2020 Sectoral Carbon Emissions and the Potential of Carbon Capture, Utilization, and Sequestration in the Continental United States

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Background:

Carbon capture, utilization, and storage (CCUS) is the capture of carbon dioxide directly from the atmosphere or from large scale emission sources, such as industrial or energy generation. This CO2 is either directly stored on site or transported via pipelines to locations where the CO2 will be injected into deep underground geologic formations. Coupling CCUS and emissions created by industrial processes allows for a positive long-term outcome to help companies reach climate initiatives in the near future. It is important to monitor and understand the CO2 emissions around the globe, especially as fossil fuels continue, and will continue, to power the world as we know. However, CO2 emissions are not just a result of cars driving to and from work. There are a large collection of stationary sources that contribute to the emissions of CO2 which include: agriculture, chemical processing, energy production, cement production, fertilizer production and ethanol production all lead to a large influx of carbon dioxide within our atmosphere. The U.S. Department of Energy (2015) has monitored 6,358 of these stationary CO2 sources and found that 3,071 million metric tons of CO2 are emitted each year.

Storage of captured CO2 is targeted in various sedimentary basins within North America. The rocks are analyzed to determine if they are porous, which will allow for CO2 to be injected, and if there is an impermeable seal above the targeted injection zone. There are three major types of subsurface storage solutions targets for a CCUS project that will be discussed: oil and natural gas reservoirs, unmineable coal beds, and saline aquifer formations.

Objective:

The objective of this project is to assess the potential for carbon capture, utilization, and storage in the United States to help reduce the impact of sectoral specific carbon dioxide emissions in the continental United States.

Data:

- Sectoral emissions data was collected from the U.S. Energy Information Administration.
- All CCUS data was acquired from the National Energy Technology Laboratory Energy Data eXchange
- Through the portal on ArcGIS Pro I was able to obtain the U.S. outline and major U.S. cities which are used in this project.

ArcGIS Pro   EDX Energy Data eXchange   eia

Methods:

- First, data was imported into ArcGIS Pro from the outside data sources and combined with the data from the online portal. This data was viewed in map viewer to see the extent of the data for the project. Figure 1 shows the carbon storage target types overlaying the United States. Notice that the boundaries extend further than the boundary of the United States.

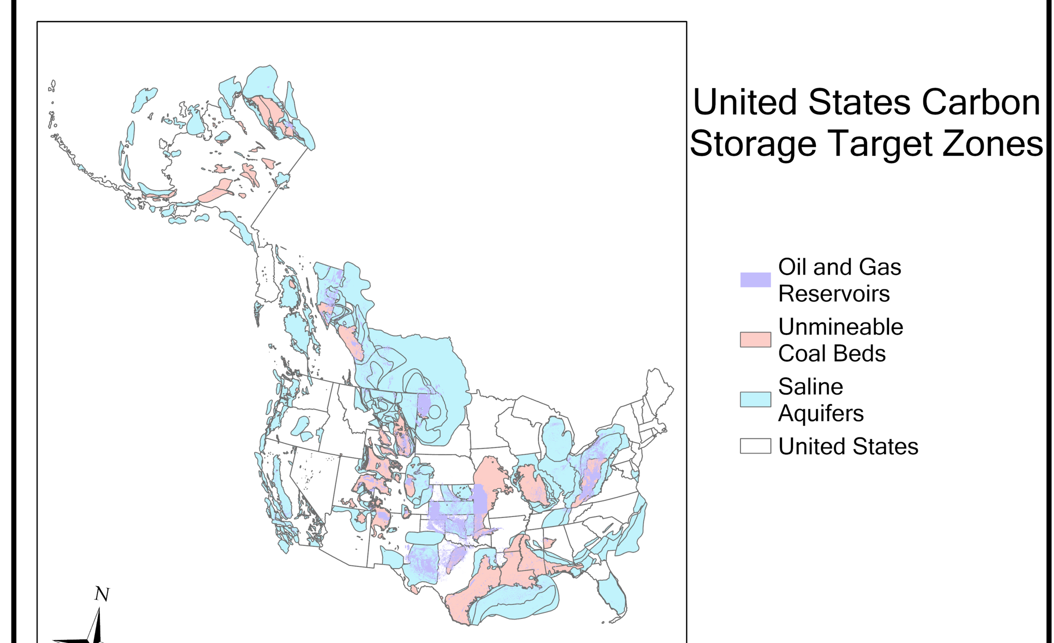

Figure 1. Map showing the extent of three major carbon storage types overlaying the United States.

- To complete this project the data had to be reduced to be represented only within the continental United States. This was achieved by using the clip tool to show only the carbon storage type layers within the lower 48 United States.

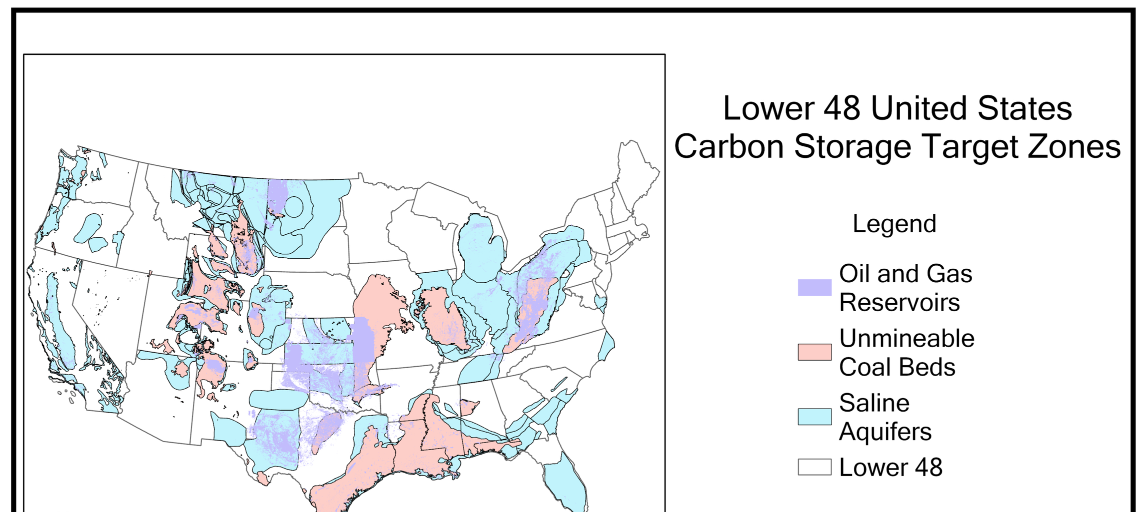

Figure 2. Map showing the continental United States with the 3 major carbon storage zones found within.

- To view the carbon storage types as one main prospective area the individual three storage types were combined into one large polygon. This was done by using the dissolve tool to dissolve the lines of any smaller polygons and created one polygon for each respective layer. Then the three storage types were combined using the merge tool to represent one main polygon for the carbon storage zones.

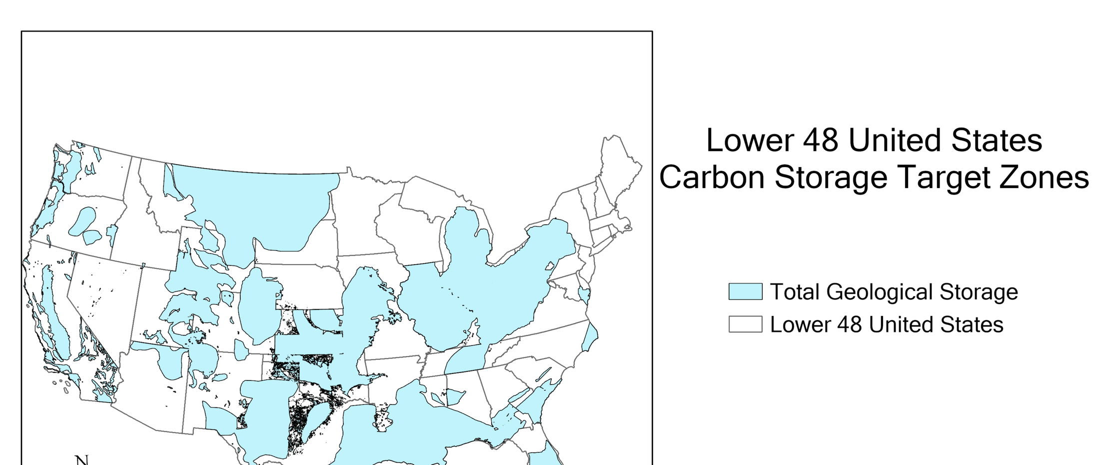

Figure 3. Map showing the result of the three major storage types combined into one large polygon. The blue polygon represents the total storage zones within the continental United States.

Results and Discussion:

- The map in figure 4, shows that there are 8 total states representing the highest emission rates in 2020.
- Within these 8 states, there are158 cities with a population greater than 100,000.
- The map in figure 4 shows that the 8 highest emission states have at least a portion, if not all, of their states having some indication of a possible carbon storage zone.
- In 2020 the continental U.S. contributed to 3,152.6 million metric tons of CO. The total estimated storage within North America is represented in table 1, with a conservative estimate of 2,619 billion metric tons of possible underground storage.

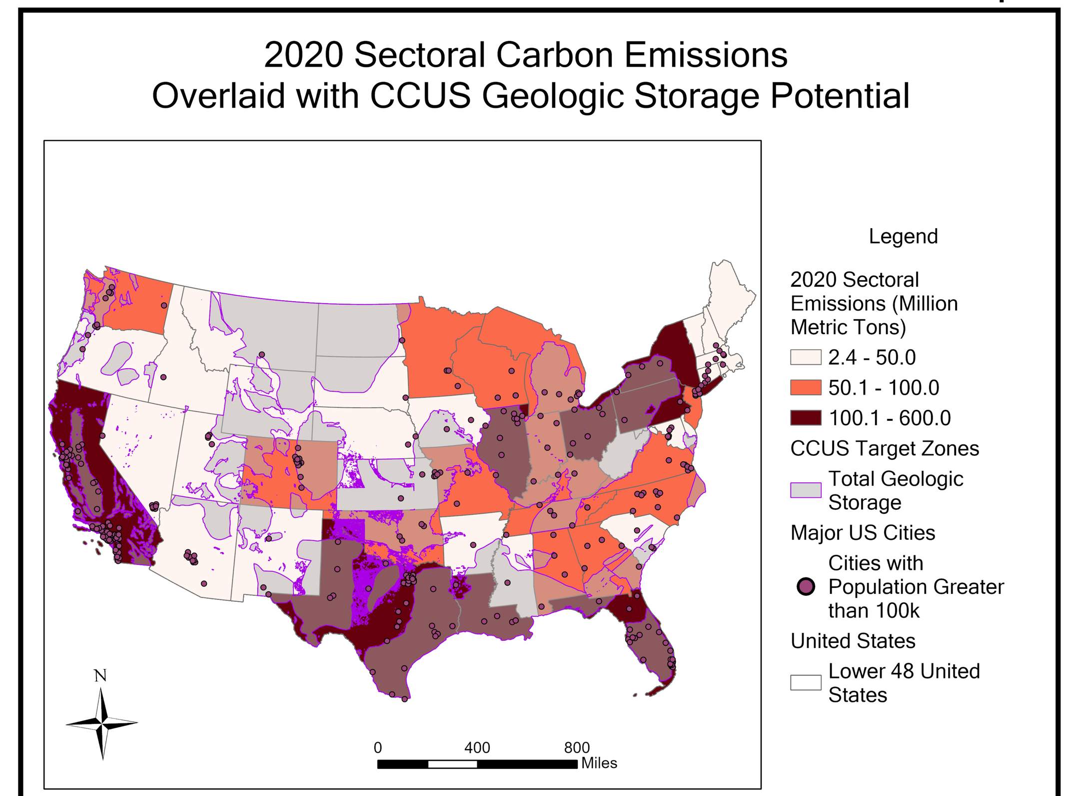

Figure 4. Graduated colors map of the 2020 sectoral carbon emissions in the continental U.S. overlaid by the carbon storage target zones. The major U.S. cities with a population greater than 100,000 is represented by dots. 158 cities are found within the 8 largest carbon emitting states. The various colors of the states represents different amounts of CO2 emitted with dark red being the most (100 < million metric tons) emissions and white being the least emissions (0 - 50 million metric tons).

Total continental U.S. sectoral emissions in 2020:
3,152.6 million metric tons

	P90	P50	P10
Total Storage:	2,619	8,613	21,978

Table 1. Total estimated geologic storage within North America in billion metric tons. P90 is the most conservative estimate and the P10 is the most aggressive estimate.

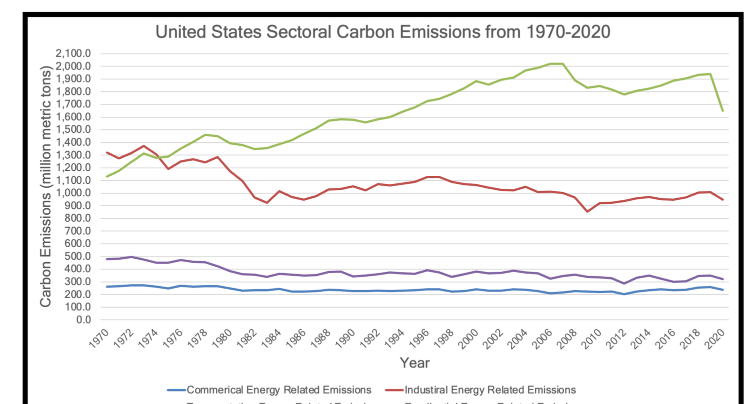

Figure 5. Graph showing fluctuations of the sectoral carbon emissions from 1970 - 2020 in the United States.

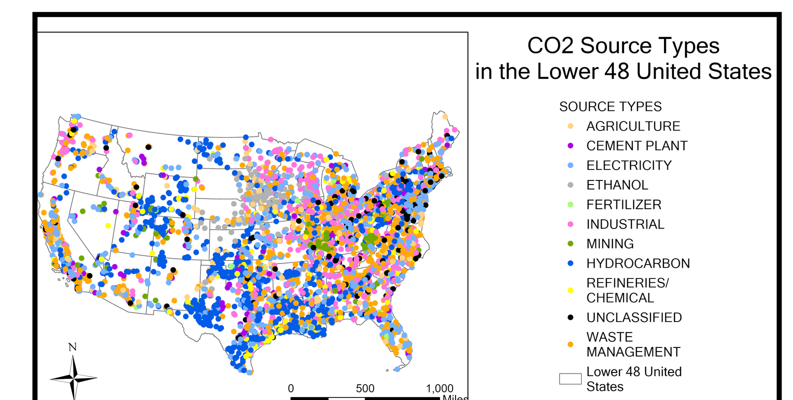

Figure 6. Map of the stationary carbon sources within the continental United

By overlaying the total target storage zones on top of the 2020 sectoral carbon emissions for the continental U.S. it is clear to see where the highest emission states are relative to potential areas for underground storage of CO2. It is clear to see that there seems to be a correlation between high emitting states and the number of cities with a population over 100,000.

Conclusions:

Due to the consistent trend of not seeing a drastic decrease in sectoral carbon emissions in the United States it is important to assess all potential areas to help reduce the continued impact that is caused by our everyday lives. Storing carbon in underground formations can be a extremely successful opportunity to help reduce this impact. With a conservative estimate of 2,619 billion metric tons of storage space within North America and the continental U.S. producing 3,152 million metric tons of sectoral CO_2 in 2020, there is abundant space to use underground storage as a means of reducing carbon emissions.