Report: *US Carbon Dioxide Emissions from 1990 to 2010*

Motivation: Despite political fissures regarding the existence and contributory causes of global warming, scientists have linked rising climate change to increasing levels of carbon dioxide in the environment. Most developed countries rely on carbon dioxide-emitting energy sources for large components of their economic activity and growth. Carbon emissions from fossil fuel combustion are influenced by population growth, economic growth, and human behaviors amongst other factors. Exploring how these factors contribute to carbon emissions may 1) help inform developing energy policies aimed to sustain economic growth while reducing the emitting of carbon dioxide through recognition of states and sectors who have not made progress towards reduced emissions over the past 20 years, 2) provide insight into incentives that may be most impactful in lowering emissions, and 3) identify scenarios where conservation behaviors could be adopted to aggressively reduce emissions.

Scope of Tasks: In order to evaluate the carbon emission dataset in context, it is first necessary to assess potential factors that may impact emissions. Contextual data, including economic growth measured by Gross Domestic Product (GDP), is available only at the national level. While considering information at macro-level, it is also helpful to view the CO2 Emission by sector nationally. The resulting tasks are as follows:

- Compare trends for US economic growth[1], population growth and carbon dioxide emissions from 1990 [1]to 2010 and identify relationships.
- Compare the Commercial, Residential, Industrial, Transportation and Electric sectors' contribution to total carbon dioxide emissions in the United States from 1990 to 2010.
- Determine whether any particular state or sector was able to make significant improvement in carbon emissions over the 20 year span and which high-CO2-emitting states/sectors require immediate changes to reduce emissions.

Visualization:

To assess the relationship of trends over time between population growth, carbon dioxide emissions and economic growth these three metrics are ordered attributes. The magnitude channel for these attributes is reflected through position on a common scale. Color is used as an identity channel to distinguish between the three attributes. These channels and attributes were employed in the following visualization:
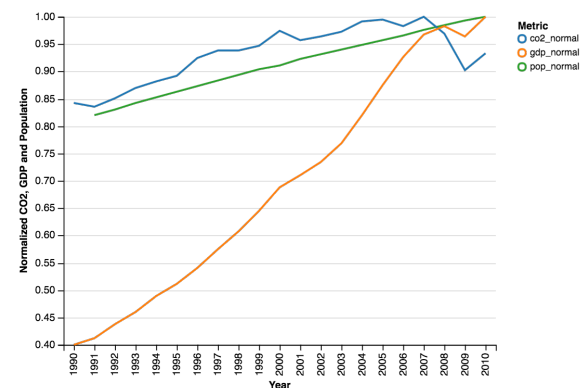
This section of the visualization is composed of a line chart showing normalized values for Gross Domestic Product, Carbon Dioxide emissions and population annually over a specified period of time (1990-2010).

Looking across the sectors at the national level, CO2 emissions are an ordered attribute. The magnitude channel is position on a common scale. Color is an identity channel denoting the sector. Note: It may appear as if an area magnitude channel is leveraged but this is a stacked bar chart with no separation between bars.

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[1] Supplemental Data: Economic growth is measured by gross domestic product (GDP). GDP data from 1990 through 2010 for the United States sourced from http://data.worldbank.org

For each year the stacked bar chart reflects the magnitude of the percent contribution of carbon emissions by sector.
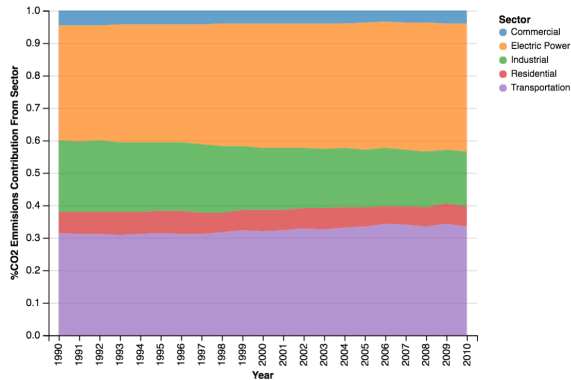
With this visual, it is clear that while two sectors appear to remain consistent with its carbon emissions contribution, two sectors contribute more and one reduces their contribution to total carbon emissions in the US over time. This makes it very clear which sectors are improving.

The last section of the visual depicts the ordered attributes, CO2 emissions and population. The magnitude channel used by the attributes is position on a common scale.
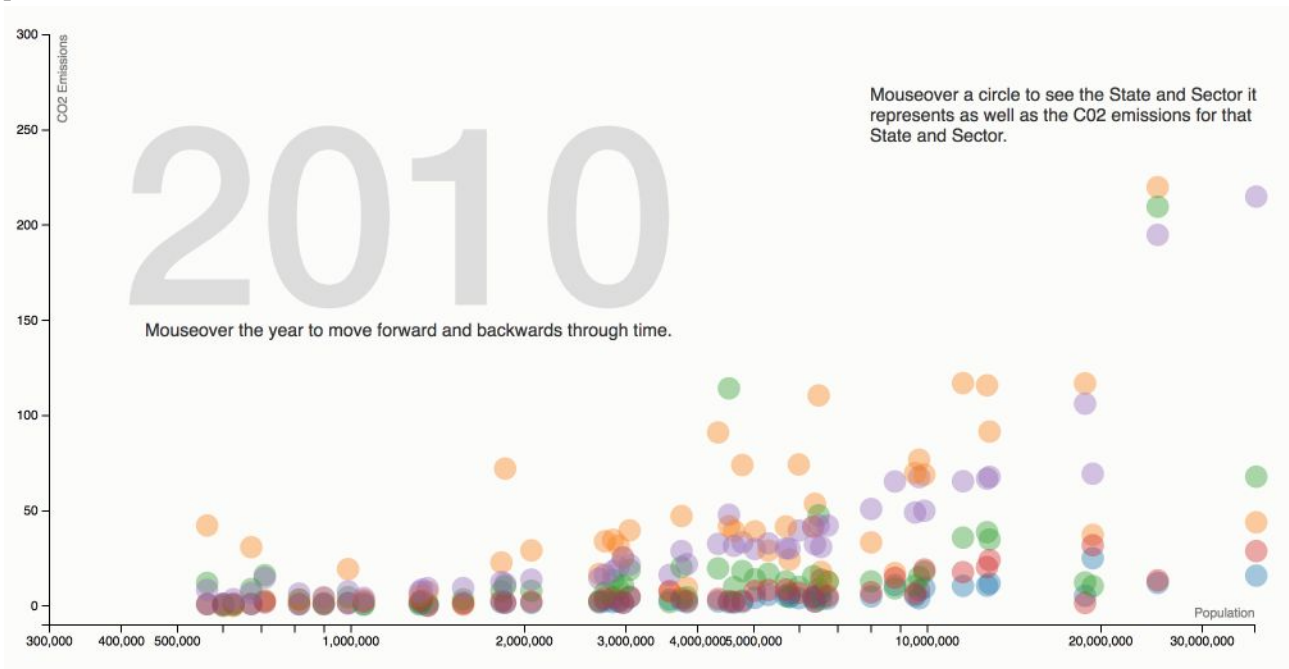
Color is used as the identity channel for the sector. This visualization is interactive. The details of the State, sector and precise value of the CO2 level is visible when hovering over the circle representation.

Upon loading, an animation automatically displays the CO2 vs. Population chart for each year (1990 through 2010). After the animation completes, frame control allows users to scroll across the date label. This allows for visual popouts that draw attention to state-sectors that change more dramatically than others between years.

This visual shows clearly that transportation and electric have not made improvement over time, and by hovering over circles in the upper, right portions of the chart, the user can discover states and sectors that require policy change, aggressive conservation efforts or at minimum an audit of CO2 emissions from these sectors.