

GHG Emissions Quantification and Reporting

Darshita Guckhool

Abstract

This project focuses on quantifying and analyzing greenhouse gas (GHG) emissions from facility-level data across Canada. The project assesses GHG emissions trends from 2004-2022, where we analyze the different provinces, facility, corporations and types of gases that contribute to GHG emissions over time, with supporting visualizations that can assist with data-driven policy and economic decisions.

Keywords

- GHG – Greenhouse gas
- CO2 – Carbon Dioxide

Findings

As can be seen in the bar chart below, when we compare the total emissions by provinces in Canada, Alberta has taken a significant lead in GHG emissions, almost the same as all the other provinces combined. This high rate in emissions can be attributed to the booming oil and gas industry in Alberta along with differences in public and political views compared to the remainder of the provinces. Alberta has had over 2.5 billion tonnes of CO₂ emissions between 2004 and 2022.

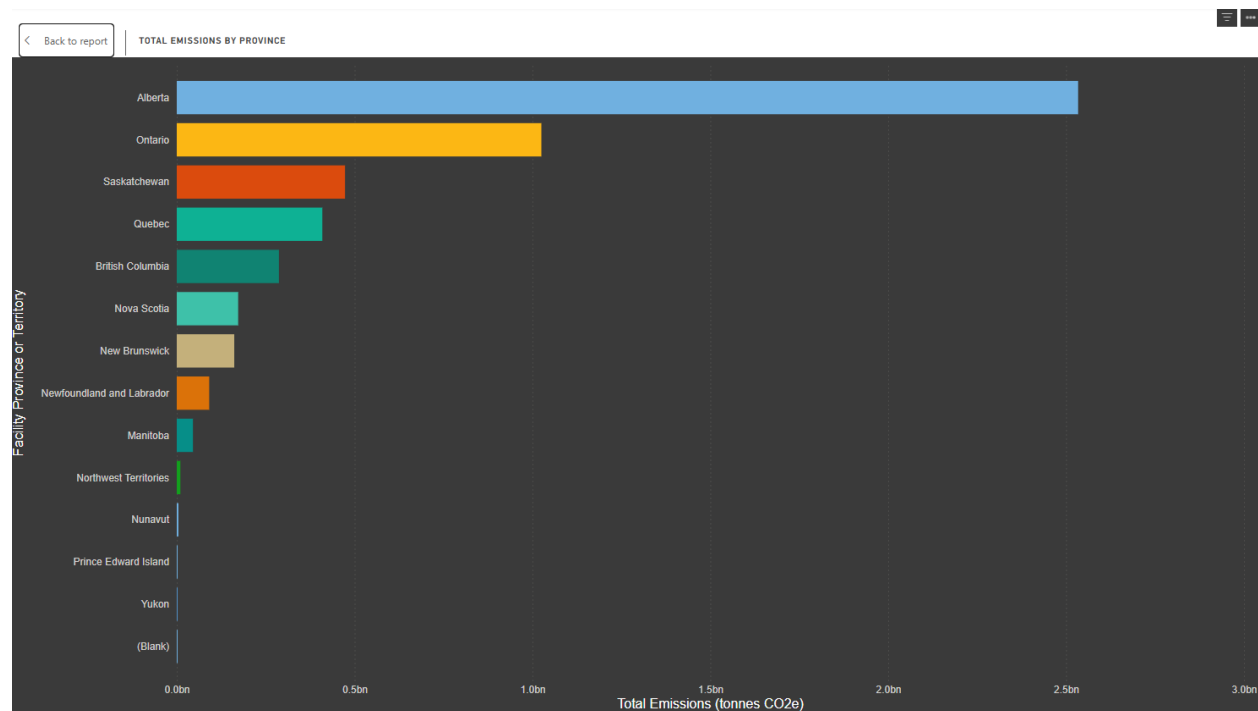


Fig 1.1 Total Emissions by Province

Another reason for Alberta having such high emissions compared to the other provinces is the sheer number of high emitting facilities present in Alberta. Majority of all electricity generation, oil extraction and thermal generation occurs in Alberta, the stacked column chart below clearly represents how Alberta holds majority of all high emitting facilities (marked in dark yellow). We notice that the Genesee Thermal Generating Station, Mildred Lake and Aurora North Plant and Sundance Thermal Electric Power Generating Plant are the highest CO₂ emitters.

Having a lot of high emitting facilities doesn't necessarily mean that Alberta as a province or Canada in general are not careful of their emissions. In fact, compared to other nations like China, Russia and the United States, Canada has relatively lower GHG emissions. This does pose economic challenges because they do not fully utilise all their natural resources, but this does give them the opportunity to diversify their energy production to more renewable alternatives.

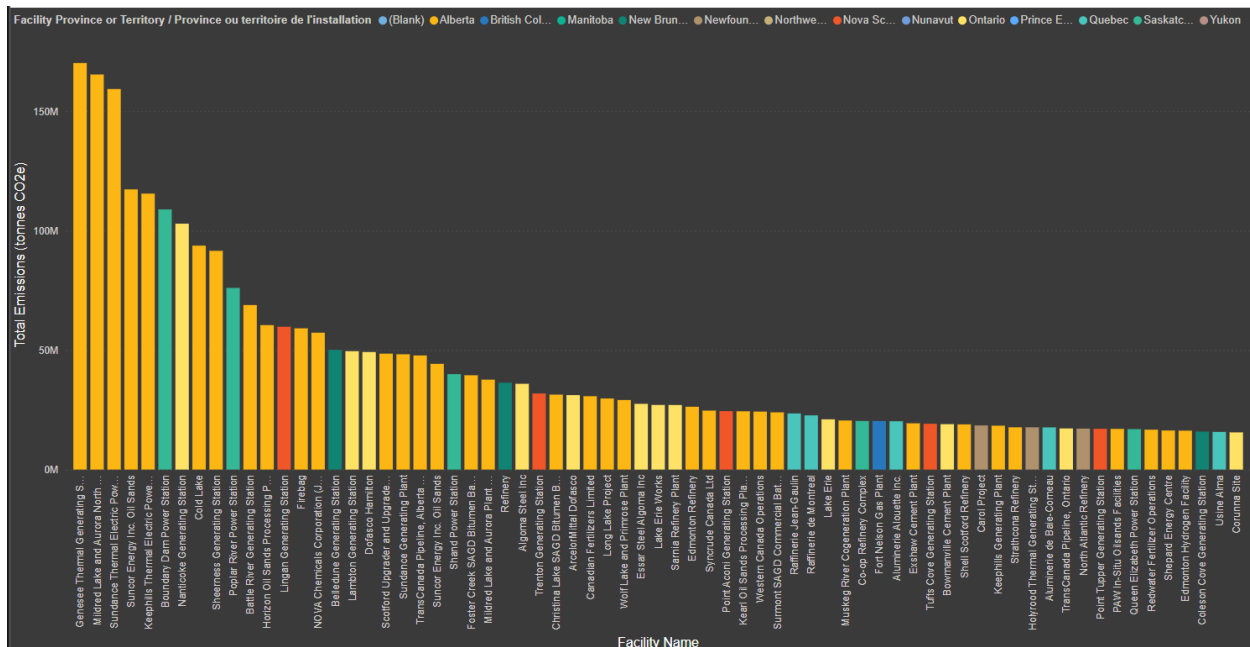
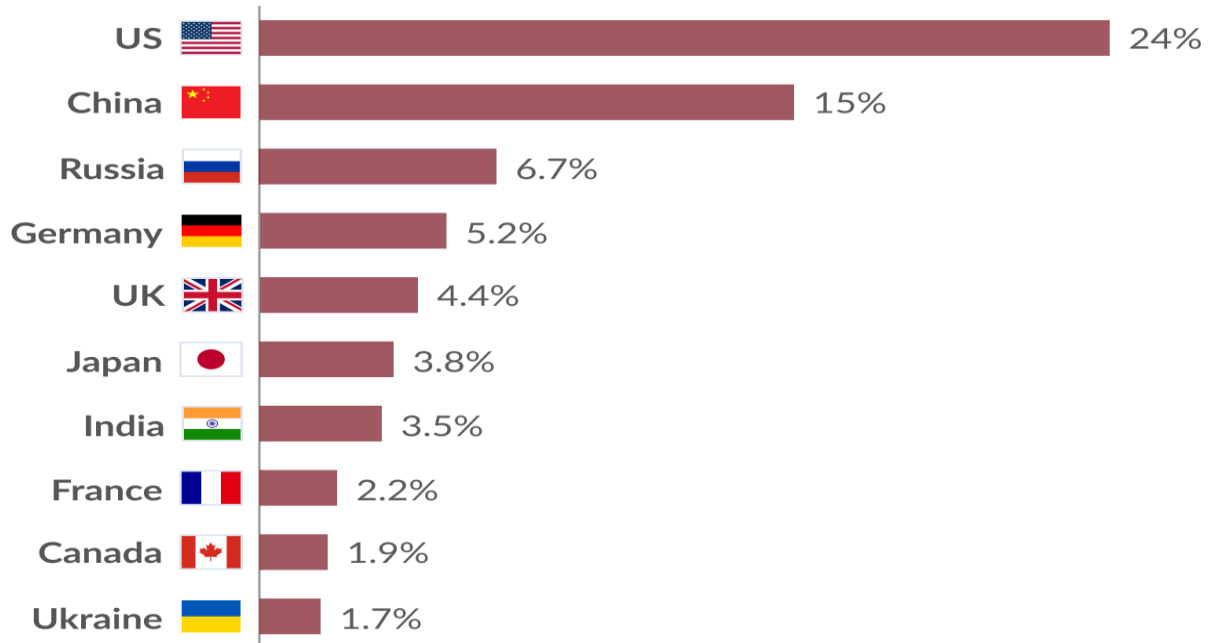


Fig 1.2 Emissions by Facility and Province.

Countries that have emitted the most CO₂ emissions to date

Our World
in Data

Each country's share of global cumulative CO₂ emissions since 1750. This measures fossil fuel and industry emissions; land use is not included.



Data source: Global Carbon Budget (2024)

CC BY

<https://ourworldindata.org/data-insights/which-countries-have-contributed-the-most-to-historical-co-emissions>

Fig 1.3 Countries with the most CO₂ emissions.

Previously in the report whenever we mention GHG emissions we have mainly been referring to CO₂ and there is a reason for that. GHG or greenhouse gases include a number of gases, out of which the key gases are CO₂, Methane (CH₄), Nitrous Oxide (N₂O), fluorinated gases, Water Vapor and Ozone (O₃). Amongst all these gases, CO₂ is the most major contributor to the greenhouse effect.

The pie chart below shows the distribution of the different gases emitted by all the provinces and its clearly observable that CO₂ is the most prominent GHG emitted.

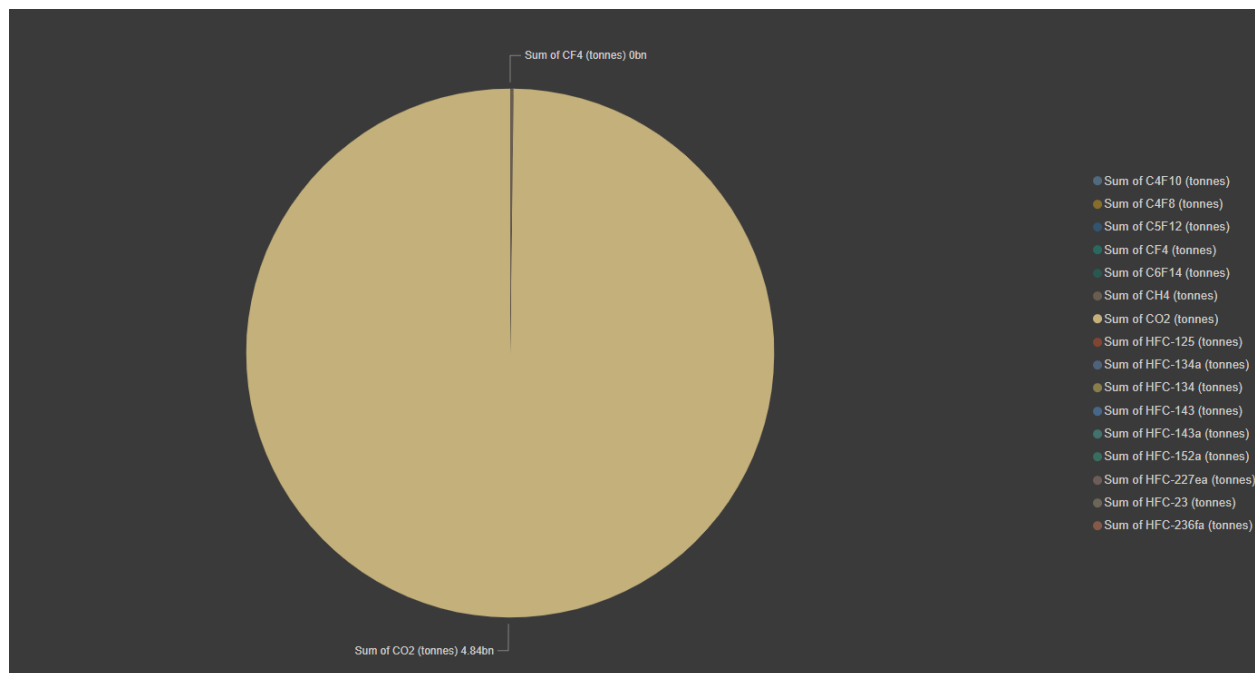


Fig 1.4 Distribution of Emitted Gases

To really analyse the root causes of GHG emissions, it not only necessary to find out which provinces or which gases make up most of the emissions but to make data driven decisions, we also need to know what kind of facilities or in the production of what products are the high CO₂ emissions happening. The clustered chart below shows the emissions different facility types have and it's clear that fossil fuel electric power generation contributes the most to GHG emissions. So, the question now arises, how to do we combat rising CO₂ emissions, well we know fossil fuel emissions are the highest, so then let's replace them. The solution isn't as simple as it sounds, technological advancements have been improving the consumption of renewable energy, however it is important to note that not all renewable energy sources can meet the energy demands of a growing population. It is also important to consider the economic consequences of conducting this, Canada is in the midst of a recession and taking away jobs of people working in fossil fuel industries will just make matters worse, especially for Alberta, who's economically reliant on the fossil fuel industry.

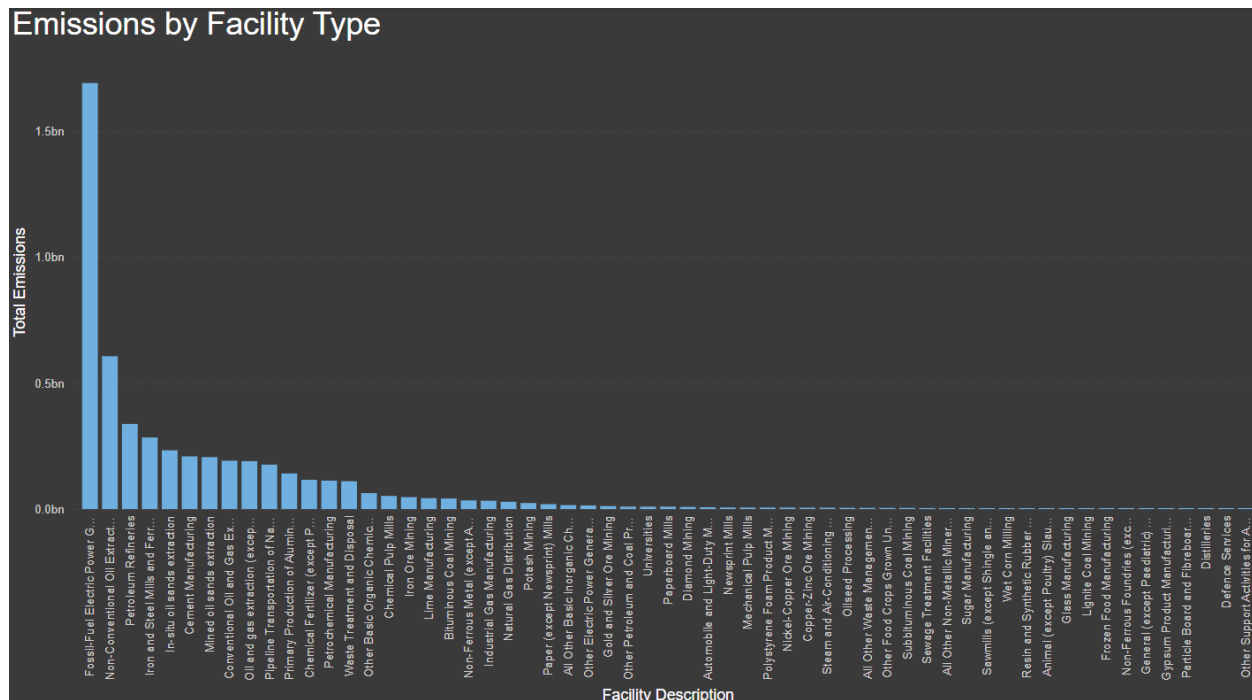


Fig 1.5 Emissions by Facility Type

Conclusion

GHG emissions are increasing globally however Canada plays a small role in it. Increasing population and energy demand in Canada may change that however and in order to reduce CO₂ emissions, Canada would need to tone down its fossil fuel power generation. Doing this can disrupt the energy balance and can worsen the already existing recession in the economy. So it boils down to finding better renewable energy sources.

References

- Canada's National Greenhouse Gas Reporting Program (GHGRP)
- Environment Canada – Emissions Inventory Reports
- Provincial Environmental Agencies

Tools and Technologies

- Python (pandas, matplotlib, seaborn) – Data processing & visualization
- Power BI – Interactive dashboards for emissions trends
- Excel – Data cleaning & formatting