# Introduction: Domain problem characterization

Since the early part of the last decade, total electricity generation for the most part has remained relatively the same in the United States. That said, the manner in which it is generated due to changes in technology have changed over time while some are used more than others. Renewable energy sources for electricity generation such as solar, wind, and hydro through the use of photovoltaics and turbines technologies, have increased in use accounting for over 16% on a national level. Alternatively, generation from nuclear sources and fossil fuels such as coal, natural gas, and oil continue to dominate the power landscape despite changes from the beginning of the start of the century. In the United States, coal was the major source power accounting for over half the total of electricity generation according to the U.S. Energy Information Administration (EIA). Since then, coal use has dropped dramatically to just under 30% of the total electricity generation. Conversely and due to advances of fracking which in turn have unlocked resources from shale deposits all around the country, natural gas takes its place as the leader in the U.S. at 32%.

Closer to home in the South East region of the United States, the changes in electricity generation between renewable and fossil fuels/nuclear sources have not kept pace with the rest of the country. By the end of 2017, renewable energy sources account for just over 6% of the region’s electricity which is just a slight increase from 2001. While the region as a whole continues to rely heavily in favor of fossil and nuclear sources, each state within the South East tells a different story as the various sources have changed over the years or more accurately for some states, a lack thereof. In our visualization and by using 2001 to 2017 data provided by the EIA, we attempt to illustrate how electricity generation has changed over time for each state in the South East region of the United States. Specifically, we illustrate changes by renewable and non-renewable energy sources as well as the various resource types across states. Furthermore, we supplement these visuals by showing carbon emissions across the various states over the same time period.

# Encoding/Interaction design

In our design, we utilized a map of the U.S. South East region as the main visualization which serves as the initial focal point. States included are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North and South Carolina, Tennessee, and Virginia. Each point represents individual electricity plants given by their latitude and longitude coordinates. The size of the point represents the energy generation measured by megawatts as the color illustrates the energy source type.

Upon the initial load of the visualization, the map shows data for the most recent year, 2017. Located at the top right is an action button and when activated, changes the year as indicated by the time line at the top of the page, to the beginning of the data set. This action at first shows data for 2001 and automatically progresses to each following year. This in turn, simultaneously animates the regional map, the stacked bar and line charts to show the yearly changes for each plot.

To supplement the main visualization and as part of the tabs located to the right of the dashboard, we utilized a stacked vertical bar chart to show total net generation by energy source over the time frame. In addition, we included tabs that contain a time series line graph showing yearly net generation by the following categories:

* + Energy Source types
  + Renewables versus Non-Renewables
  + Emissions

Like the main visualization, color is used to differentiate the various energy sources for each of supplemental charts. To focus on a particular data element, a user can interact by selecting/deselecting a type such as Coal or Renewables.

To drill down and focus on an individual state within the Southeast region, we placed a pull-down menu located at the top right side of the dashboard and above the dashboard. By utilizing, an interactor can choose a state and filter the data and visualization. Once selected, the map zooms in to that state while the supplemental visuals show filtered values. Like the regional map, the action button can be used to animate and display the year to year changes of electricity generation for an individual state.

# User evaluation

An evaluation is an opportunity for a developer to collect feedback from its end users. This in turn allows the developer to understand the visual’s usefulness, if it meets expectations, and most of all, if it provides invaluable insight. As a result the evaluation is essential in the development of a visualization.

In this section, we provide a self-evaluation for our visualization based off of the following criteria: functionality/effectiveness, efficiency, and usability.

In answering the initial domain problem, the visual is able to provide the necessary functionalities in order to answer the initial domain problem which in turn illustrates its effectiveness. Given how the South East region has not kept pace with the changes of the greater U.S. and that each state has changed individually, the visualization is effective in illustrating these insights. Specifically, it is able to illustrate how electricity generation has changed over time for the South East region. In addition, the visual allows the user the ability to drill down further and view data by state, energy type, and emissions over a period of time.

As with all visualizations, audiences are better able to process visual information more efficiently. Use of the regional map to summarize data coupled with the animation to illustrate the yearly changes, users are able to grasp the multiple dimensions of the data faster as opposed to viewing the data in its raw form. In addition, the animation allows users to notice trends that emerge over the course of time. A clear example is viewing in both the map and the line charts, the emergence of solar energy in North Carolina highlighted in yellow or the significant increases in natural gas usage in Florida which is highlighted in orange. Finally the visual is effective in its design since it allows users to explore by interacting with the data. This can be achieved for example, by using the drop down to select and focus on an individual state or by selecting an energy type in one of the supplemental line charts.

In terms of its usability performance and given the amount of data and the visualization’s functionality, the dashboard is able to load initially in a relatively short period of time. In addition, the end user is able to use the dashboard’s many interactive features (even simultaneously) without experiencing any significant lag. Coupled with the fact that the layout reads from left to right where the map is the main focal point followed by the supplemental line charts, the visual is both simple and intuitive in its design.

# Future work

Include the ability to highlight and/or filter the energy source types either by selecting one of the categories in the legend in the map