Mission: Possible

Projections, 2020-2050

Reductions in CO_2 Emissions
Production of Renewable Energy

Green Party of Canada Shadow Cabinet
Climate Caucus

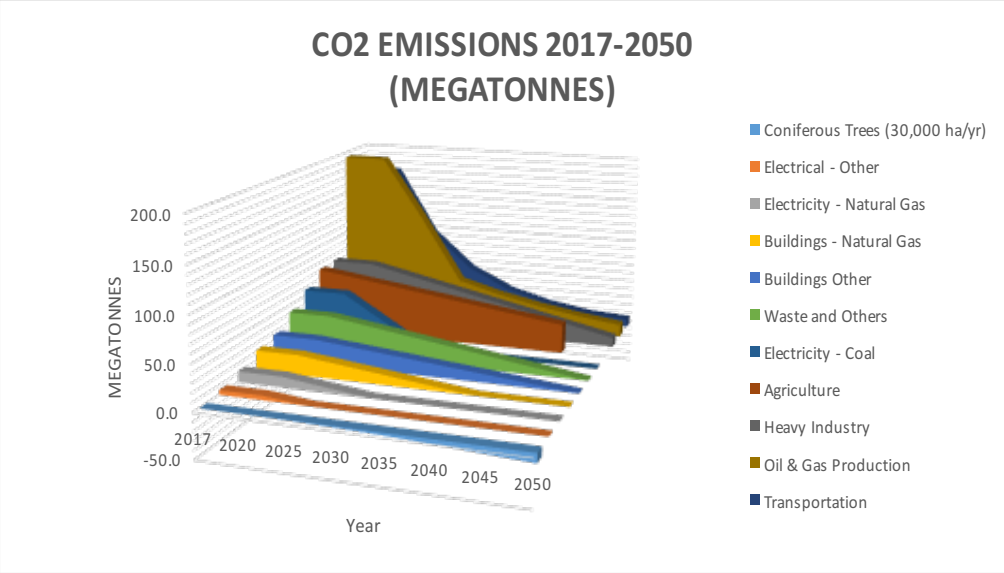
SUMMARY

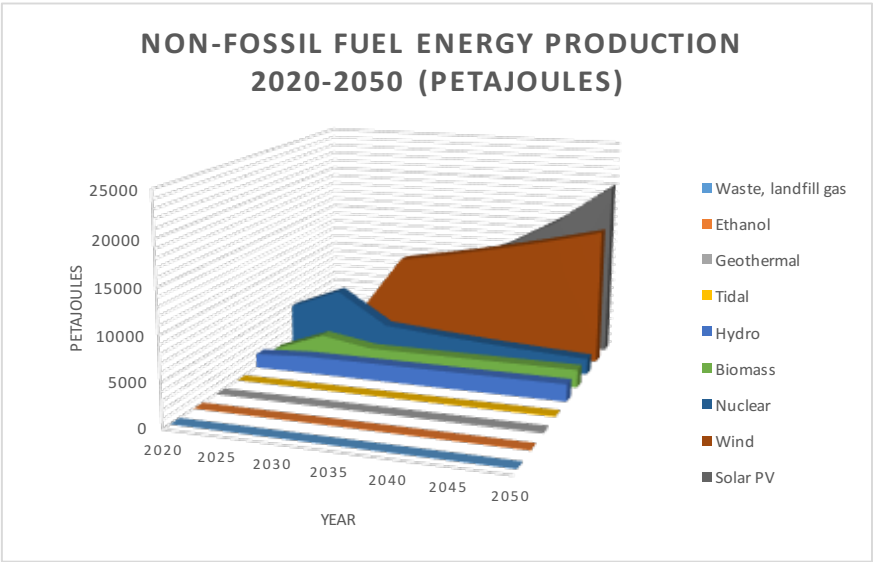
These two graphs summarize this study. Supporting data and details and are in the body of the document.

The first figure shows projected decreases of CO_2 emissions from industrial and household activities, and the projected uptake of atmospheric CO_2 from newly planted coniferous trees. The bulk of the reductions are from dramatically reduced oil & gas production and from shifts in the transportation sector. Coal is not used. Cumulative output is reduced 60% by 2030, the first goal of "Mission: Possible".

By 2050, CO2 emissions have been reduced by 92%. The remaining 8% still emitted from agriculture, heavy industry, transportation and legacy oil & gas production is expected to be balanced by other carbon sinks: more forest planting, improved agricultural practices, advances in bio-energy carbon capture and storage, and other as yet unproven technologies.

The second figure shows electricity production from various non-fossil fuel sources. In this scenario, solar photo-voltaics (PV) and wind provide most of the power. Hydro and nuclear power decrease gradually from peaks around 2030. As detailed in the text and tables following, there is likely to be more power produced from other renewable sources – biomass, geothermal and tidal all have substantial potential, and all will developed to some extent.





PURPOSE OF THIS DOCUMENT

1. At the 21st Conference of the Parties ("COP21") in Paris in 2015, Canada and the other nations of the world committed to limiting global average temperature increases to 1.5°C above pre-industrial levels, or at least as far below 2°C as possible[1].
2. The Intergovernmental Panel on Climate Change ("IPCC") compared the implications of 1.5°C or 2°C temperature increases. The IPCC report of October 2018[2], approved by all governments, concluded that an increase of 1.5°C was likely to allow survival of the biosphere, albeit with substantial impacts.
3. The IPCC reported that the 1.5°C goal could be met by reducing CO_2 emissions 45% below 2010 levels by 2030, and achieving carbon-dioxide-neutrality by 2050. The IPCC stated that deploying existing technologies to replace fossil fuels with renewable energy, along with a rapid halt to deforestation and substantial re/afforestation, would likely be sufficient to achieve that goal, if tackled immediately and with urgency.
4. A 45% global reduction in GHGs by 2030 should therefore be viewed as an internationally accepted binding constraint on CO_2-emitting economic activity.
5. The Green Party of Canada's more assertive climate plan is called "Mission: Possible" [3]. It calls for CO_2 emissions from Canada to be cut 60% by 2030, and for carbon-dioxide neutrality by 2050.
6. The figures and tables attached show one path Canada could take to meet the Mission: Possible commitments
    a. immediate and drastic reductions in fossil fuel production,
    b. reductions in energy consumption across all sectors,
    c. immediate and substantial investment in renewable energy production and distribution, and
    d. significant reforestation and afforestation.
    e.

These actions are required to meet the world's constraints and Canada's international commitments.

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[1] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

[2] https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/

[3] https://www.greenparty.ca/en/mission-possible

7. The intention of this exercise is not to quantify costs or benefits, nor to describe policy instruments to achieve the necessary changes, nor to predict impacts on affected economic sectors.

8. These projections are not set out as matters of fact. There will be major variations in all the numbers. The purpose is to demonstrate that there exists at least one feasible path to meet the constraints now placed on emissions.

9. Producing oil and gas generates more than 26% of Canada's total CO_2 emissions[4]. Of this, almost half (12%) comes from mining and processing bitumen. Notwithstanding the industry's successful efforts to improve efficiency, that figure is continuously rising as more and more energy is required to produce bitumen from ever-lower-quality deposits. Greenhouse Gas (GHG) emissions will rise even more dramatically when the massive emissions of methane from fracking for natural gas are included.

10. This scenario is designed to produce a 60% reduction in CO_2 emissions by 2030, and carbon-dioxide neutrality by 2050.

    a. Production of bitumen and fracked natural gas is ceased by 2030. By 2050, output of conventional oil has been reduced to 13% of 2017 levels, and conventional natural gas reduced to 16% of 2017 levels.
    b. Fully electric passenger vehicles and light trucks are about 50% of the market by 2030. By 2050 most transportation (with the exception of rail, aviation and marine) will be electrified.
    c. Consumption of natural gas in buildings is reduced 50% by 2030, and to zero by 2050 through replacement of most natural gas by electricity. Mission: Possible calls also for retrofitting buildings nationwide for energy efficiency - the resulting reduction in demand is not included in this scenario.
    d. Emissions from heavy industry, agriculture and waste management are reduced 17%, 18%, and 33% respectively by 2030, and 865 55% and 100% by 2050 through adoption of new technologies and practices.
    e. Electrical power from solar photo-voltaics and wind grow 45% and 35% respectively by 2030. Provincial utilities nation-wide are connected with storage and load buffering on a national electrical grid.
    f. 30,000 ha of coniferous trees are planted each year through 2050.
    g. From 2025 to 2035, meeting domestic energy demands in Canada while winding down production of fossil fuels in Canada may require curtailing some electricity exports to the United States . After 2030, numerous options are open for further reducing overall energy consumption and for generating electricity from renewables.

[4] https://www.nrcan.gc.ca/science-and-data/data-and-analysis/energy-data-and-analysis/energy-facts/energy-and-greenhouse-gas-emissions-ghgs/20063 - L1

11. Changes in the oil and gas sector will affect the economy. There will be a reduction in export revenues (now some $4.7 billion per year from oil & gas, of which about 35% flows to non-Canadian owners), taxes (now some $2.2 billion) and royalties (now some $8.6 billion to all orders of government). There is substantial economic activity in construction of oil & gas infrastructure, estimated by NRCAN at half the impact of actual production. Most of this will cease by 2050, with or without this specific scenario. While some, like the construction of infrastructure, will be replaced by other activities, there will be a reduction in private sector and government revenues in the near term.

12. The climate crisis will cause a write-down of asset values of oil & gas companies in Canada and around the world. Mark Carney, Governor of the Bank of England, has warned that the recognition that most oil and gas reserve "assets" will never be exploited could result in a drop in world stock market valuations, with the potential for destabilization of financial markets overall[5]. Financial institutions, insurers and regulators around the world are increasingly insisting that companies disclose such risks in financial reporting – when such disclosure does appear, most institutional investors (banks, pension funds, Crown corporations, etc.) will no longer be able to hold investments in fossil fuel companies, now an average of 12-16% of their portfolios. There may not be other willing buyers when the institutional investors divest.

13. This transition will require significant financing. Building the western portion of the national electrical grid could require almost as much money as would be required for the Trans-Mountain ("TMX") pipeline expansion. Financial uncertainties and decreased valuations and dividend flows from traditional energy might make investors and governments more likely to supply the necessary financing for renewable energy and retrofit projects. This will happen without the specific actions described here, but as a natural effect of the world's coming off fossil fuels. It is unlikely that the necessary financing will all come from the private sector, contrary to the predictions of the "Final Report on Sustainable Finance" to the Minister of Environment and Climate Change and to the Minister of Finance.[6]

14. Canadian resource companies have not hitherto been famous for paying to clean up after themselves. Notwithstanding the recent "Redwater" decision of the Supreme Court of Canada, which held that even in bankruptcy, a company's agreed-upon environmental liabilities rank ahead of secured creditors and shareholders, history suggests that they may flee the field with their assets and go bankrupt before they pay much to remediate damage done by oil and bitumen extraction to land, water, living systems and First Nations communities. A regulator estimated that the environmental liabilities there are in the order of $260 billion in Alberta alone. The Green Party believes that restoration work should begin immediately while the companies still have some cash and marketable assets. But in time, governments and the public must be prepared to assume responsibility for most.

[5] https://www.mainstreamingclimate.org/publication/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability/
[6] https://www.canada.ca/en/environment-climate-change/services/climate-change/expert-panel-sustainable-finance.html

15. The business model for regulated power utilities will be substantially changed. It already costs less to produce solar or wind power than it does to generate electricity from hydro dams or nuclear facilities. This scenario assumes that Site C and Muskrat Falls are the last major hydro projects in Canada, and that some required maintenance and upgrading of existing nuclear plants is performed[7], but no new ones are built. With inexpensive local power generation, storage, distribution and load buffering, it is no longer good public policy to allow a monopoly on electricity generation[8]. The utilities will be needed only as power distributors and market makers. Utilities have accumulated billions of dollars of debt backed by expected cash flow from high-priced energy in a controlled market. It will be difficult for some to avoid defaulting on that debt. Where the utilities have sold to business interests, the investors will take the loss like those who are still invested in oil and gas. Where they remain public entities like Crown corporations, the debt will become the burden of citizens and governments.

16. The supply chain will be affected. Suppliers will have to shift their current businesses to new areas. Canadian companies have always adapted to disruption in the "staples" economy, like changes from fish to furs to timber to minerals, etc. They should be able to quickly shift to supplying new industries. The buildout of renewable energy is already providing business and employment for many suppliers and business is growing fast.

17. To meet global constraints on greenhouse gases, the oil and gas industry must be taken off life support and moved to palliative care. Most of the short-term adjustments and costs will be borne by bankers, institutional investors, pension plans and governments, and by management personnel in smaller Canadian companies. The vast majority of Canadian citizens are not likely to be affected.

18. The transition will provide employment for thousands of people: decommissioning oil & gas production, restoring the oilpatch, building out the electrical grid, and generating and bringing renewable energy online. Workers in the oil & gas sector will not be displaced – decommissioning existing infrastructure and physical plant, plus efforts to remediate environmental damage, will provide jobs for all of and more the workers than are now employed in development and production. Employment in "clean tech" already exceeds that in oil & gas. More thousands will be needed to retrofit buildings. Demand for tradespeople will require education of a massive workforce – the Green Party recommends that "Red Seal" trades training be made widely available and free.

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[7] see David Hughes - Canada's Energy Outlook

[8] For example, Nevada's largest utility NVEnergy has announced a solar/battery power facility with a capacity of roughly 1200 megawatts, to be build out over 18 months at a cost of about $1.2 billion USD. Compare with BC Hydro's proposed Site C project, intended to produce about 1200 megawatts, to be built over 10-12 years at a cost now projected to be $8-10 billion USD. https://www.reuters.com/article/us-usa-nevada-solar/nevada-utility-announces-three-major-solar-projects-with-battery-storage-idUSKCN1TQ2H5

19. Energy will be abundant and inexpensive. The capital cost of solar PV is dropping 25% per year – the cost is thus cut in half every three years. Operating costs are only for maintenance and upgrading. New technologies continue to emerge with potential to make the conversion to renewables more rapid and less costly. Advances in battery and other forms of energy storage will make regional "micro-grids" more efficient and reduce the need for a nationwide electrical grid. The marginal cost of a unit of energy will be much lower, in many cases near-zero. This is a revolution as big as the Industrial Revolution, and much more rapid.

20. Any number of other factors may cause these projections to understate the speed of the transition. Passenger vehicles and light trucks may be converted to electricity faster than presumed here – disruption almost always happens more rapidly than expected. Smaller passenger aircraft may be converted to electric more quickly than supposed. Note the example of Harbour Air in British Columbia which has announced plans to convert its fleet of 30 seaplanes to all-electric propulsion. Retrofitting building stock is likely to be sped by ongoing advances in modular construction; and any number of other advances in building design and techniques will make the path easier. Industries will have more efficient, less maintenance-dependent and longer-lasting power equipment.

21. The cost of living for most Canadians will go down. The costs of heating and air conditioning will be significantly reduced. Vehicle owners will save on fuel, and maintenance costs will go almost to zero (except for wear on tires).

22. Home and building retrofits will require substantial investments. In addition to necessary pubic financing (see para. 13 above), required capital might be raised through innovative financing mechanisms. For example, municipal retrofit loans that are repaid through property tax bills over time, or loans from utilities that are repaid though utility bills. Where governments act as loan guarantors, such mechanisms may be attractive to the capital market. Citizens might react positively to a bond issue for such a national project.

23. Through and after the transition, Canada will have an improved economy, an expanded workforce, a low-cost energy system based on abundance instead of scarcity, industrial output at higher efficiency and lower costs, and lower costs of living for householders.

24. Canada can meet its international commitments to reduce greenhouse gas emissions, and can meet the Green Party's goals set out in "Mission: Possible."

25. The mission is possible.

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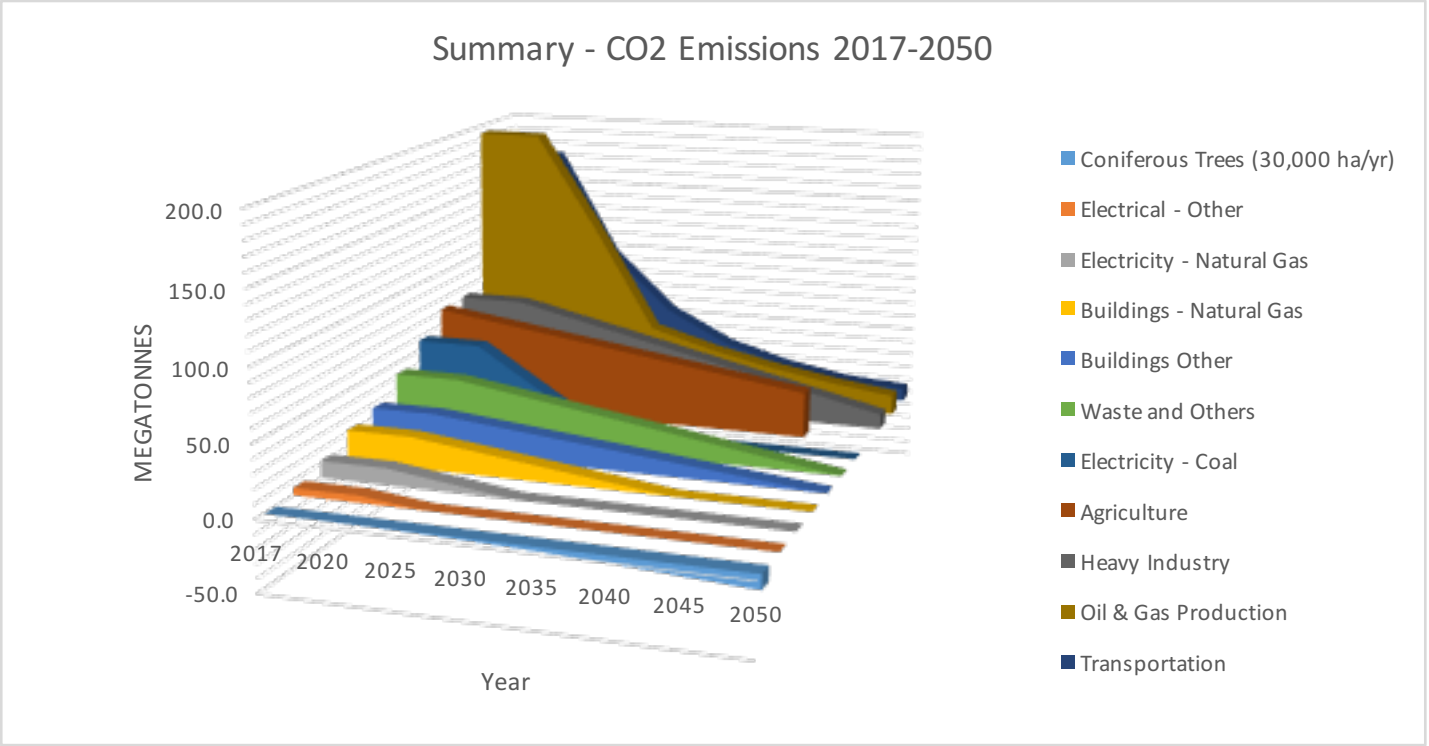
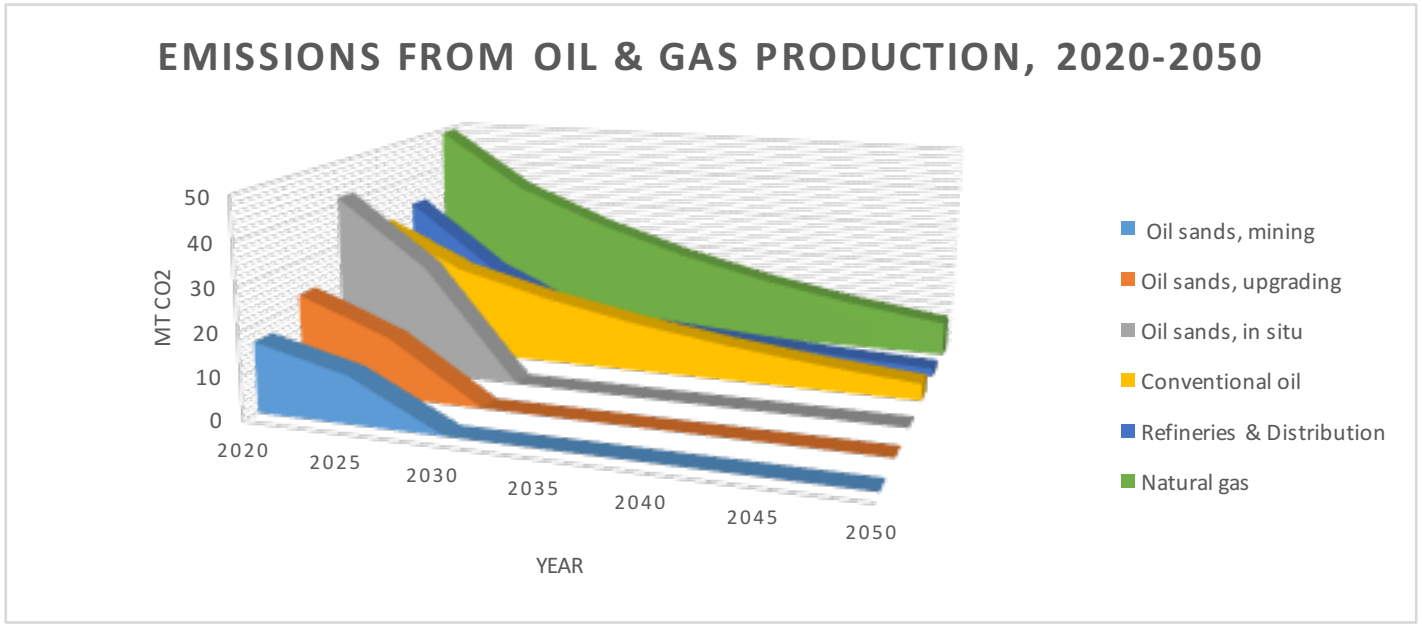
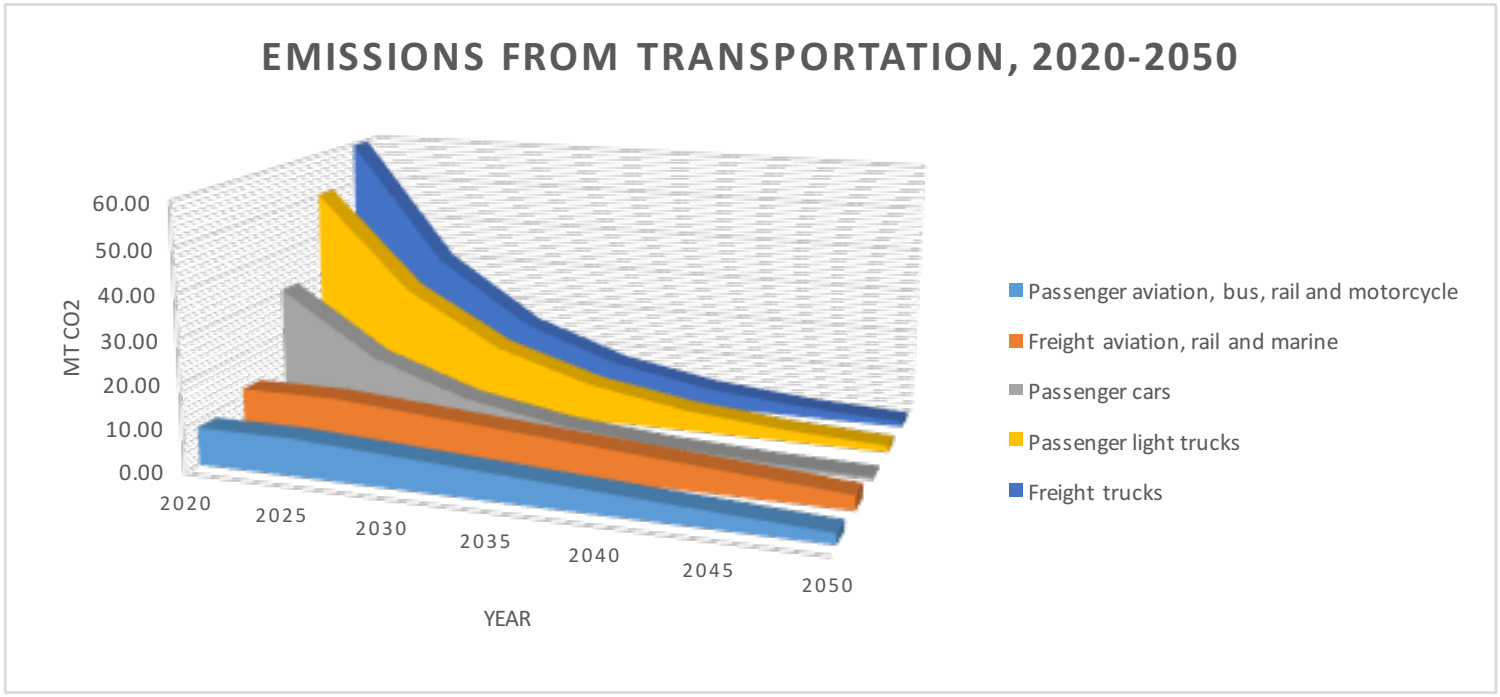


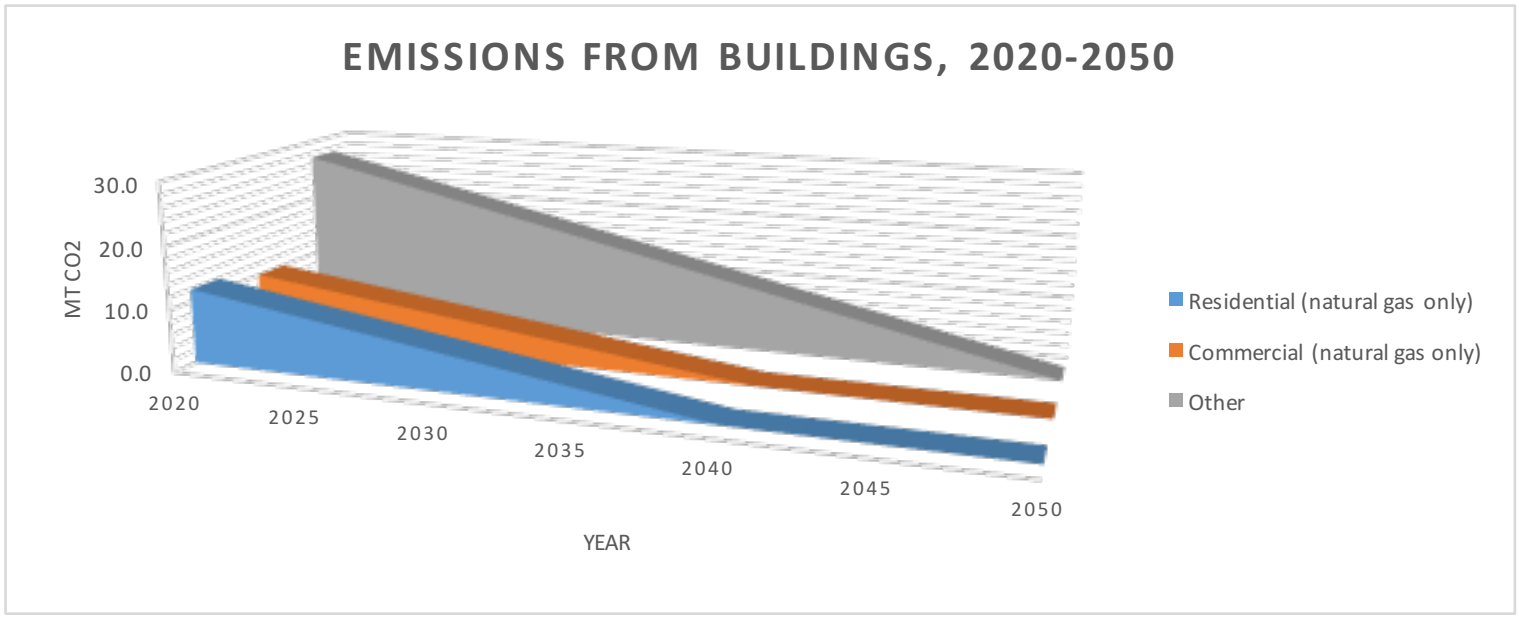
	2017	2020	2025	2030	2035	2040	2045	2050	cumulative % reduction
Coniferous Trees (30,000 ha/yr)		0.00	-0.51	-1.53	-3.05	-5.09	-7.64	-10.18	
Electrical - Other	5.1	5.1	0.0	0.0	0.0	0.0	0.0	0.0	-100%
Electricity - Natural Gas	11.8	11.8	5.9	0.0	0.0	0.0	0.0	0.0	-100%
Buildings - Natural Gas	22.2	22.2	16.6	11.1	5.5	0.0	0.0	0.0	-100%
Buildings Other	27.3	27.3	22.8	18.2	13.7	9.1	4.6	0.0	-100%
Waste and Others	42.0	42.0	35.0	28.0	21.0	14.0	7.0	0.0	-100%
Electricity - Coal	57.4	57.4	28.7	0.0	0.0	0.0	0.0	0.0	-100%
Agriculture	72.0	72.0	65.5	58.9	52.4	45.8	39.3	32.7	-55%
Heavy Industry	73.0	73.0	62.6	52.1	41.7	31.3	20.9	10.4	-86%
Oil & Gas Production	194.5	194.5	125.5	50.5	37.7	27.8	20.0	14.0	-93%
Transportation	174.7	174.0	97.4	56.2	33.3	20.1	12.3	9.1	-95%
Total	680.0	679.3	459.4	273.6	202.2	143.0	96.3	56.0	
Cumulative % Reduction	0%	0%	-32%	-60%	-70%	-79%	-86%	-92%	



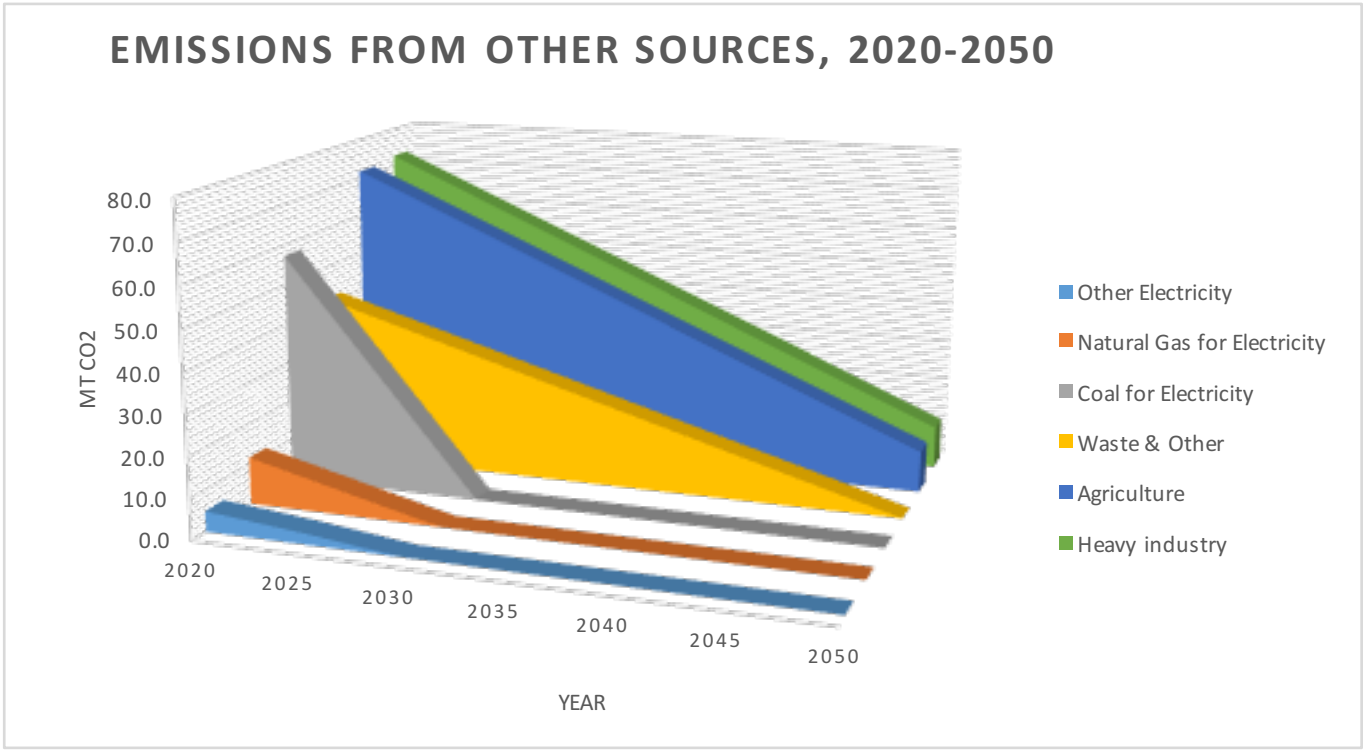
	2020	2025	2030	2035	2040	2045	2050	cumulative % increase
Oil sands, mining	16.4	11.100	0.000					-100%
Oil sands, upgrading	22.4	14.100	0.000					-100%
Oil sands, in situ	41.7	26.000	0.000					-100%
Conventional oil	31.3	21.376	15.984	11.785	8.515	5.968	3.984	-87%
Refineries & Distribution	33.20	17.37	7.54	5.58	4.05	2.87	1.94	-94%
Natural gas	49.5	35.55	27.02	20.38	15.21	11.18	8.04	-84%
Total	194.5	125.5	50.5	37.7	27.8	20.0	14.0	
Cumulative % Reduction	0%	-35%	-74%	-81%	-86%	-90%	-93%	



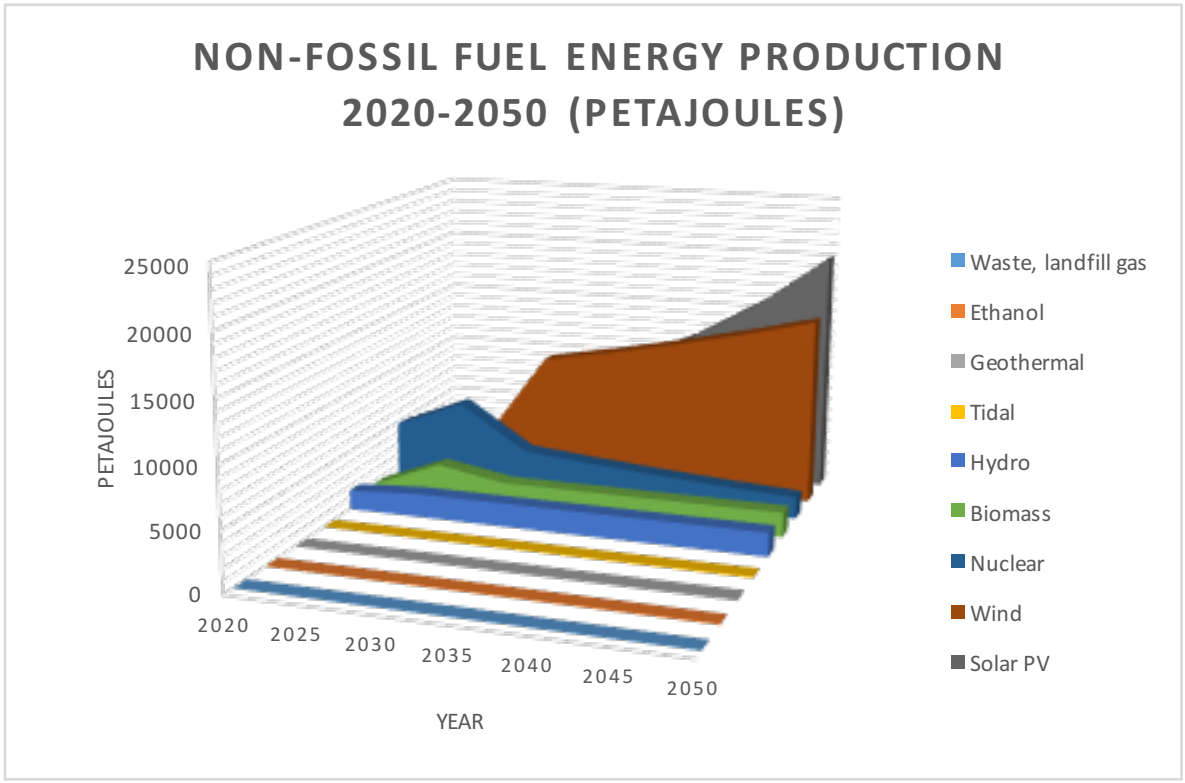
	2020	2025	2030	2035	2040	2045	2050	Cumulative % reduction
Passenger aviation, bus, rail and motorcycle	8.60	8.60	7.37	6.14	4.91	3.69	2.46	71%
Freight aviation, rail and marine	11.9	11.9	10.20	8.50	6.80	5.10	3.40	71%
Passenger cars	30.89	16.30	8.60	4.54	2.40	1.26	0.67	98%
Passenger light trucks	50.50	28.20	15.75	8.79	4.91	2.74	1.53	97%
Freight trucks	59.90	31.61	16.68	8.80	4.65	2.45	1.29	98%
Other Transport	8.90	4.70	2.48	1.31	0.69	0.36	0.19	98%
Total	170.69	101.31	61.08	38.09	24.36	15.61	9.54	
Cumulative % Reduction	0.00	-41%	-64%	-78%	-86%	-91%	-94%	



	2020	2025	2030	2035	2040	2045	2050	cumulative % reduction
Residential (natural gas only)	12.1	9.1	6.0	3.0	0.0	0.0	0.0	-100%
Commercial (natural gas only)	10.1	7.6	5.0	2.5	0.0	0.0	0.0	-100%
Other	27.3	22.8	18.2	13.7	9.1	4.6	0.0	-100%
Total	49.5	39.4	29.3	19.2	9.1	4.6	0.0	-100%
Cumulative % Reduction	0%	-20%	-41%	-61%	-82%	-91%	-100%	



	2020	2025	2030	2035	2040	2045	2050	cumulative % reduction
Other Electricity	5.1	2.8	0.0	0.0	0.0	0.0	0.0	-100%
Natural Gas for Electricity	11.8	5.9	0.0	0.0	0.0	0.0	0.0	-100%
Coal for Electricity	57.4	28.7	0.0	0.0	0.0	0.0	0.0	-100%
Waste & Other	42.0	35.0	28.0	21.0	14.0	7.0	0.0	-100%
Agriculture	72.0	61.7	51.4	41.1	30.9	20.6	10.3	-86%
Heavy industry	73.0	62.6	52.1	41.7	31.3	20.9	10.4	-86%
Total	261.3	196.7	131.6	103.9	76.1	48.4	20.7	-92%
Cumulative % Reduction	0%	-25%	-50%	-60%	-71%	-81%	-92%	



	2020	2025	2030	2035	2040	2045	2050	cumulative % increase
Waste, landfi	28	35	45	45	45	45	45	63%
Ethanol	44	57	72	72	72	72	72	63%
Geothermal	15	25	40	51	65	83	106	588%
Tidal	15	16	40	51	65	83	106	588%
Hydro	1636	1990	1994	1994	1994	1994	1994	22%
Biomass	800	3076	2075	2075	2075	2075	2075	159%
Nuclear	4858	7246	3510	2983	2536	2155	1832	-62%
Wind	526	2360	10581	11682	12898	14241	15723	2888%
Solar PV	264	676	7623	9729	12417	15847	20226	7575%
Total	8186	15480	25980	28683	32168	36596	42179	
Cumulative % Increase	0%	89%	217%	250%	293%	347%	415%	

Sources:

David Hughes - Canada's Energy Outlook
Natural Resources Canada - Energy and Economy
Natural Resources Canada - Energy and Greenhouse Gas Emissions
Department of Environment and Climate Change - GHG Emissions
Narwhal Magazine - Handy Facts About Canadian Energy
Bloomberg News - Oil Sands Production
Pembina Institute - Takeaways from Canada's Latest Greenhouse Gas Emissions
Mission: Possible - Green Party of Canada
Forestry Research and Engineering Journal: Carbon sequestration: how much can forestry sequester CO2?

Assumptions:

Light truck emissions/fuel economy regulations made equivalent to passenger cars in 2020
Average passenger vehicle lifetime assumed 15 years, light truck 10 years, freight truck 12 years
Electric light trucks assumed available by 2020, freight trucks by 2025
4% of conventional natural gas production maintained to 2050 for legacy users
18% of conventional oil production maintained to 2050 for legacy users
Electricity production from nuclear sources reduced by 39% by 2040 due to reactor aging (source: David Hughes)
30,000 ha of coniferous trees planted each year from 2020
CO2 absorption by coniferous trees assumed to grow linearly from 0 at planting to maximum 53 T/ha at year 25

METHODOLOGY

Emissions all in MegaTonnes (MT) of CO_2. CO_2 is used here as an imperfect but convenient proxy for all greenhouse gases ("GHGs"). In particular, no accounting is made here for the large amounts of methane emitted in fracking for natural gas, or for other non-CO_2 GHGs emitted in agriculture.

Production all in PetaJoules (PJ)

All base data on production, emissions from NRCAN or Environment and Climate Change Canada

Emissions targets from Mission: Possible - 60 % reduction from 2005 levels by 2030, 100% reduction by 2050

Base emissions for all projections from 2017, total 716MT, overall reduction of 2% from 2005 730MT

Oil sands mining, in situ and upgrading eliminated by 2030

Fracked natural gas production eliminated by 2030

Residential and commercial buildings assumed free of natural gas by 2040, retrofits yield net zero emissions by 2050

Electricity production from coal and natural gas eliminated by 2030

Heavy Industry emissions assumed 15% legacy emissions by 2050

Agriculture emissions assumed 14% legacy emissions by 2050

Waste and other emissions assumed 0 by 2050

For each sector, base year set at 2017 for emissions and production

Conventional oil and gas production/emissions declines exponential from 2020 start to 0 by 2060

Oil sands, fracked natural gas production/emissions decline exponential from start 2020 to 0 by 2030

All other sectors emission declines assumed linear from 2020 to specified end year

Wind energy production rises at 35% per year until 2030, 2% per year thereafter

Solar PV energy production rises at 40% per year until 2030, 5% per year thereafter

Geothermal, tidal energy production rises at 10% per year until 2030, 5% per year thereafter

Biomass energy production rises at 10% per year until 2030, 0% per year thereafter

Ethanol, waste landfill gas energy production rises at 5% per year until 2030, 0% per year thereafter

Hydroelectric energy production rises at 2% per year until 2030, 0% per year thereafter

Electricity exports to the United States of 3,120 PJ diverted to domestic uses for years 2025-2030

Notes:

These projections show only one possible path of many that could lead to the same goals. The choices made to arrive at these results are the responsibility of the writers. Other options must also be explored. The Green Party of Canada looks forward to discussing other suggested pathways and combinations of actions, and to agreement among all parties on the optimal way forward.

One constraint binds all other choices. The only way to achieve a 60% reduction in CO2 emission by 2030 is to begin immediately to cut production of fracked natural gas and bitumen for fuel with the clear and explicit goal of ending it entirely by 2030.

This scenario shows a rapid deployment of solar PV and wind power. Wind power now has a larger installed base and has experienced rates of growth exceeding that of solar for the last few year. The levelized cost of energy delivered by wind and solar are now close to par, but the costs of solar are dropping more rapidly. The choice to favour solar in the long term in this model was made because available evidence indicates that the costs of solar PV continue to decline at a rate of about 20% per year, while future decreases in the cost of wind power may well level out.

Likewise, the model shows only a small contribution to renewable energy from biomass, geothermal and tidal sources. Biomass in particular may have larger potential, especially because in Canada energy from biomass is mainly derived from combustion of wood industry waste, not from purpose-grown materiel. Geothermal also may have excellent potential through low-cost development of abandoned oil wells for thermal power potential. This is so far shown only at demonstration levels, and its potential is not included here. Tidal power is similarly not yet commercially established, but may have great potential.

Past 2030, there are clearly many attractive choices for generation of clean electrical energy. As time passes, capital costs will continue to decline and efficiencies will continue to rise over time, resulting in an energy economy based on abundance and very low marginal cost, rather than today's economy based on scarcity and continuously rising financial and environmental cost.

In the period from 2025 to 2030, this model shows substantial decline in energy production from fossil fuels, before renewable energy can ramp up to meet the demand, and before retrofitting buildings yields substantial demand reductions. That deficit may be met by temporarily showing restrictions of exports of electricity to the United States. As renewable energy and fossil fuel production increases in the US, US demand for imported Canadian energy will likely continue to be reduced anyway.

Finally, the annual rates of increase shown here in both wind and solar PV (40% and 35% respectively until 2030) are large, even given a small installed base. In addition to the actual generation of the electricity, a functioning national electrical grid is required. The demand for supplies and for labour to meet such rates of increase will be substantial and shortages may delay implementation.