Emissions and Covid

How did Covid impact Air Quality and Why?

Contents

Project Overview

Objectives

- Determine the impact of Covid to air quality and identify factors that were key contributors to those changes

- Discover patterns during Covid that improved air quality and determine if those factors are repeatable post-Covid.

- Explore less obvious dimensions during Covid that also contributed positively or negatively to Air Quality. Such as, political, geographic and demographics.

Project Overview

Key Questions

1. What regions showed the most improvement in air quality and why?

2. What regions showed the least improvement in air quality and why?

3. What did emissions and air quality look like before, during and post-Covid?

4. What changes to 'status quo' happened during Covid that affected emissions and air quality, and can they be reproduced post-Covid?

5. Did types of fuel have different effects on emissions?

Project Overview

Method

1. Research publicly available datasets for air quality, emissions, travel, work force patterns, manufacturing and emission producing sectors.

2. Determine best scope for analysis – most consistent data, timeframe available, geographic information and credibility of source data.

3. Identify patterns related to Covid

4. Using Tableau and Excel, explore the best graphic presentation for each data element.

5. Analyze and ask questions
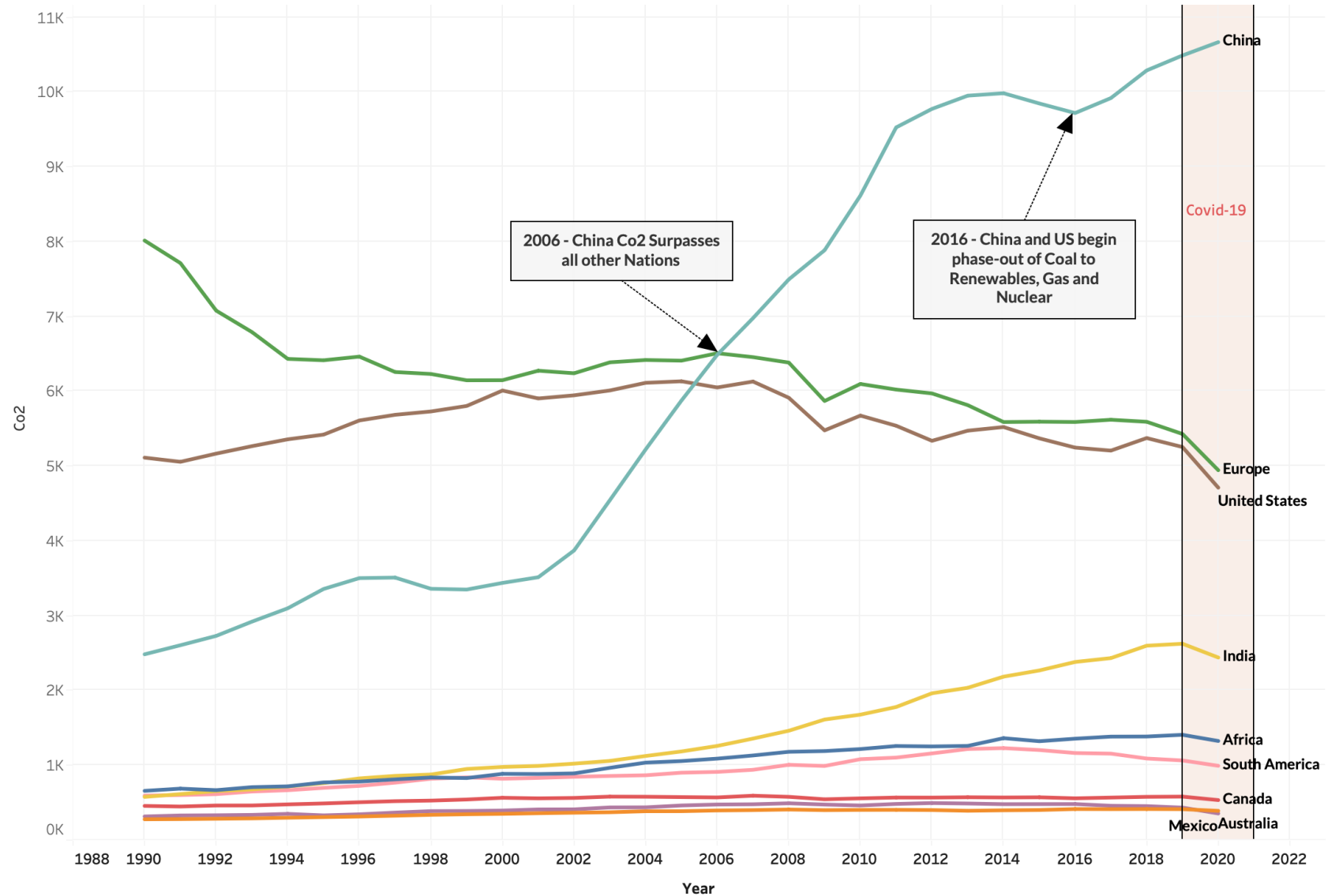
About Emissions

Primary Greenhouse Gases
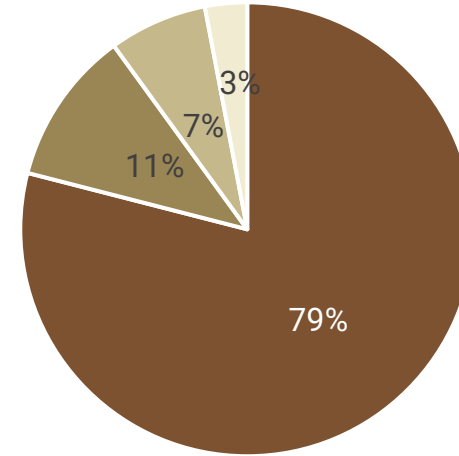
- **Carbon Dioxide (CO2)** ■ **Methane (CH3)**
- **Nitrous Oxide (N2O)** ■ **Fluorinated Gases**

- **CO2** enters the atmosphere primarily through the burning of fossil fuels.

- **Methane** is emitted from agricultural activities and during production of coal, gas and oil.

- **Nitrous oxide** is emitted during agricultural land use, and industrial activities; combustion of fossil fuels and solid waste; as well as during treatment of wastewater

- **Particulate Matter (PM)** is a mixture of chemicals, soil, moisture, and other particles too small to see without magnification and can contain hundreds of chemicals with unpredictable interactions. Airborne particulate matter of 2.5 or less micrometers (PM2.5) in diameter enters our lungs
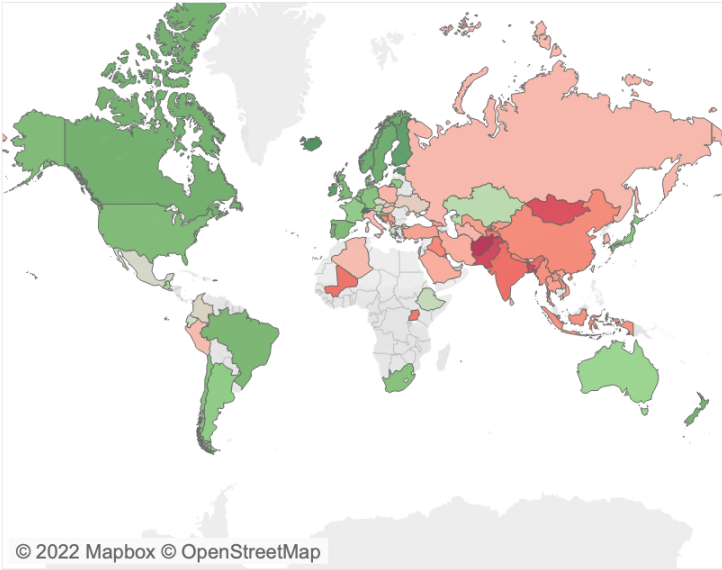
Historical Global CO2 Emissions

China vs. Rest of the World

- Until 2006, China emissions were lower than other industrialized nations.

- In 2006, China began to exceed all other nations and by 2019 China emissions were twice the combined emissions of the rest of the world.

- In 2016 many countries including China, US and Europe began to show a decrease in emissions. Primarily due to movement to renewable energy sources.
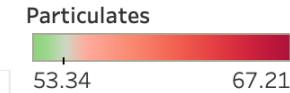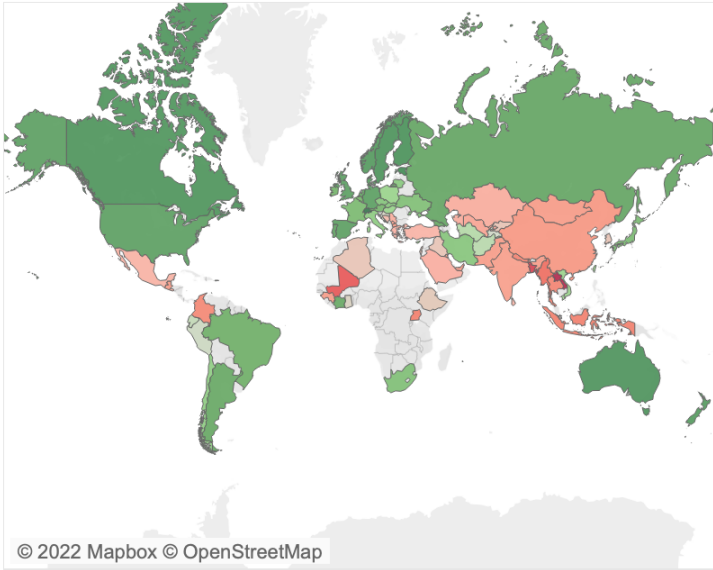
2006 - China Co2 Surpasses all other Nations

2016 - China and US begin phase-out of Coal to Renewables, Gas and Nuclear

Covid-19

China

Europe

United States

India

Africa

South America

Canada

Mexico Australia

Co2

Year

Air Quality - Airborne Particulates (PM 2.5)

December 2019

© 2022 Mapbox © OpenStreetMap

March 2020

© 2022 Mapbox © OpenStreetMap

Particulates

53.34 — 67.21

November 2021

© 2022 Mapbox © OpenStreetMap

2018 to 2022

Date

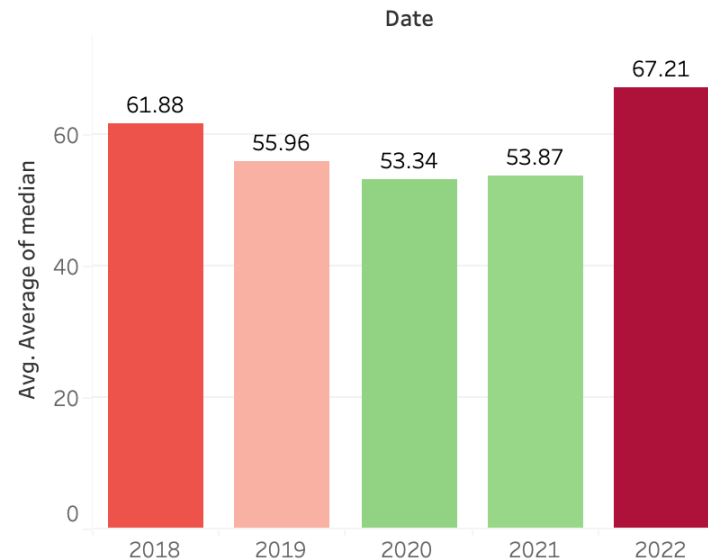- 2018: 61.88
- 2019: 55.96
- 2020: 53.34
- 2021: 53.87
- 2022: 67.21

Avg. Average of median
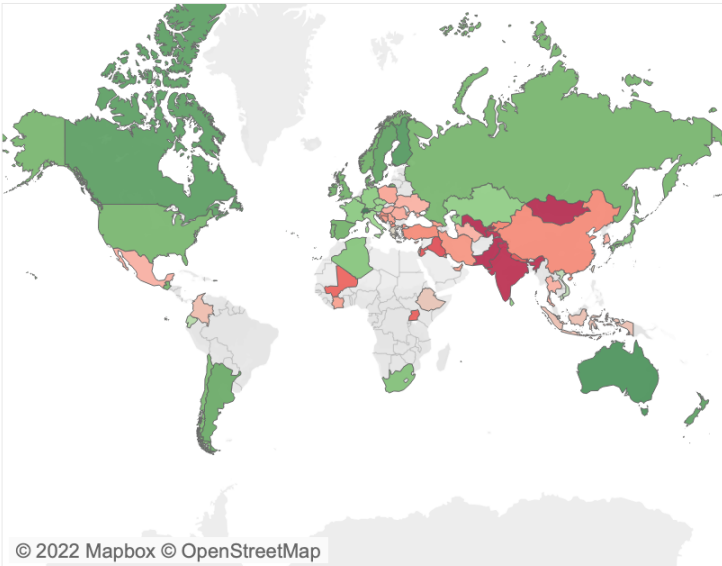
Air Quality and Covid

- Air Quality is best measured on amounts of particulates in the atmosphere.

- Between 2019 and 2020, particulates decreased worldwide as a result of lockdowns and decreased manufacturing activity.

- By 2021, China, India and Mexico began to show measurements close to pre-Covid.

- By 2022, Air Quality was worse than pre-Covid.

Covid and Seasonal Effects

- This graph shows the seasonality of CO2 emissions worldwide.

- Seasonal lowering of CO2 is primarily due to the 'greening' in the Spring and throughout the summer. The increase in plants and photosynthesis, which consumes CO2, during Spring and Summer result in reduced CO2 in the atmosphere.

- Though 2020 experienced the same seasonal drop in CO2, because of Covid, the drop was greater.

Global CO2 Emissions 2019 - 2021
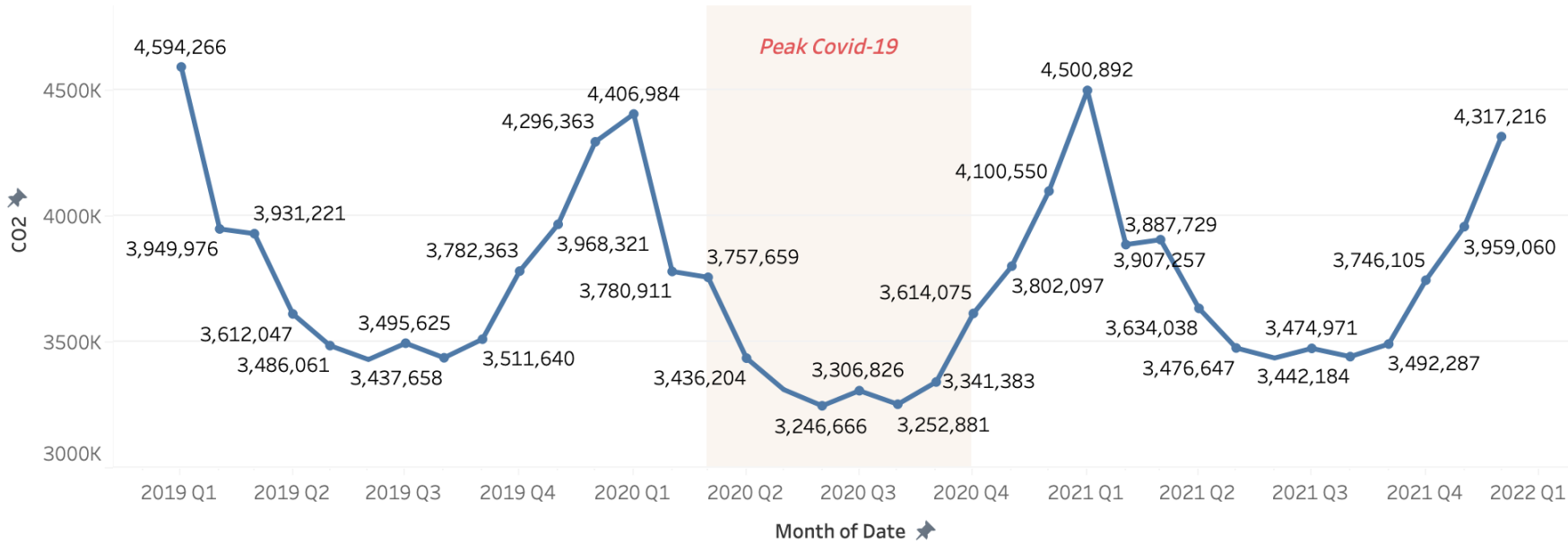
Group of Twenty (G20) CO2 2019 to 2021
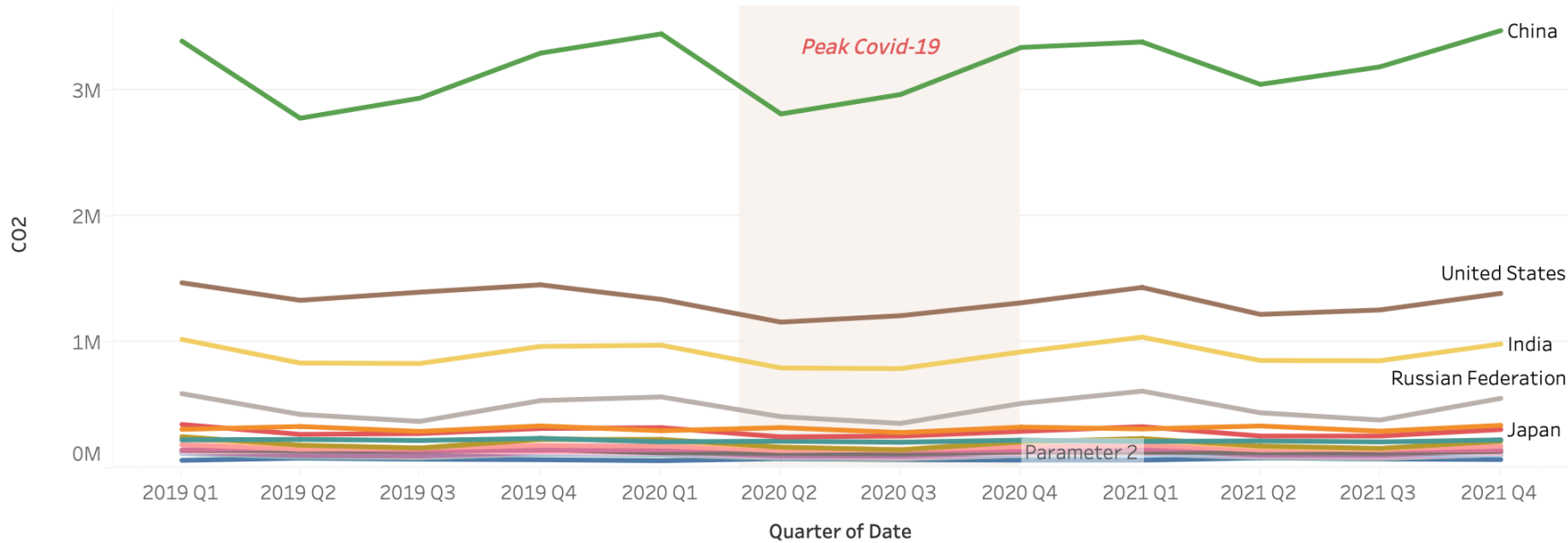
Assumptions & Disclaimers

Assumptions and Disclaimers
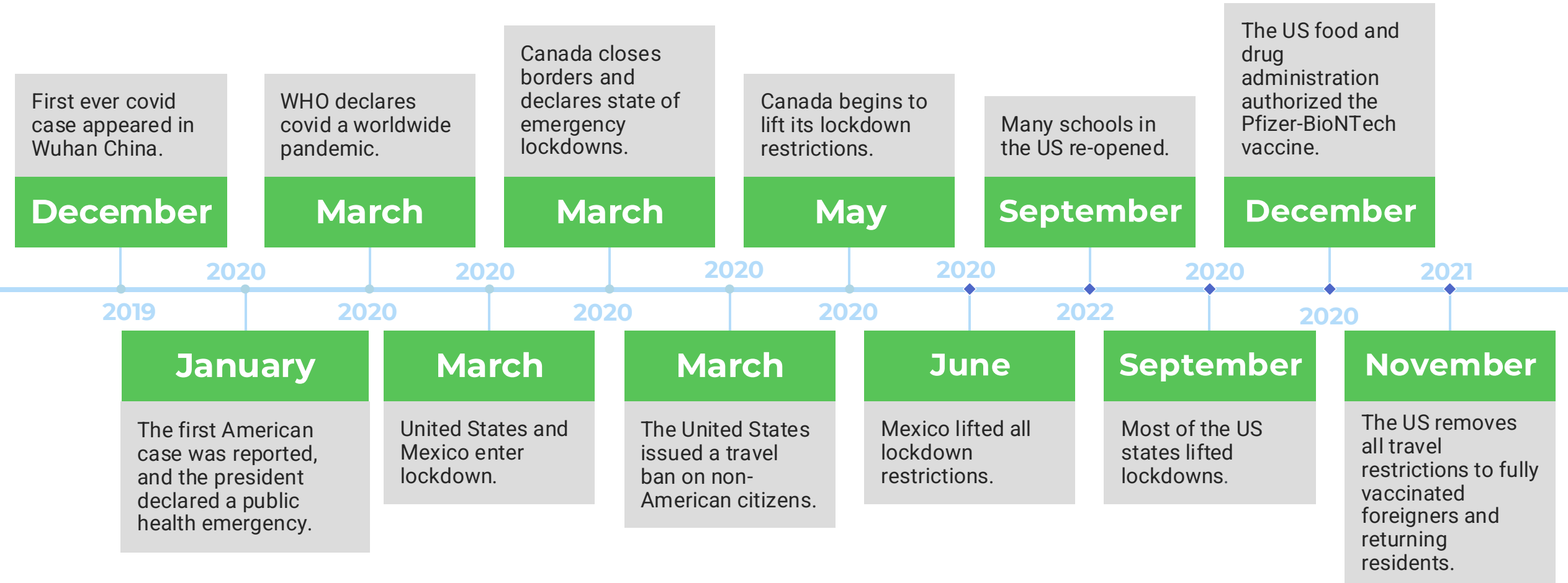
1. Aside from some Global Level Air Quality and CO2 emissions data, it was very difficult to find consistent measurements globally for other measures needed to fully analyze Covid-19 effects on Climate. Because of this, the analysis specific to Covid cause-effect addressed North America only – specifically US, Canada and Mexico.

2. Air travel and Stay-at-Home data was only available for the US. However, as the US is by far the major contributor of emissions in the Northern Hemisphere, we felt it was indicative of North America.

3. Carbon Dioxide (CO2) and Particulate Matter 2.5 microns or less (PM2.5) were the primary measurement for emissions and air quality because these data points are the biggest contributor to climate change and poor air quality.

4. CO2 data was taken from the Our World in Data "Our World in Data CO2 and Greenhouse Gas Emissions" database

5. Air Quality PM2.5 measurements were taken from the Air Quality Open Data Platform's "COVID-19 Air Quality Worldwide 2022 Dataset"

6. Air Travel statistics were for US only due to lack of detail for other countries. Statistics obtained from tsa.gov website.

7. US energy consumption by type of fuel data is from the U.S. Energy Information Administration.

8. People staying at home data was obtained from the US Department of Transportation. This data was calculated using GPS data from mobile phones across the US population. Data is anonymized.
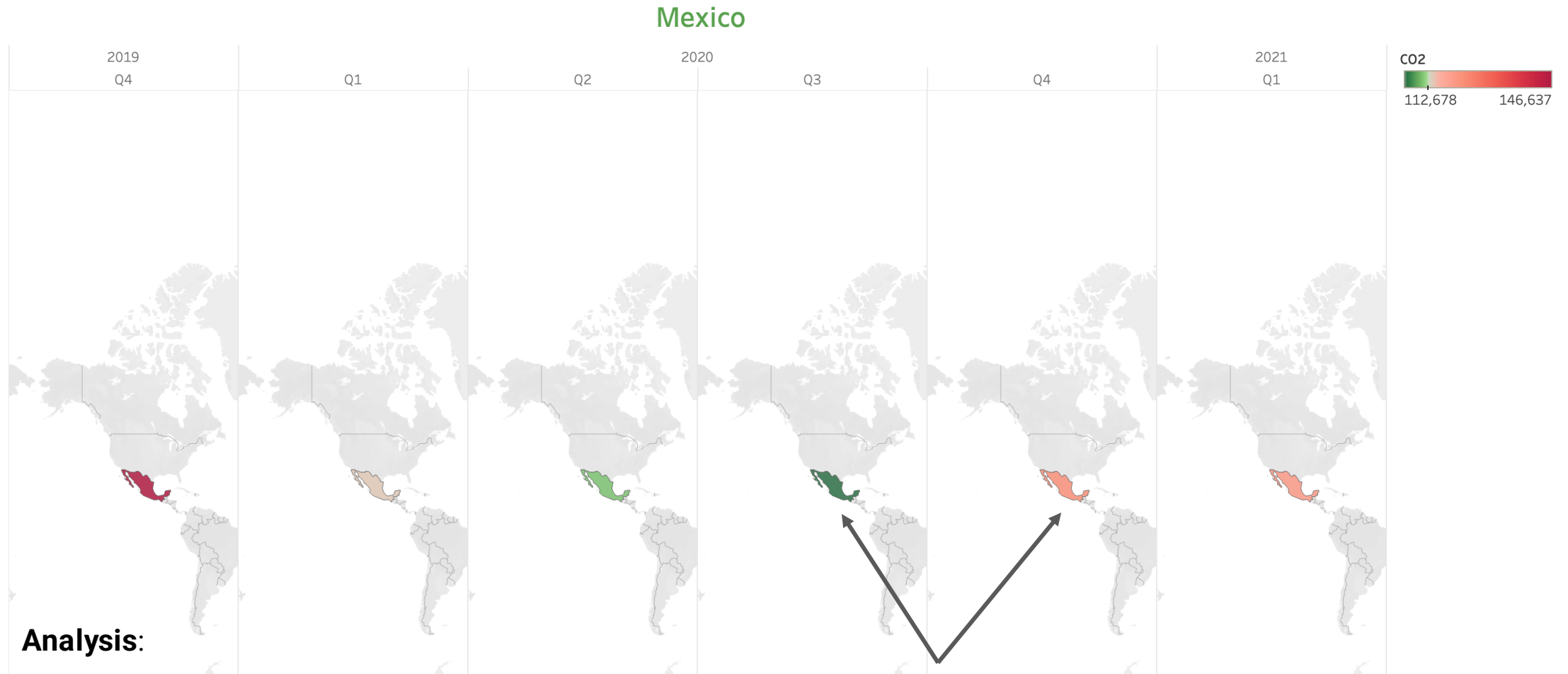
Data Insights

Covid and its impact on North America

COVID-19 Timeline

For The United States, Canada, and Mexico

First ever covid case appeared in Wuhan China.

December

2019

WHO declares covid a worldwide pandemic.

March

2020

Canada closes borders and declares state of emergency lockdowns.

March

2020

Canada begins to lift its lockdown restrictions.

May

2020

Many schools in the US re-opened.

September

2020

The US food and drug administration authorized the Pfizer-BioNTech vaccine.

December

2020

2020

January

The first American case was reported, and the president declared a public health emergency.

2020

March

United States and Mexico enter lockdown.

2020

March

The United States issued a travel ban on non-American citizens.

2022

June

Mexico lifted all lockdown restrictions.

2020

September

Most of the US states lifted lockdowns.

2021

November

The US removes all travel restrictions to fully vaccinated foreigners and returning residents.

Air Quality for Mexico 2019 Q4 to 2021 Q1

Mexico

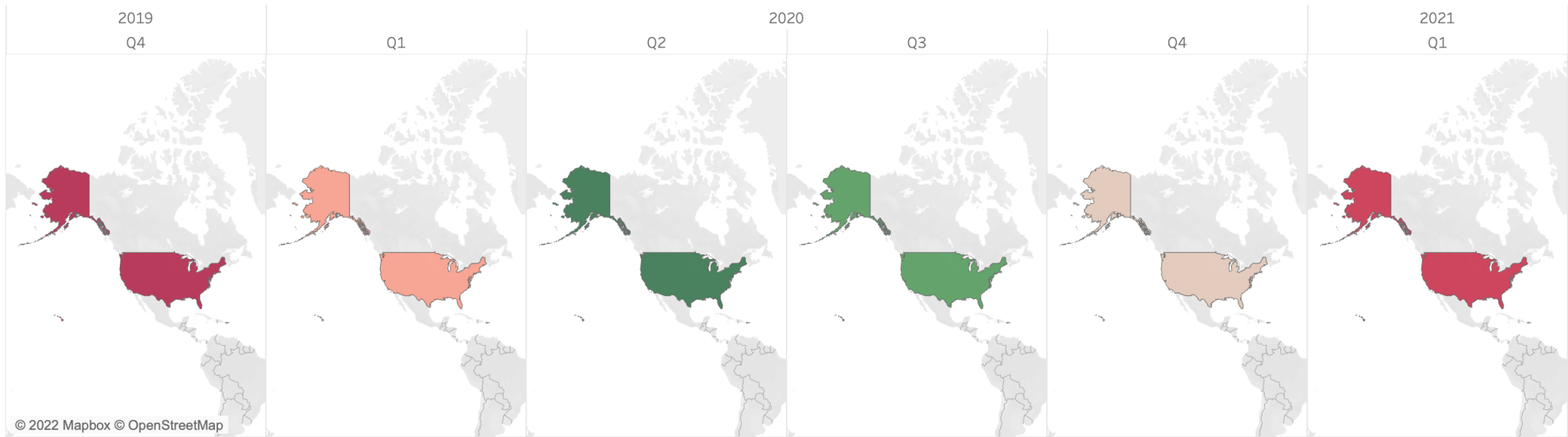| 2019		2020			2021
Q4	Q1	Q2	Q3	Q4	Q1

CO2

112,678   146,637

Analysis:

- Mexico's Air Quality decreased in Q4-2020 because political pressure from the US pushed Mexico to re-start manufacturing critical to the US.

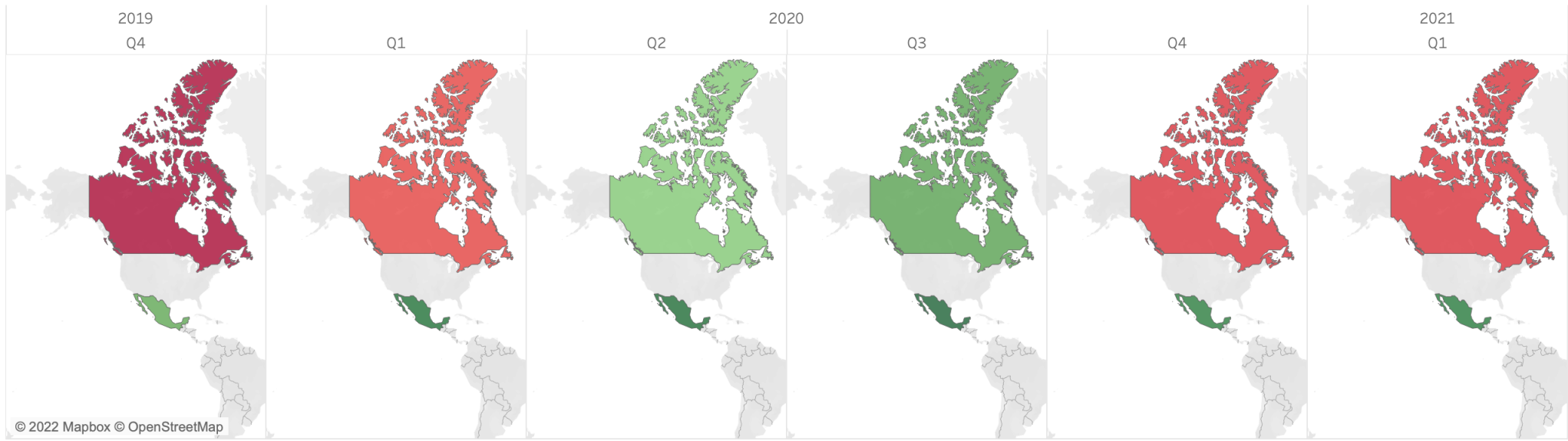# Pre-Covid, Covid and Post-Covid CO2
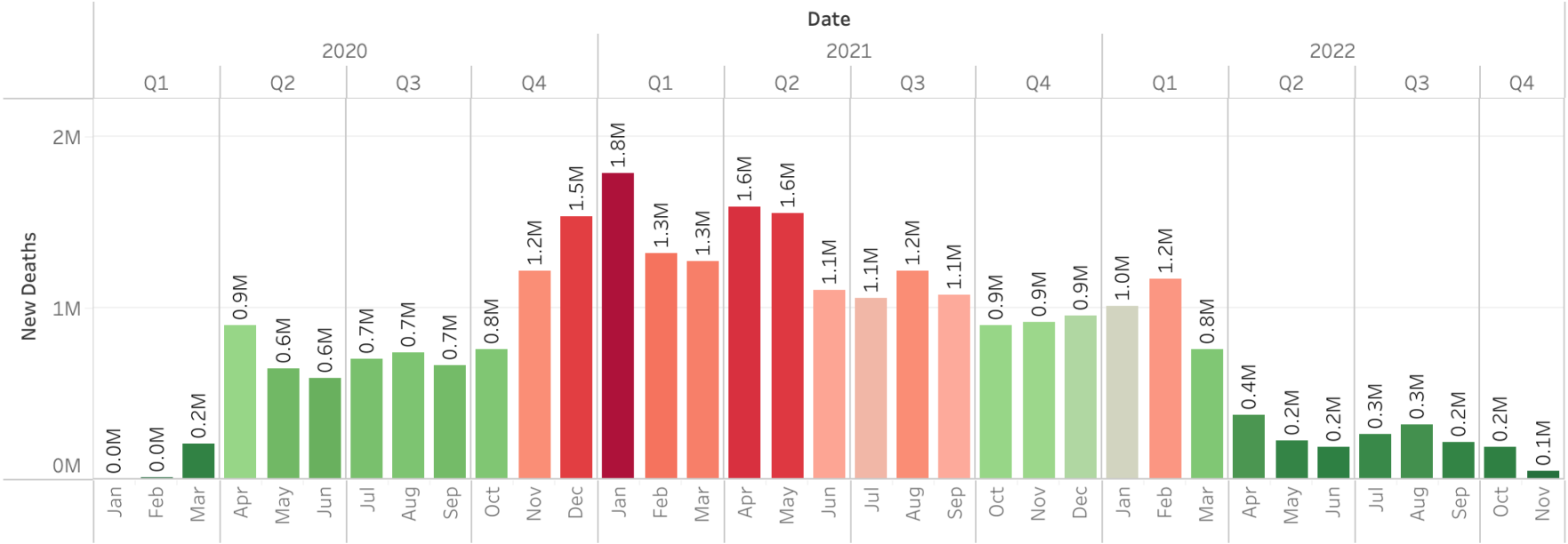
United States

Analysis:

- Reductions started in Q1 2020 and continued through 2020

- US almost at Pre-Covid levels by Q1 2021

- Mexico did not see as dramatic reduction in CO2 because of US pressures to re-start manufacturing.
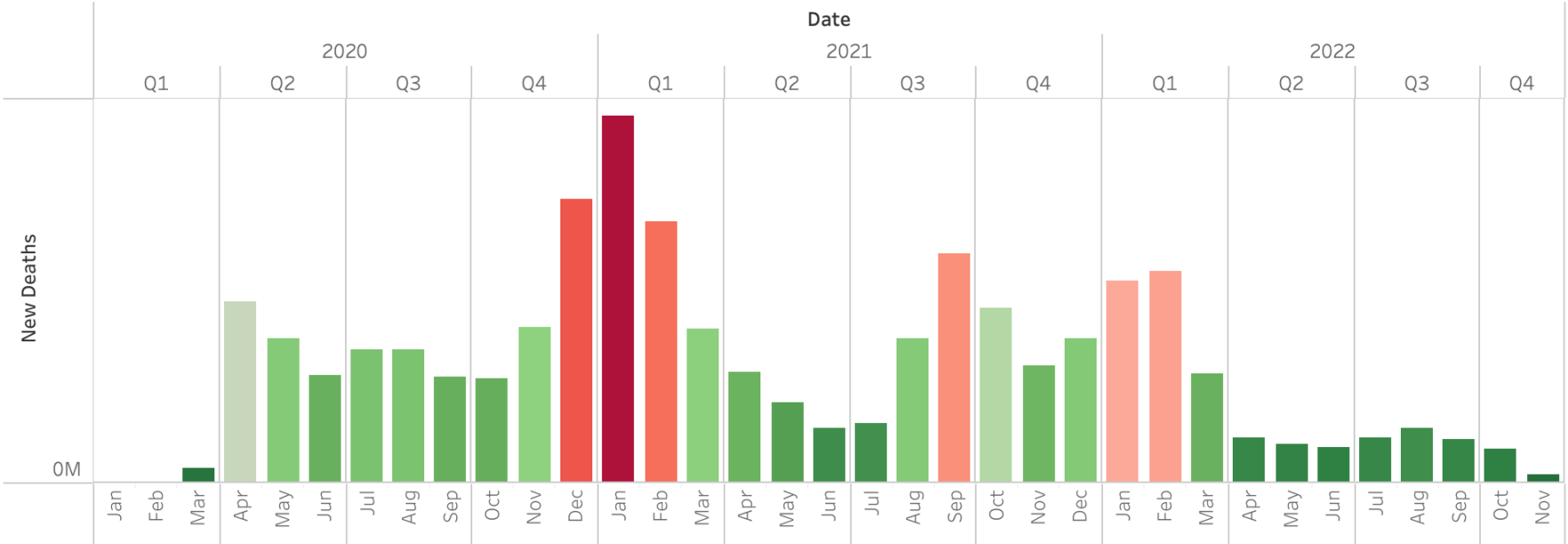
Canada and Mexico

Global Covid Deaths

New Deaths by Date

2020											2021												2022								

2020: Q1 (Jan 0.0M, Feb 0.0M, Mar 0.2M), Q2 (Apr 0.9M, May 0.6M, Jun 0.6M), Q3 (Jul 0.7M, Aug 0.7M, Sep 0.7M), Q4 (Oct 0.8M, Nov 1.2M, Dec 1.5M)

2021: Q1 (Jan 1.8M, Feb 1.3M, Mar 1.3M), Q2 (Apr 1.6M, May 1.6M, Jun 1.1M), Q3 (Jul 1.1M, Aug 1.2M, Sep 1.1M), Q4 (Oct 0.9M, Nov 0.9M, Dec 0.9M)

2022: Q1 (Jan 1.0M, Feb 1.2M, Mar 0.8M), Q2 (Apr 0.4M, May 0.2M, Jun 0.2M), Q3 (Jul 0.3M, Aug 0.3M, Sep 0.2M), Q4 (Oct 0.2M, Nov 0.1M)

North America Covid Deaths
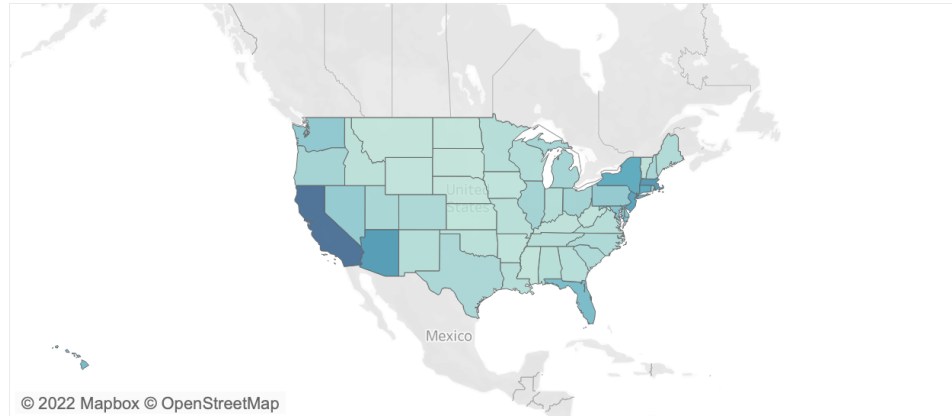
New Deaths by Date

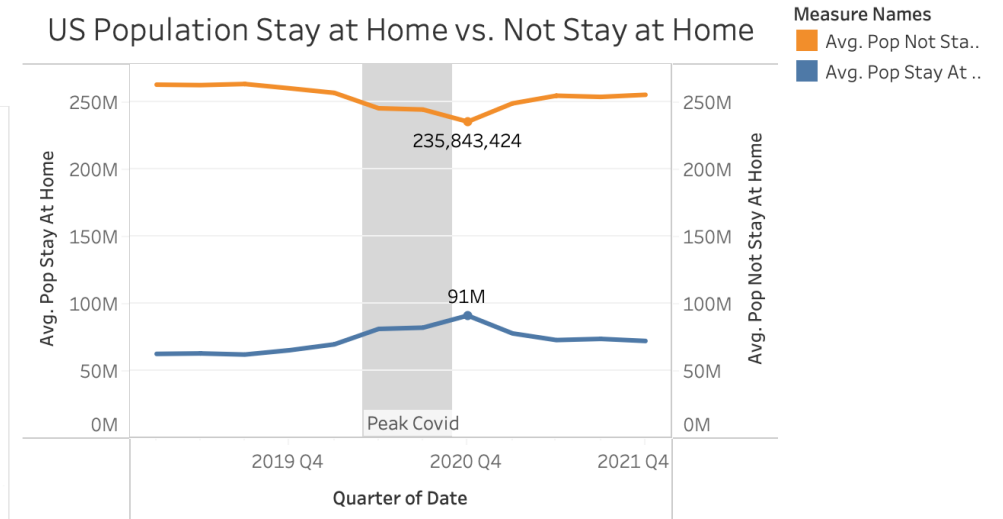# United States Population Staying at Home During Covid

Analysis:

- Peak Stay At Home was Q4 2020 due to resurgence of Covid in the fall and renewed lockdowns.

- Stay-at-Home population level was still elevated post-Covid compared to Pre-Covid. Likely due to people who did not work from home pre-covid but have stayed working from home as work-life balance becomes more important.

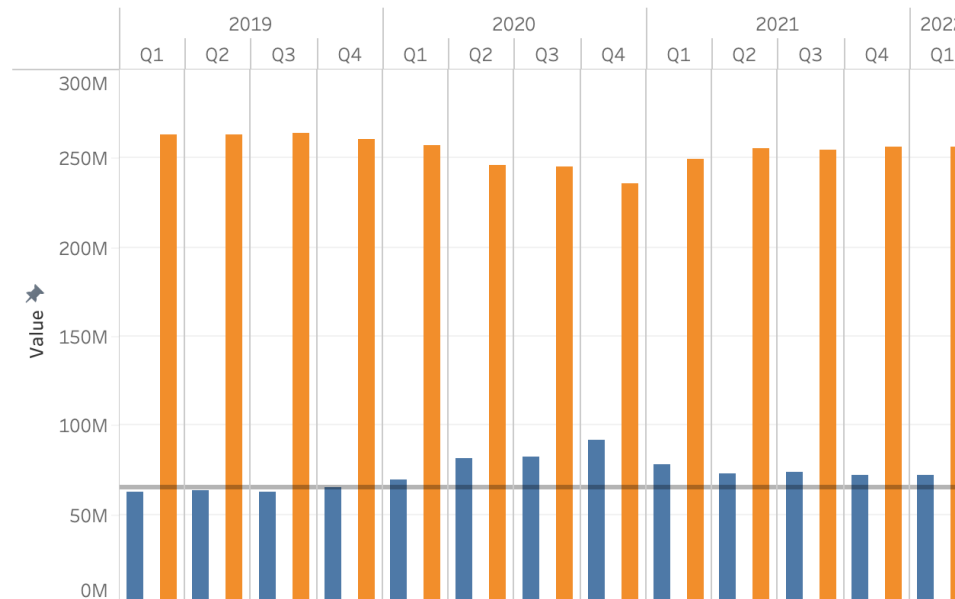- California had the longest and most severe lockdowns in the US.

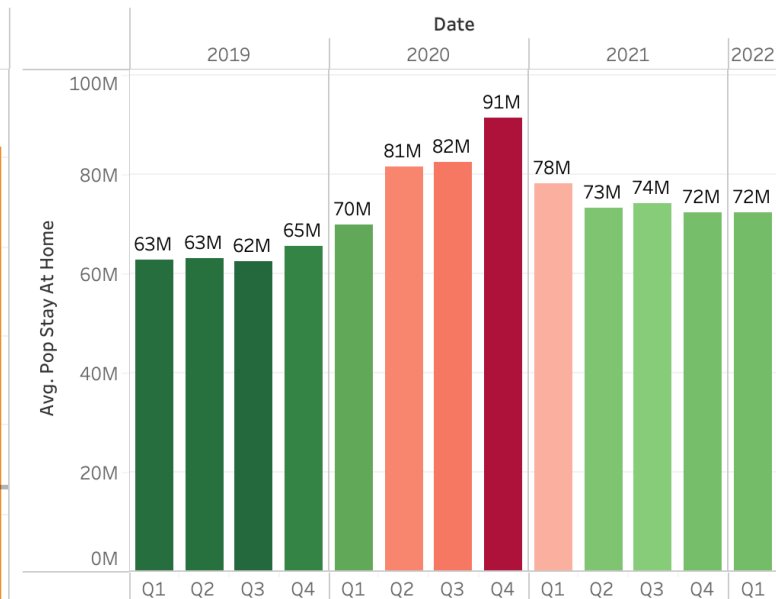## People Staying Home During Covid
March 2020 to July 2020

© 2022 Mapbox © OpenStreetMap

US Population Stay at Home vs. Not Stay at Home

Measure Names
- Avg. Pop Not Sta..
- Avg. Pop Stay At ..

235,843,424

91M

Peak Covid

2019 Q4   2020 Q4   2021 Q4

Quarter of Date

Population Stay-at-Home vs. Not Stay-at-Home

Stay at Home US

Date

	2019				2020				2021				2022
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
	63M	63M	62M	65M	70M	81M	82M	91M	78M	73M	74M	72M	72M

Air Travel in the United States

TSA Checkpoint Traffic - 2019 through 2021
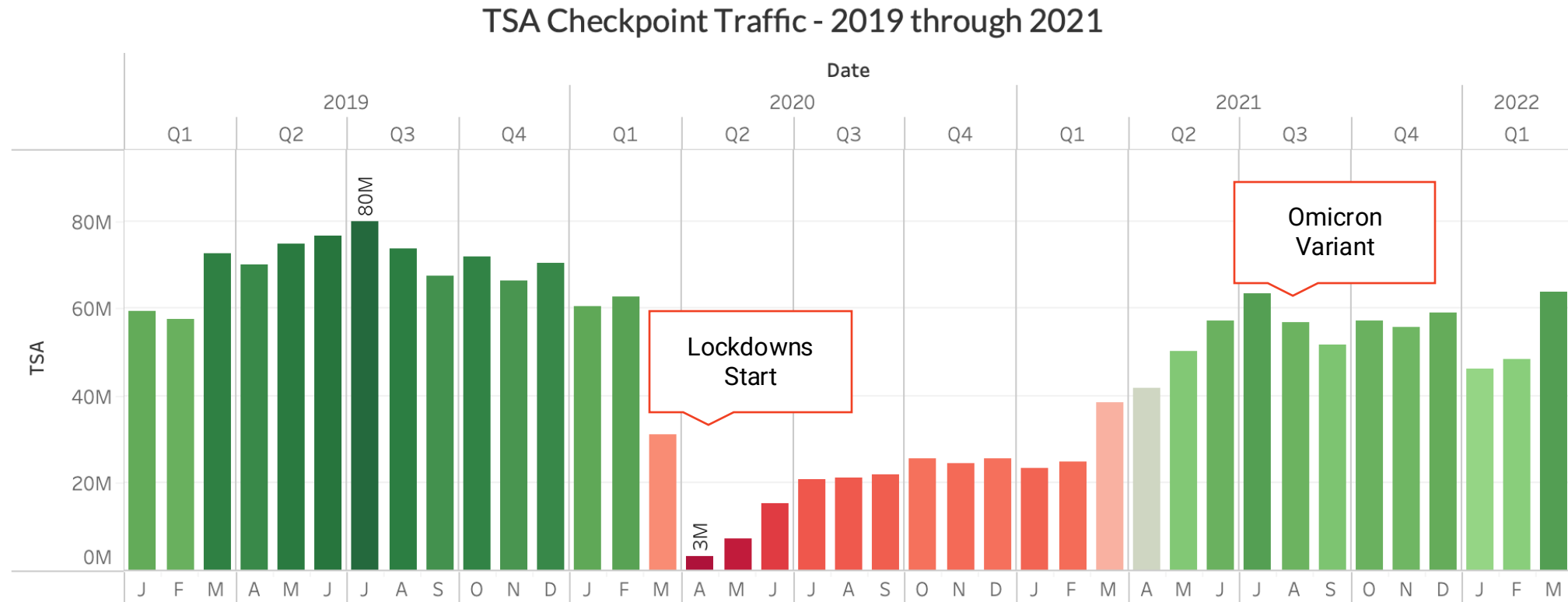
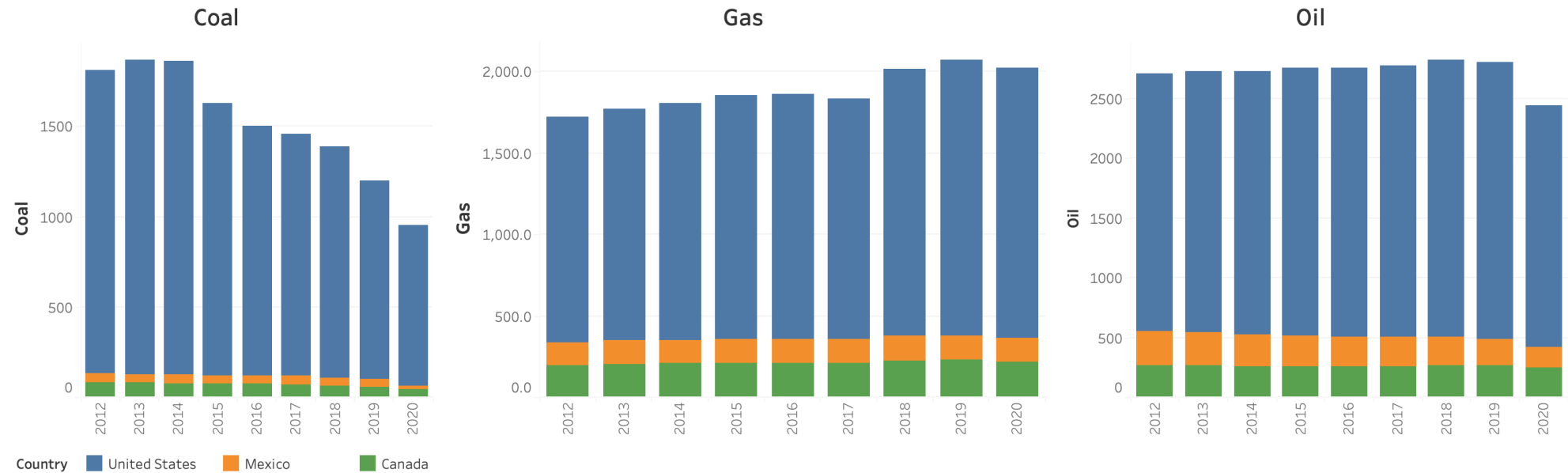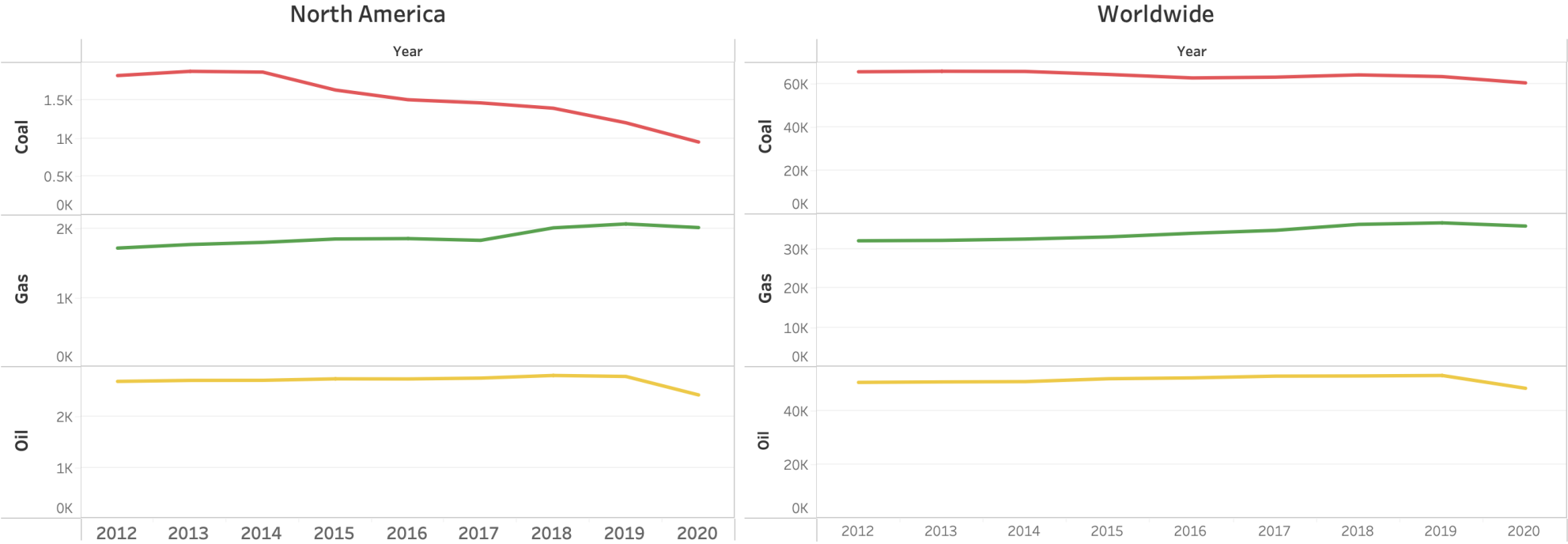**Analysis**:

- Starting in March 2020, countries began closing borders and air traffic came to a virtual stop

- Travel was discouraged even when lockdowns were removed in summer 2020. Harsh rules for travelers and worries about Covid contact kept air travel low through out 2020 and into Q1 2021.

- Travel began increasing in Q1 2021 but with a drop mid-year 2021 when the highly contagious Omicron variant arrived.

- As of 2022, travel levels have still not been restored to pre-Covid levels.

Historical Emissions by Type of Fuel - North America and Global

North America

Worldwide

Coal

Gas

Oil

Country ■ United States ■ Mexico ■ Canada

Analysis:

- In 2006 US consumption of Coal and Oil started to decrease.

- Decrease was due to closing of Coal plants and increased use of renewable energy sources.

- Covid saw the most significant decline in Coal and Oil.

- Primary decreases in Coal and Oil during Covid most likely are due to decrease in Air and Road travel, business and school closures (office buildings) and decreased manufacturing activity.

- As US moves from coal and oil to renewables, renewables are increasing.

1949 to 2021 US Energy Consumption by Fuel Type
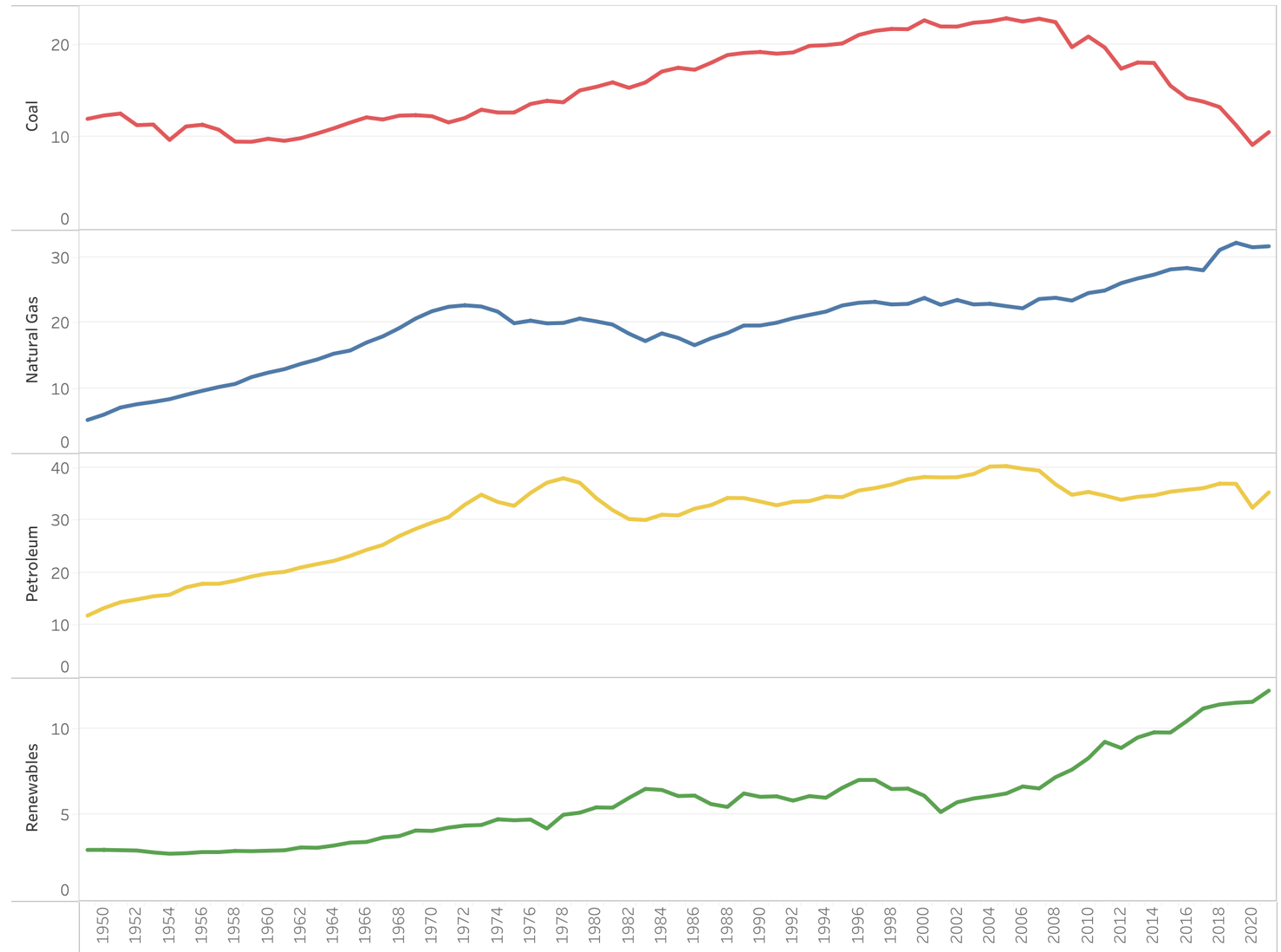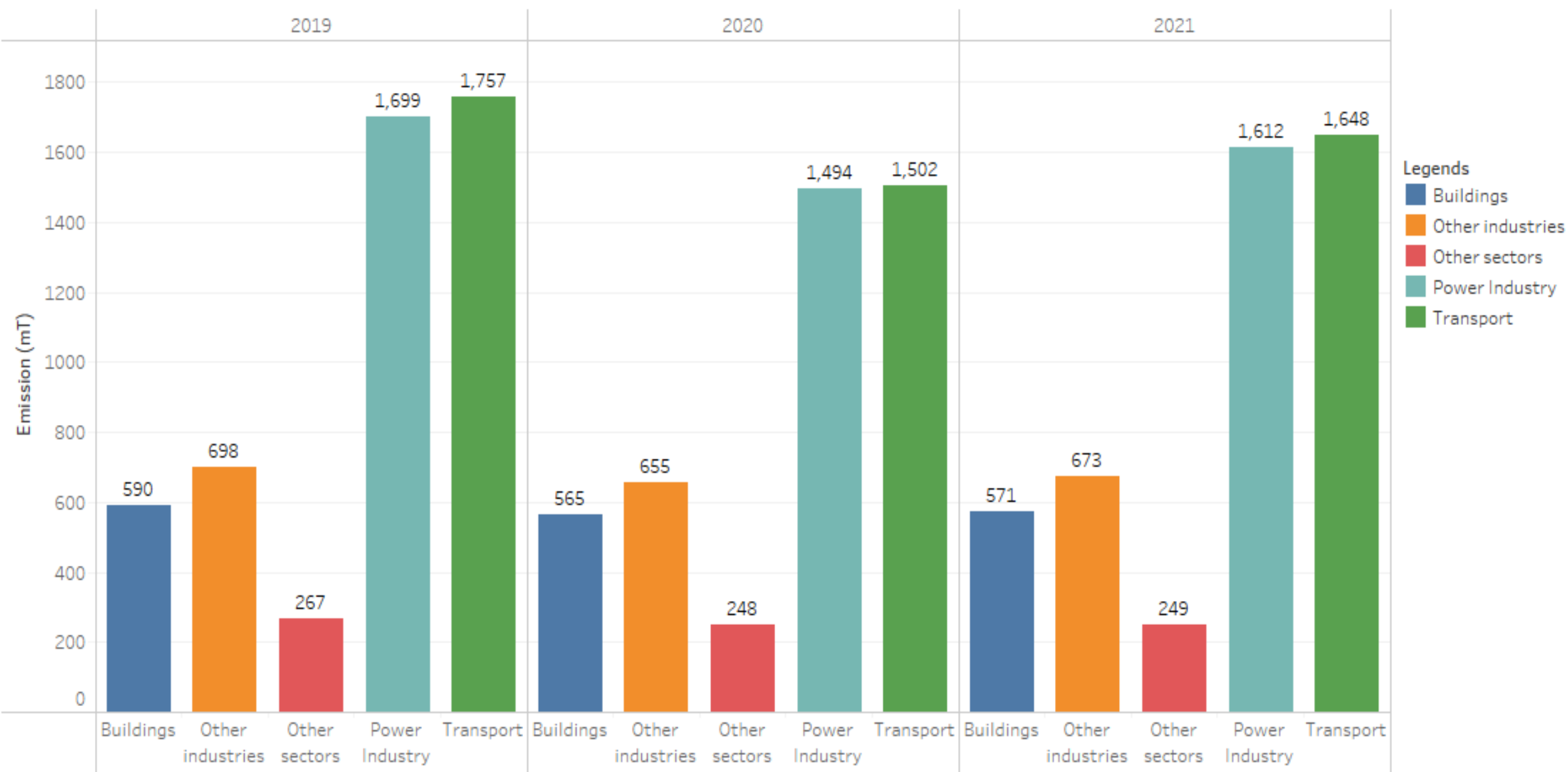
Emissions by Sector

Analysis

- Transportation saw the largest decrease in emissions during Covid. This is likely due to almost complete stoppage of Air Travel and significant decrease in commuter traffic.

- Power, which includes the process of extracting and refining of fuels saw a decrease due to a decrease in demand for fuels.

- The Building Sector clearly shows a decrease from 2019 to 2020 and then an increase again in 2021. This sector covers energy for buildings which includes office, schools, manufacturing and residential structures.

- Building sector decreases are likely due to the move from corporate workplace to work from home, school closures and decreases in activity at manufacturing facilities.

- Building decrease would not be as significant as other sectors because decreases in business use are offset by increase in residential use.

- An increase in online shopping requiring increased transportation costs and warehousing costs offset decreases elsewhere.
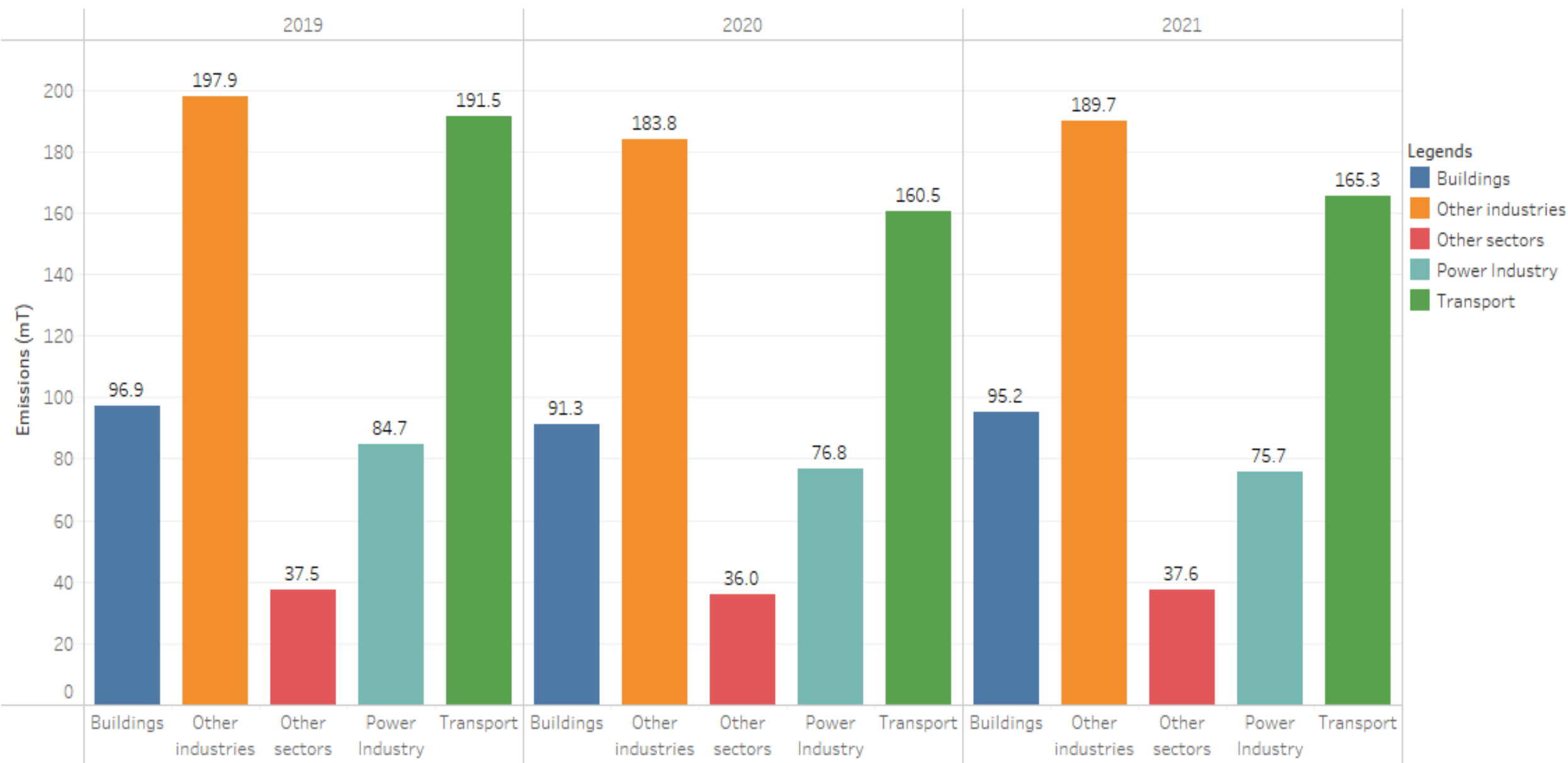

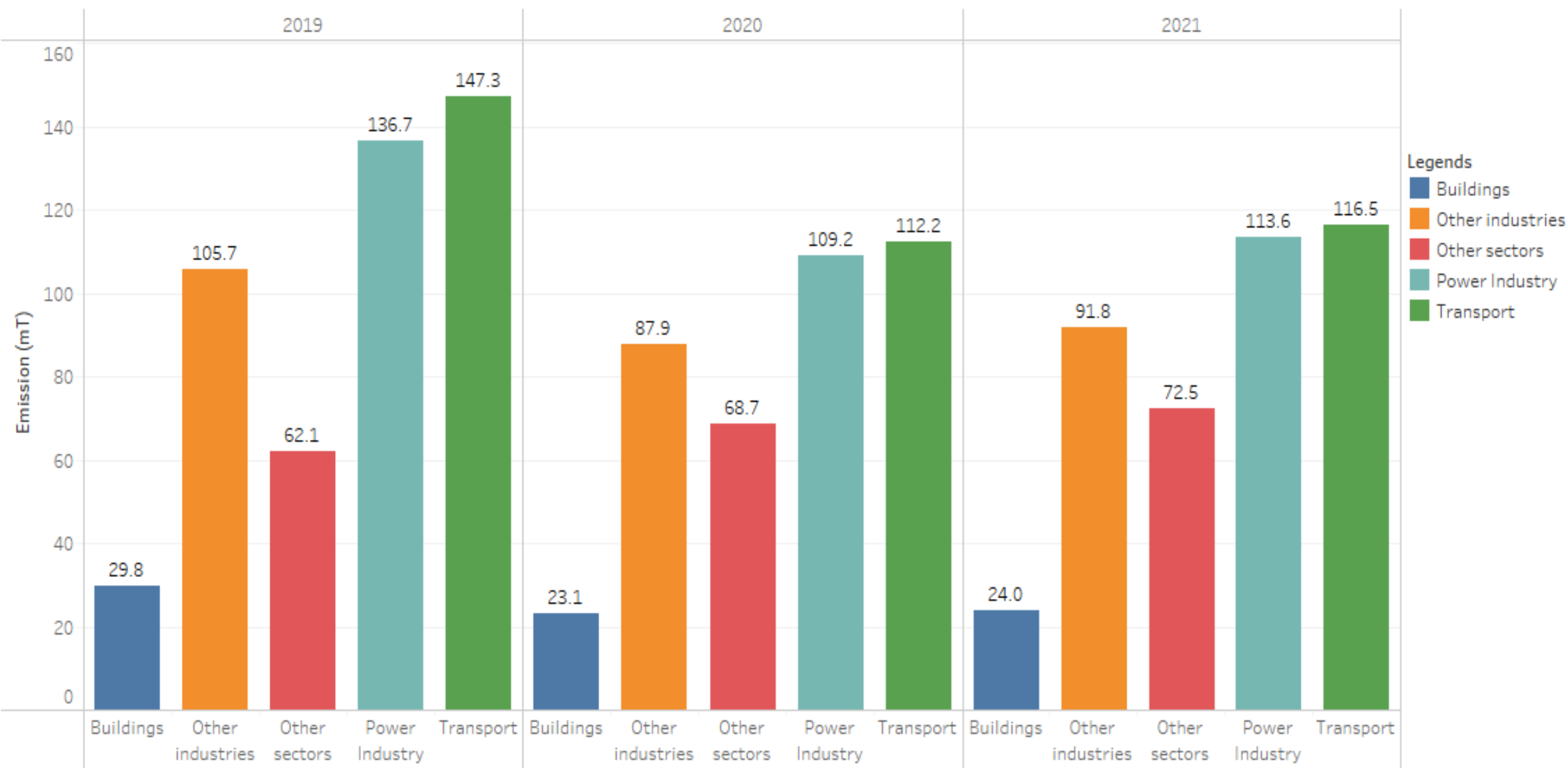North America Emissions Per Sector (2019-2021)
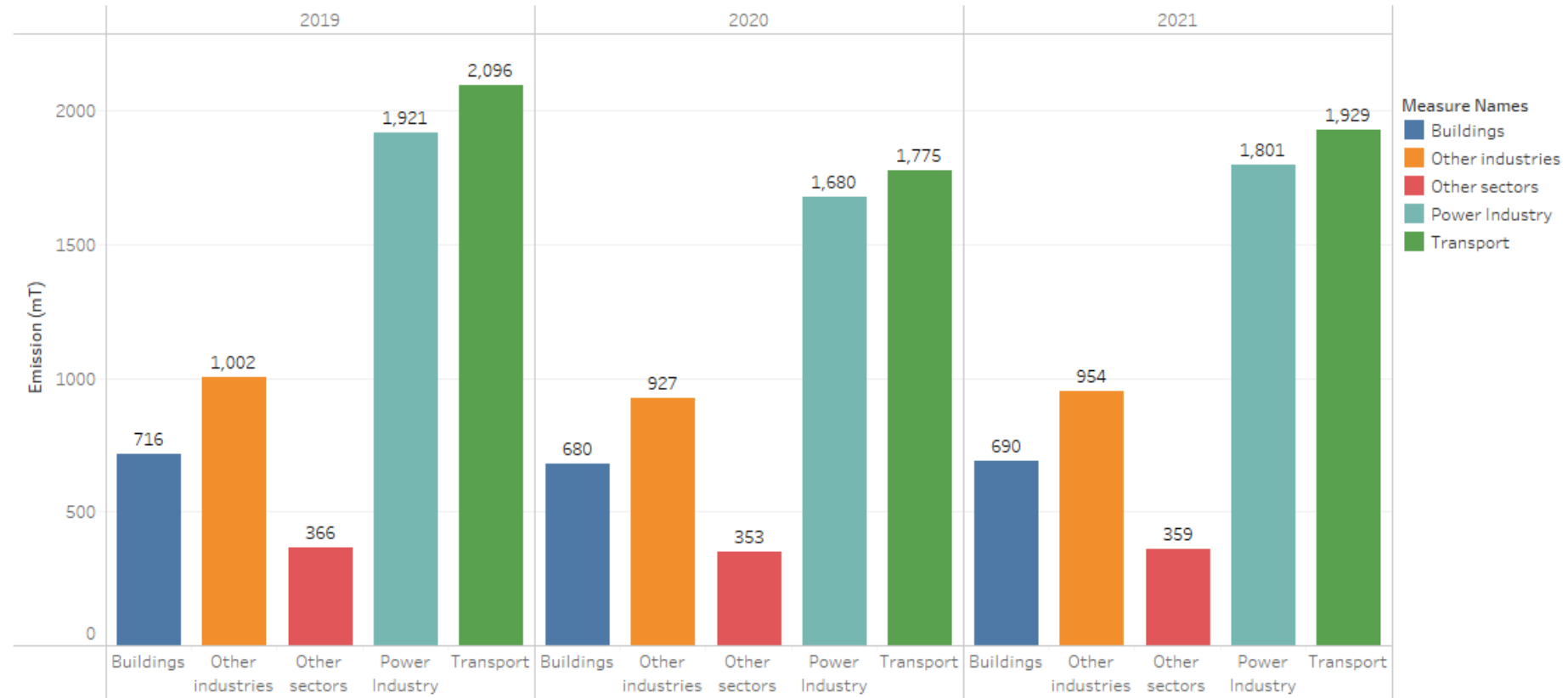
United States' Emission Per Sector (2019-2021)

Canada's Emission Per Sector (2019-2021)

Mexico's Emission Per Sector (2019-2021)

Legends
- Buildings
- Other industries
- Other sectors
- Power Industry
- Transport

2019
- Buildings: 29.8
- Other industries: 105.7
- Other sectors: 62.1
- Power Industry: 136.7
- Transport: 147.3

2020
- Buildings: 23.1
- Other industries: 87.9
- Other sectors: 68.7
- Power Industry: 109.2
- Transport: 112.2

2021
- Buildings: 24.0
- Other industries: 91.8
- Other sectors: 72.5
- Power Industry: 113.6
- Transport: 116.5

Emission (mT)

Why did Covid Improve Air Quality?

- Many power plants have cut down on their emissions.

- Daily human activities were put on hold.

- Airline stoppages.

- Factories shutdown or temporarily closed.

- Reduced the levels of GHG that agriculture emits.

How Covid Impacted Emissions – Daily Life

- Employment – layoffs, work from home.

- School closings.

- Restaurants, malls and shops closed.

- Almost all social interactions were forced to be online.

- Many people were stranded in foreign countries and unable to go back home due to the sudden lockdowns.

- People moved to online shopping and delivery services, reducing automobile emissions

How Covid Impacted Emissions – Transportation

- Online shopping decreased road traffic

- Delivery services optimized travel times

- Road traffic decreased significantly due to laid off workers not commuting.

- The shipment of many essential goods had to be delayed due to lack of manpower and strict border control.
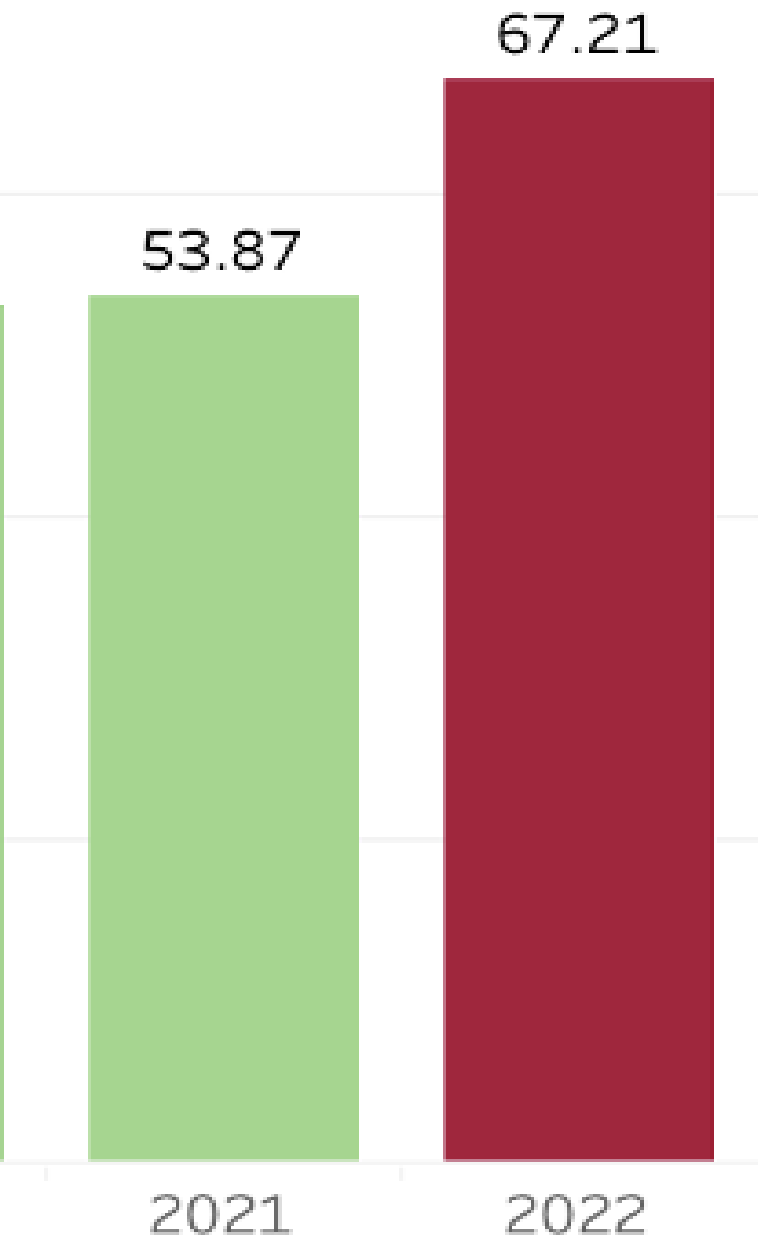
Have emissions returned to Pre-Covid Levels?

- Generally, CO2 levels and air quality have returned to Pre-Covid levels worldwide.

- The major player is, of course, China. Removing China from global analysis, air quality has slightly improved as CO2 levels decrease.

- It would take more investigation to determine all the factors that go into these improvements.

- The combination of changing lifestyles (work from home, online shopping, delivery services), online learning, major nations moving to renewable energy and possibly other factors need to be considered.

What impacts did Covid have on air quality and how can we apply to post-covid world?

- The power of humanity to adapt is probably the biggest lesson from Covid. People who never would have thought of working from home, students who never tried online learning and not being able to jump in your car at anytime found they could adapt. Many people gained a new appreciation of the 'Staycation' and may not travel as much in the future.

- Biggest impact on emissions/air quality was Transportation and Renewables

- It is unlikely that North America will return to Pre-Covid levels because of the move to renewables and continuation of some work-from-home.

- Focus on Transportation sector has the potential for the greatest near-term impact. Adoption of EV cars and trucks, more efficient aircraft and optimization of logistics are some of the areas to target.

Conclusion

Conclusion regarding what our research revealed

Conclusions

- Politics play a big part
  - MX re-opened borders earlier than others
  - US pressured MX because of factories
  - In the US, lockdown vs. no lockdown became a political issue when it should have been based on science.
- China's emissions are 1.33% times higher than that of the entire western world (Europe/Americas, etc.) and unless China can move to renewables, impact from other countries will be very limited.
- China locked down earlier and restarted earlier as they tried to offset their losses in GDP from Covid by ramping up production as quickly as possible. This meant that the decrease in emissions due to Covid were not nearly as much as expected.
- Transportation showed the biggest impact to Covid due to extreme travel restrictions between countries, vaccine requirements, and fear of contact with Covid positive persons during travel and lockdowns.

Interesting and Unexpected Insights

- Seasonal effects on CO2 emissions

- Emissions from workers have not returned to pre-covid – probably people continuing to WFH

- Travel requirements that people need to be vaccinated to travel to certain countries has restricted travel in many cases

- The data showing work from home data was interesting mostly in how the data is collected. By tracking (anonymously) mobile phones for millions of US Citizens. Using GPS the trips are determined by time away from a primary location and based on similar geographic data, data is extrapolated to population level.

And for a Future Report....

- During our research we learned that even water may have been a resource that experienced savings

- Some people noted that they didn't take as many showers (nobody could see them) and less laundry (who cares what you wear when no one can see you?)

- But maybe offset by more alcohol consumption ☺

- More research is needed....