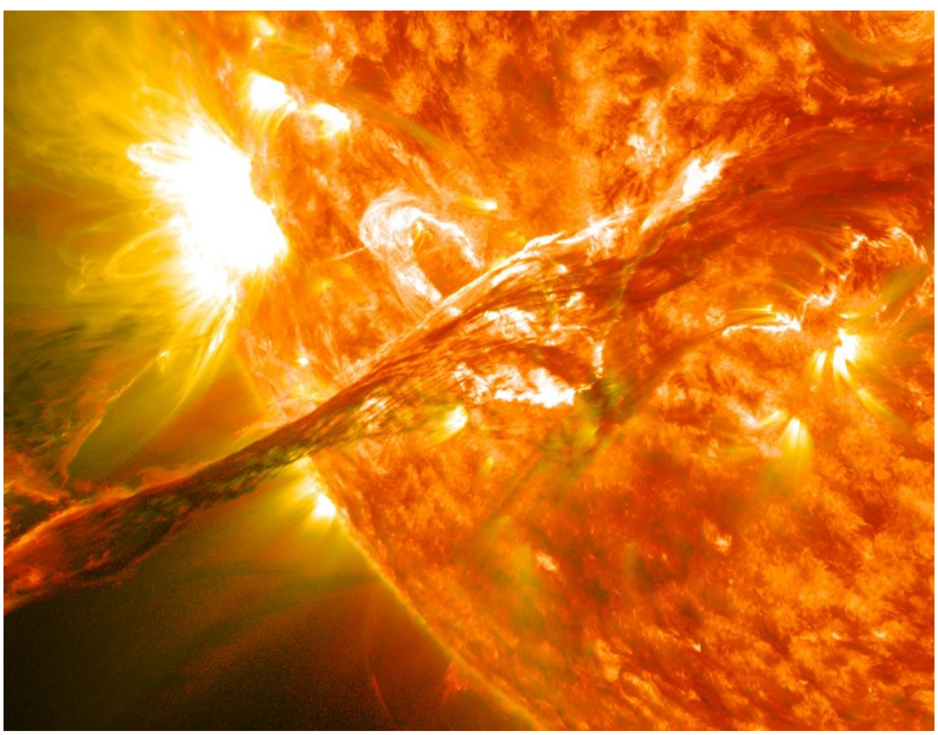
a) Carbon dioxide is not a control knob that can fine tune climate

b) Reducing carbon dioxide emissions to stop global warming may prove to be futile in the face of natural variability (solar and ocean cycles and other natural factors being more influential).

10. Solar influence on Canada's climate offers more robust evidence of the driver of climate change. Importantly, the CCCR2019 report failed to inform its Canadian readers that the IPCC climate models failed to correctly simulate the Northern Hemisphere snow cover extent for the past 50 to 100 years.

11. Since 2005, green billionaires have been funding ENGOs worldwide for millions of dollars a year to push the 'climate catastrophe,' 'climate crisis,' for their own vested interests in renewables, global cap and trade and carbon pricing. They have co-opted union pension funds and institutional investors to their 'cause,' thus skewing markets and policies.

12. Can so many scientists and government agencies be wrong? Yes, history shows us that science, especially when politicized, can go wrong based on faulty premises that cannot be questioned. A crucial example is that of Lysenkoism in the Soviet Union where faulty agricultural science became government policy. This diktat did not allow for scientific dissent on pain of excommunication, incarceration in a mental institute, or execution.[10] Following on his theories, in Maoist China, those 'deniers' and 'right-leaning conservatives' who argued against the Great Leap Forward were 'struggled' into submission by their peers – lack of freedom of speech and scientific inquiry led to the deaths of ~36 million.



By NASA Goddard Space Flight Center - Flickr: Magnificent CME Erupts on the Sun - August 31, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=21422679

10 https://www.forbes.com/sites/peterferrara/2013/04/28/the-disgraceful-episode-of-lysenkoism-brings-us-global-warming-theory/#69a698e67ac8

About Policy Contributor - Robert Lyman

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 20th 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 (CO2).

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