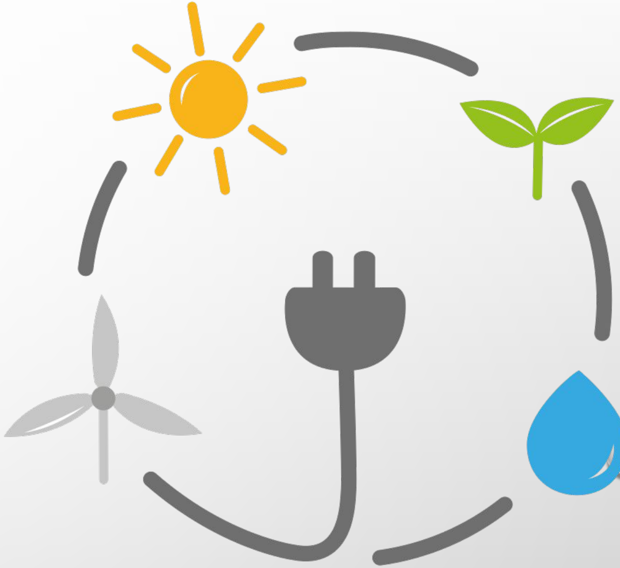
DATA SCIENCE IN EMISSION CALCULATION



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MENTOR: LING BAI

SPE International

Society of Petroleum Engineers

PROJECT DESCRIPTION

Project Selection

- Mentor gather interested and proposed 2 projects for the team to choose from
- Scope 1 calculator project was chosen as a group

Project start

- Regulation familiarization
- Data gathering

Project process

- Machine Learning
- Trained model by using...
- Cross validation
- Hyper-parameter tuning
- Used the dataset from years

Project validation

- Compare to other calculators
- Check with energy emission companies
- Obtain more data over time

Learning debrief and conclusion

- Carbon energy emissions increased over time
- Companies have service level agreements to meet
- Could cater to carbon credits

PROBLEM STATEMENT:

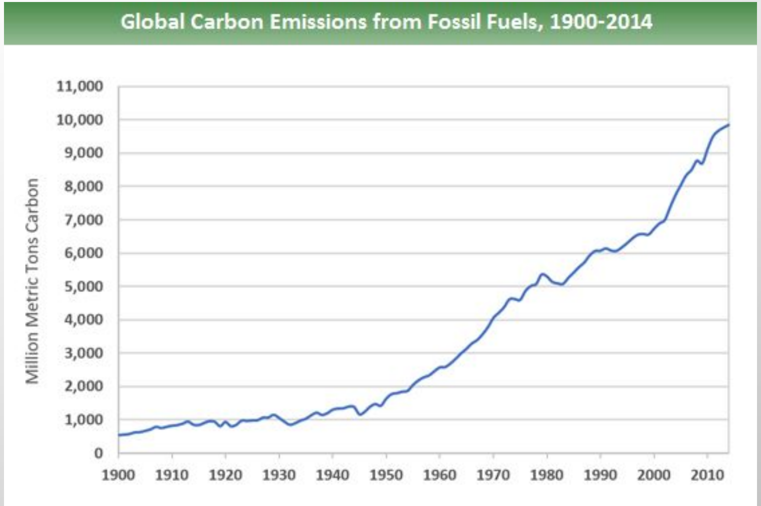
CO_2 EMISSIONS HAVE INCREASED BY ABOUT 90% SINCE 1970.

THREE MAJOR IMPACTS OF INCREASE EMISSIONS INCLUDE-

★ ENVIRONMENTAL
- EXTREME CLIMATE CHANGE/ GLOBAL WARMING

★ HUMAN HEALTH
-RESPIRATORY AND CARDIOVASCULAR PROBLEMS

★ ECONOMICAL
-ECONOMICAL STRESS ON INDUSTRIES

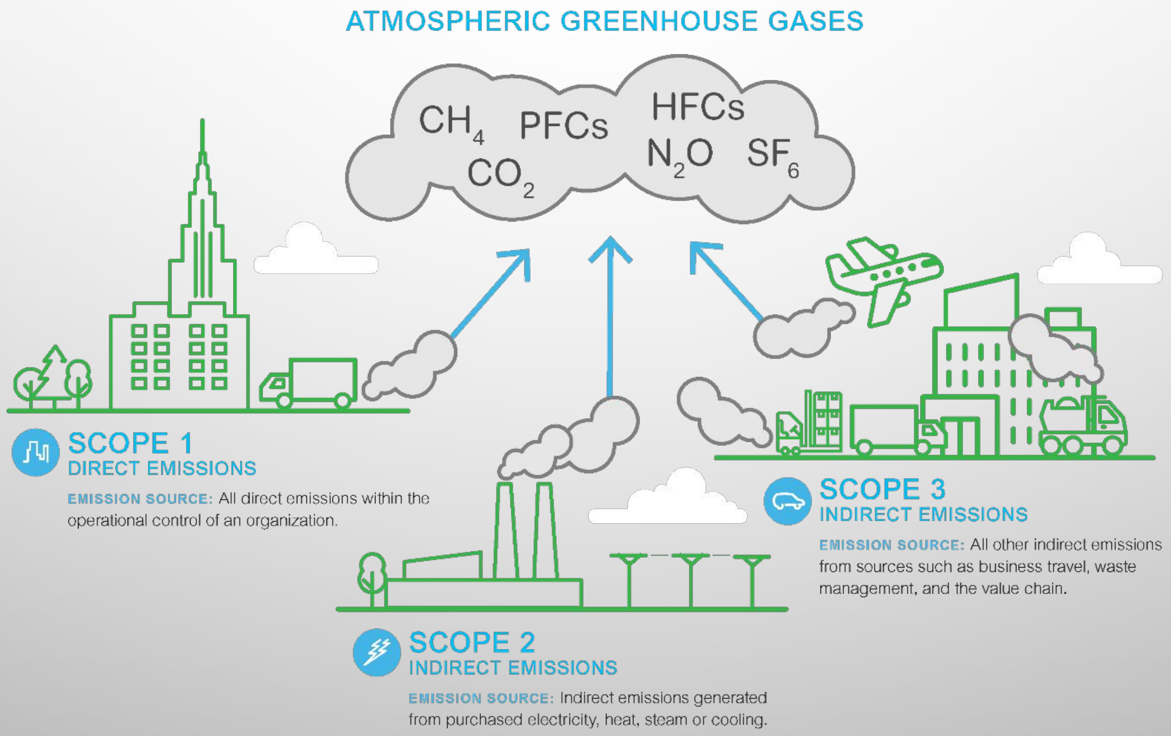


Source: EPA 2014 report

CO_2 Emissions   Impacts

GHG PROTOCOL

GREENHOUSE GAS EMISSIONS ARE CATEGORISED INTO THREE GROUPS OR 'SCOPES' BY THE MOST WIDELY-USED INTERNATIONAL ACCOUNTING TOOL, THE GREENHOUSE GAS (GHG) PROTOCOL.



The 3 Scopes

The GHG Protocol outlines 3 emission scopes. Scope 1 and 2 must be reported, while Scope 3 is optional (as it's the hardest to monitor).

Scope 1: Direct Emissions

- These are emissions released into the atmosphere from company-owned and controlled resources.
- 4 categories: stationary combustion, mobile combustion, fugitive emission, process emissions

Scope 2: Indirect Emissions - Owned

- These are emissions released into the atmosphere from company-owned and controlled resources.
- Includes all GHG emissions caused by the consumption of electricity, steam, heat, and cooling.
- Scope 2 is about the energy consumed by the end-user.

Scope 3: Indirect Emissions - Not Owned

- Scope 3 includes all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company.
- Energy consumed during transmission and distribution (employees, business travel, etc)
- Includes both upstream (suppliers) and downstream (customers) emissions

SCOPE 1 CALCULATION BY FUEL ANALYSIS METHOD

- THE FUEL ANALYSIS METHOD TO CALCULATE CO_2 EMISSIONS IS BASED ON FUEL-SPECIFIC INFORMATION OR DEFAULT EMISSION FACTOR TO DETERMINE THE CARBON CONTENT IN THE FUEL COMBUSTED.

Equation 1

Emissions = Fuel x EF1

Where:

Emissions = Mass of CO_2, CH_4, or N_2O emitted.

Fuel = Mass/ volume of fuel combusted.

EF1 = CO_2, CH_4, or N_2O emission factor per mass or volume unit.

- Recommended when fuel consumption is known only in mass or volume units, and no information is available about the fuel heat content or carbon content.
- Least preferred

Equation 2

Emissions = Fuel x HHV x EF2

Where:

Emissions = Mass of CO_2, CH_4, or N_2O emitted.

Fuel = Mass/Volume of fuel combusted.

HHV = Fuel heat content.

EF2 = CO_2, CH_4, or N_2O emission factor per energy unit

- Recommended when the actual heat content is provided by fuel supplier and fuel use is provided in energy units.
- Preferred over equation 1.

Equation 3

Emissions = Fuel x CC x 44/12

Where:

Emissions = Mass of CO_2 emitted.

Fuel = Mass or volume of fuel combusted.

CC = Fuel carbon content.

44/12 = ratio of MW of CO_2 and carbon

- Recommended to calculate CO_2 emissions when the actual carbon content of the fuel is known.
- Most preferred for CO_2 calculations
- Used in conjugation with equation 1 or 2 to calculate CH_4 and N_2O.

PROPOSED SOLUTION/ FUTURE OBJECTIVE

CREATE A CARBON CALCULATOR TO GIVE COMPANIES INSIGHT ON HOW THEY CAN GET MORE CARBON CREDITS AND SAVE THE ENVIRONMENT

OBJECTIVES:

DEVELOPMENT OF REPORTING TOOLS

1. GHG CALCULATOR DEVELOPMENT REPORTING GREENHOUSE GAS EMISSIONS - CANADA.CA
2. NPRI CALCULATOR DEVELOPMENT REPORT TO THE NATIONAL POLLUTANT RELEASE INVENTORY - CANADA.CA
3. MSAPR DEVELOPMENT MULTI-SECTOR AIR POLLUTANTS REGULATIONS: FREQUENTLY ASKED QUESTIONS - CANADA.CA
4. EMISSION TRACKING DEVELOPMENT- GENERAL TOOL

MACHINE LEARNING

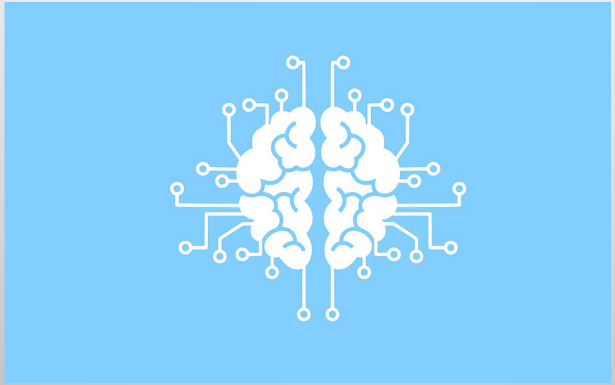
PREPROCESSING OF MODEL BY COMBINING 17 YEARS WORTH OF CARBON EMISSIONS DATA AND CREATING CARBON EQUIVALENT VALUES. UNNECESSARY COLUMNS WERE DROPPED.

LIBRARIES USED WERE PANDAS, NUMPY, AND MATPLOTLIB AND FOLIUM AS WELL AS TABLEAU.

TRAINED MODEL BY USING TRAIN AND TEST DATA, THEN MADE A DECISION TREE REGRESSION.

CROSS VALIDATION - COMPARED DECISION TREE REGRESSION WITH RANDOM FORESTS REGRESSION.

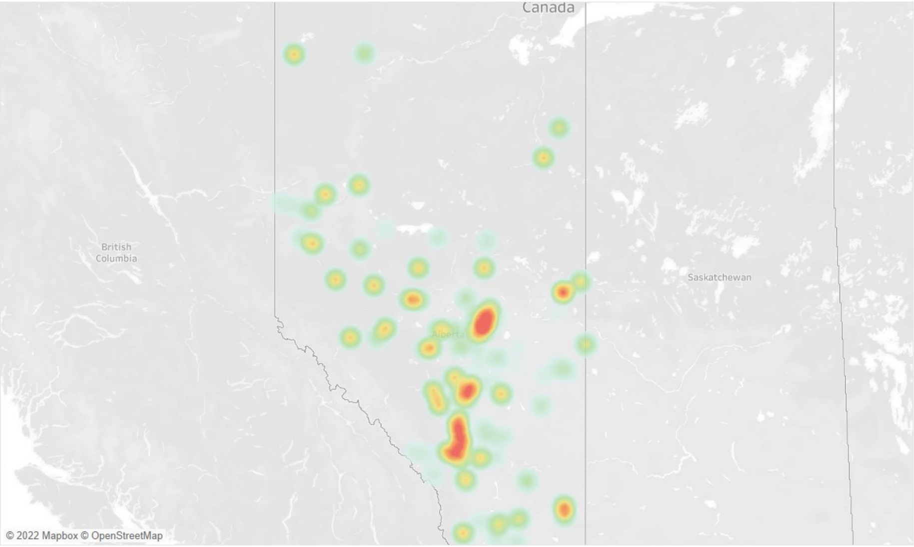
HYPER-PARAMETER TUNING



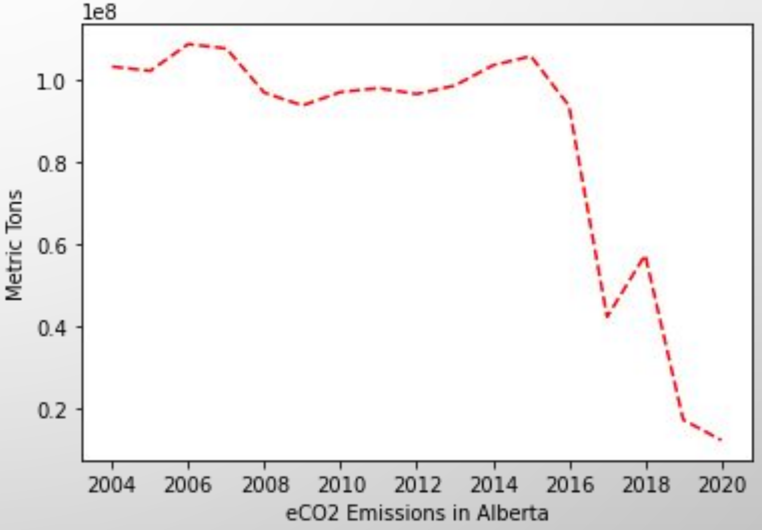
VISUALIZATIONS

SCATTERPLOT, TIME SERIES DATA, FOLIUM MAP WITH EMISSIONS

GHGs Distribution



Map based on Longitude (generated) and Latitude (generated). Details are shown for City, Year and 群集. The view is filtered on Latitude (generated), Longitude (generated) and City. The Latitude (generated) filter keeps non-Null values only. The Longitude (generated) filter keeps non-Null values only. The City filter keeps 271 of 384 members.



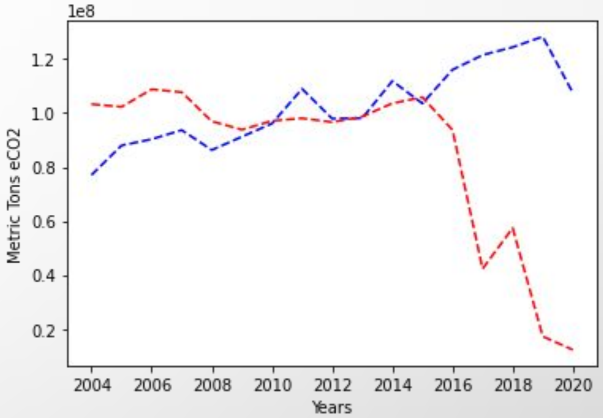
CROSS VALIDATION

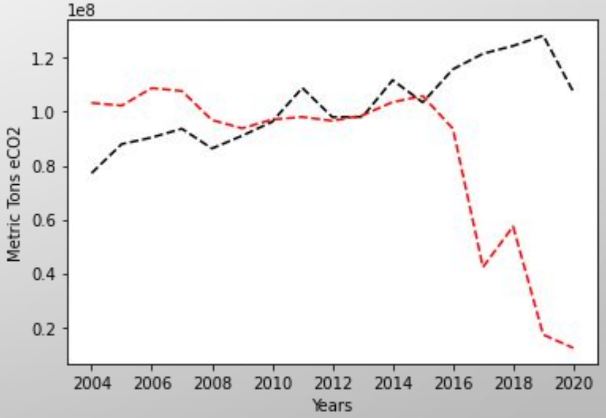
Decision Tree Model

```
Scores: [64867.51432011 26868.50715699 42531.03700938 22377.70743505
 34474.94504557  3818.26806629 11661.16290459  5250.72864014
  5731.65866009  5183.44165069]
Mean: 22276.497088890177
Standard deviation: 19243.992884395848
```

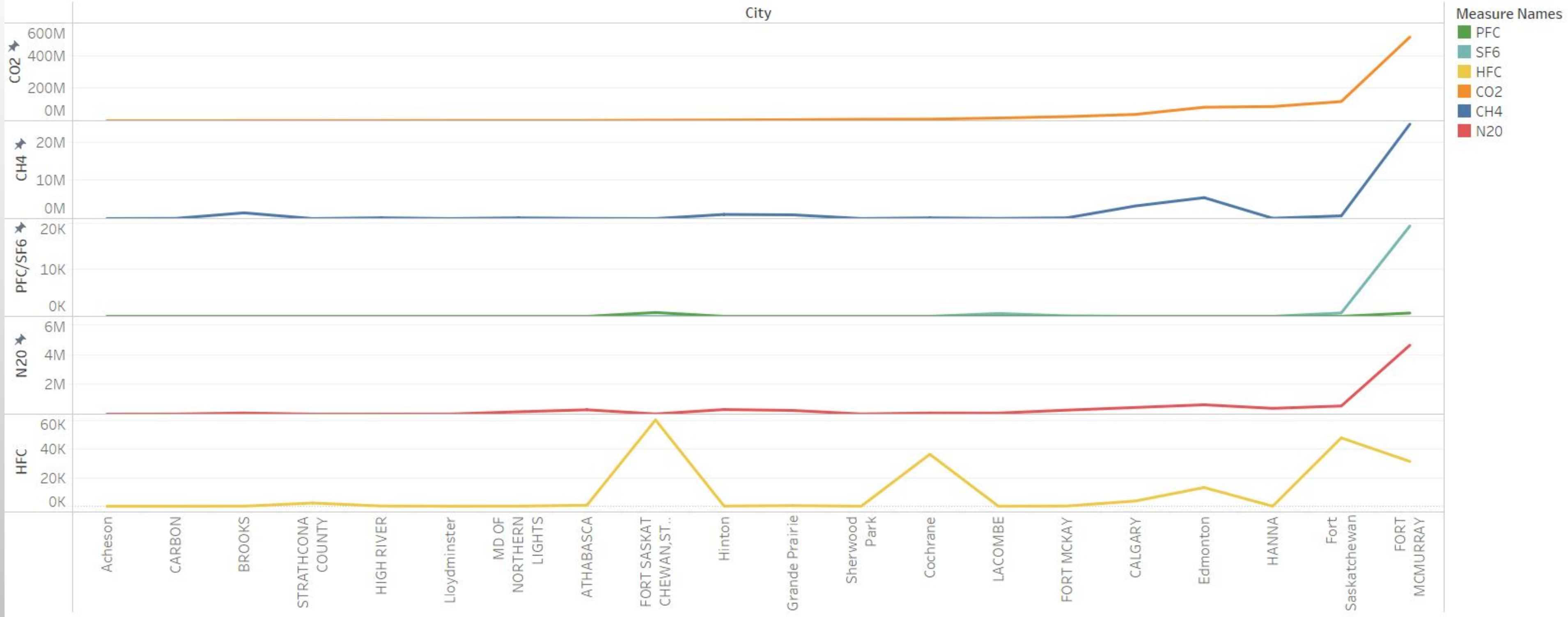
Random Forest Regressor

```
Scores: [60950.97624862 52276.05454633 25486.29424158 35083.57243078
 48181.83560872  7846.77320751 16444.04025711 11958.14932691
 12443.26244903 10134.13972749]
Mean: 28080.50980440951
Standard deviation: 18700.443365331957
```

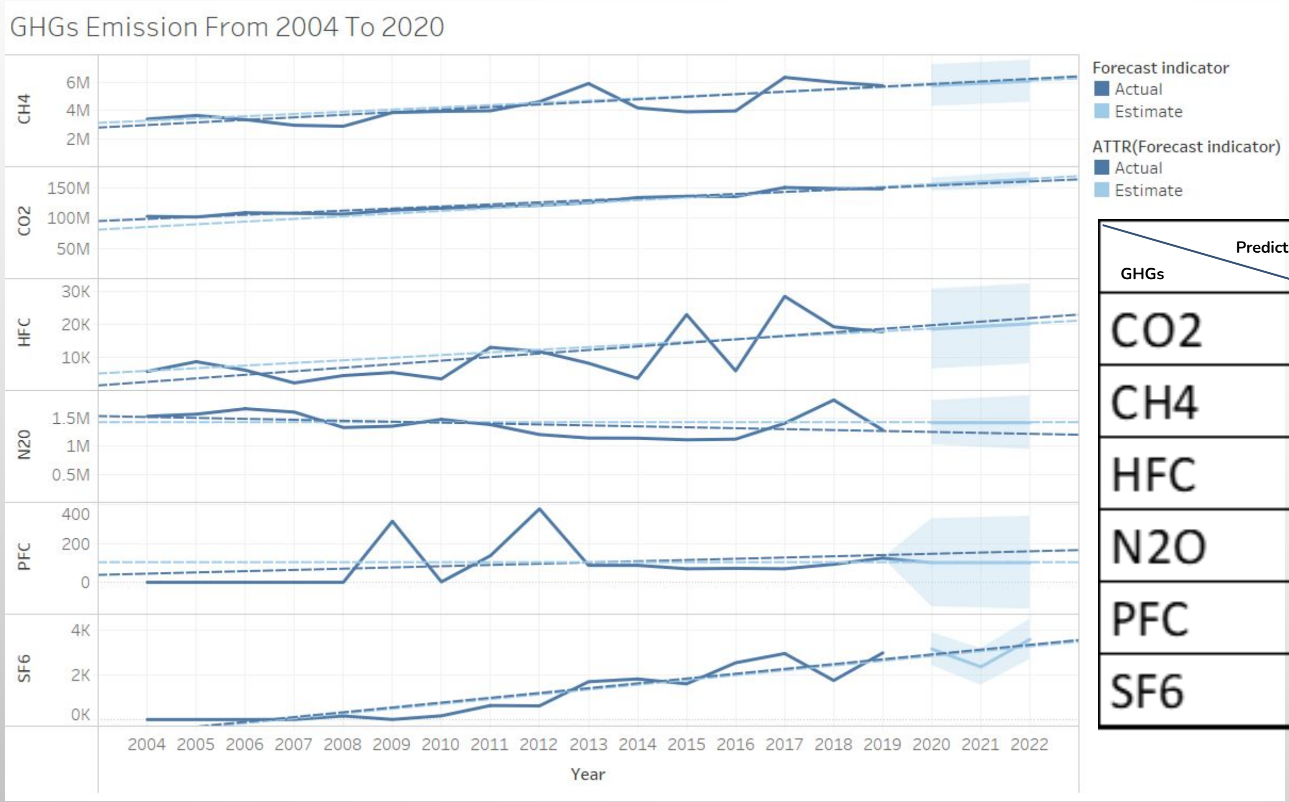




GHGs Emission For Cities



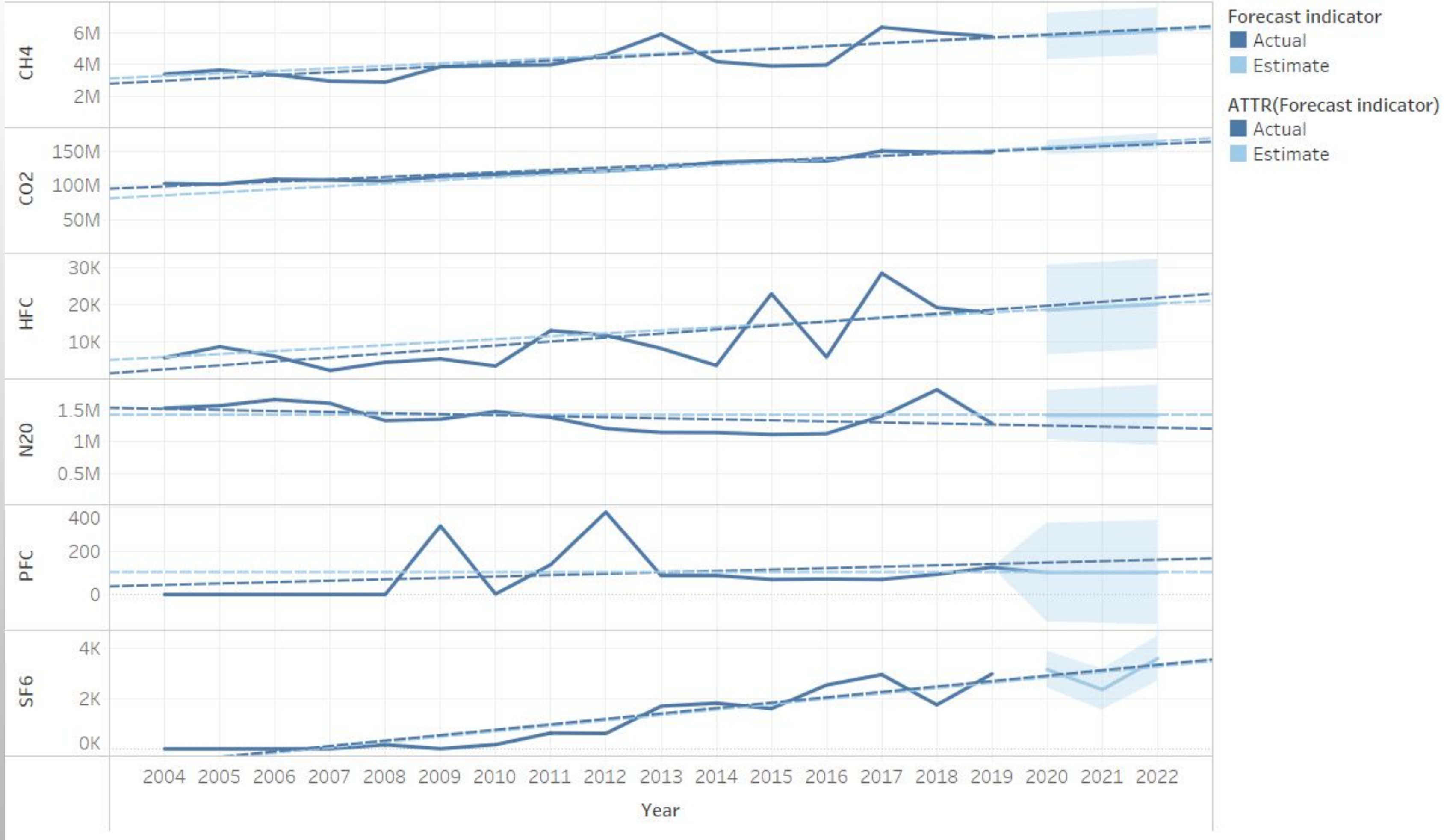
The trends of CO2, CH4, CO2, CH4, PFC, SF6, N20, HFC, N20 and HFC for City. Color shows details about CO2, CH4, PFC, SF6, N20 and HFC. The data is filtered on Year, which ranges from 2004 to 2020. The view is filtered on City and sum of PFC. The City filter keeps 20 of 384 members. The sum of PFC filter includes everything.



GHGs \ Prediction	2021	2022
CO2	159,524,694	159,524,694
CH4	5,923,587	6,081,864
HFC	19,468	20,272
N2O	1,412,477	1,412,477
PFC	102	102
SF6	2,368	3,606

Tableau Public

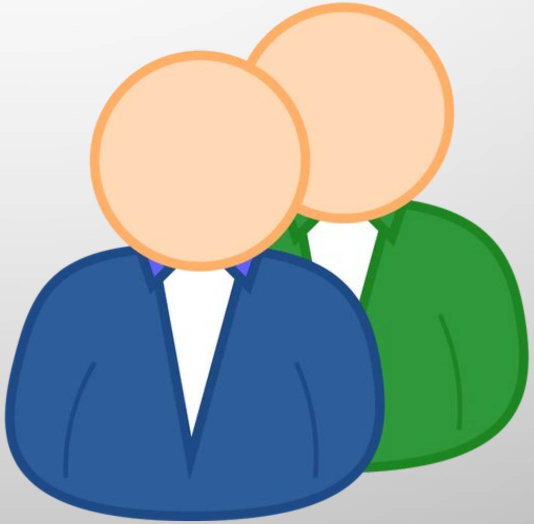
GHGs Emission From 2004 To 2020



END USERS

-COMPANIES WHO ARE GOING TO BE AFFECTED BY CARBON CREDITS

-INDIVIDUALS WHO ARE TRYING TO TRACK THEIR CARBON FOOTPRINT ON AN INDIVIDUAL LEVEL, THEY WOULD SUBMIT THEIR DATA TO AN APP



FUTURE DIRECTIONS

TOP CARBON PRODUCING COMPANIES:

GREENHOUSE 100 RANK	PARENT CORPORATION OR ENTITY	2019 EMISSIONS (CO2 EQUIVALENT METRIC TONS)
1	VISTRA ENERGY	106,510,086
2	DUKE ENERGY	87,140,105
3	SOUTHERN COMPANY	86,244,286
4	BERKSHIRE HATHAWAY	74,960,726

WHERE EMISSIONS ARE COMING FROM:

“THESE ARE EMISSIONS GENERATED BY A CORPORATION'S OWN FACILITIES—FACTORIES, VEHICLES, POWER PLANTS—AND THE EMISSIONS GENERATED BY THIRD PARTIES FROM WHOM THE CORPORATION BUYS ENERGY. THESE EMISSIONS ARE EASY FOR CORPORATIONS TO MEASURE, AND RELATIVELY EASY FOR THEM TO CONTROL.”

HOW TO OPTIMIZE CARBON CREDITS:

THE TRADING OF CARBON CREDITS CAN HELP COMPANIES—AND THE WORLD—MEET AMBITIOUS GOALS FOR REDUCING GREENHOUSE-GAS EMISSIONS

RECOMMENDATIONS

SYNERGIZE DATA AND EMISSION APPROACH

- Identifying and quantifying CO_2 emissions helps to identify excessive energy usage or other inefficiencies.
- Lowering GHG emissions typically goes hand in hand with increasing efficiency and cost-effectiveness in a company's processes.
- Data analytics, networked devices, sensors, and other digital technologies are changing how energy is used and consumed across the economy.
- These technologies also create new opportunities to optimize energy use and decrease greenhouse gas emissions.


Q&A