CARBON SOLUTIONS

How To Net-Zero America: Nationwide Cost and Capacity Estimates for Geologic CO_2 Storage

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Date: October 18, 2023

Acknowledgements

This material is based upon work supported by the U.S. Department of Energy, Office of Science, Small Business Innovations Research program under Award DE-SC0021570. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Department of Energy.

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Executive Summary

Reaching a US net-zero carbon economy may require drilling and operating hundreds of CO_2 injection wells by 2030 and thousands by 2050 in deep saline formations. Accomplishing this scale of infrastructure deployment will require a coordinated effort across all sectors of the economy. A first step is estimating the cost and capacity of geologic CO_2 storage across the entire country to provide high-level guidance for national geospatial infrastructure decisions. Prior to this study, such an analysis had not been completed because it requires a combination of a fast-running, physics-based software tool *and* a fine-resolution nationwide database of geologic properties, which did not exist. Here, we addressed this gap by constructing the Sequestration of CO_2 Tool (SCO_2T^{PRO}) geodatabase to provide the first-ever cost and capacity screening estimates for onshore geologic CO_2 storage across the United States.

Using the SCO_2T^{PRO} screening estimates, we find that there is a substantial capacity of low-cost CO_2 storage in the United States, but that this capacity is not uniformly distributed across the country. For example, there are regions of the country with capacity for geologic CO_2 storage, but the cost of that capacity can vary widely. Overall, this finding demonstrates that simply having a deep saline geologic resource in a given location does not always mean geologic CO_2 storage is a viable option for decarbonization efforts. This result underscores the crucial importance of geospatial planning for reaching net-zero by midcentury. For example, geologic CO_2 storage is widely regarded as critical for decarbonizing “hard to decarbonize” sectors of the economy (e.g., cement production), but our results show there are portions of the country where widespread low-cost CO_2 storage is unavailable. As reaching net-zero nationwide requires addressing the emissions from every region in the country, our results imply that identifying plausible pathways for decarbonizing these “hard to sequester” regions should be prioritized.

Additionally, our results also demonstrate that knowledge of capacity and injectivity are insufficient indicators for identifying low-cost CO_2 storage. This finding may have large ramifications for reaching net-zero because, currently, preliminary CO_2 storage site characterization typically entails estimating the capacity and injectivity across various potential sites, and then using that information to down-select locations for more detailed and expensive characterization efforts. We show here that these intermediate results are not always robust indicators of low-cost resources and that preliminary site-characterization activities should go beyond capacity and injectivity to also consider cost.

1. Introduction

1.1 Background: CO_2 Storage within Modeled US Net-Zero Carbon Economies

In a US net-zero carbon economy, CO_2 may be captured from a variety of sources. For example, CO_2 that would otherwise be emitted can be captured from industrial processes that provide the commodities society relies upon (e.g., cement, ammonia), from facilities that produce liquid fuels like ethanol, or from biomass-fired or fossil-fuel power plants that generate electricity. Additionally, CO_2 may also be captured from the air directly using carbon dioxide removal technologies (e.g., direct air capture, or DAC) that offset residual emissions from "hard to decarbonize" sectors of the economy. Once captured from any of these potential sources, the CO_2 can be permanently isolated from the atmosphere via injection into saline aquifers that are deep underground. In this way, geologic CO_2 storage is a critical technology in a US net-zero carbon economy.

Overall, reaching net-zero emissions will require geologically storing multiple orders of magnitude more CO_2 than is being stored today. Figure 1 shows the quantity of CO_2 that is stored within dedicated saline geologic formations in net-zero modeled pathways from two studies: the Princeton Net-Zero America Study (PNZA)[1], and the Low-Carbon Resources Initiative Net-Zero 2050 Report (LCRI) by EPRI and GTI Energy[2]. It also shows the 2022 operational capacity of dedicated saline geologic storage in the USA, which is the sum of only two projects: 1) The Illinois Industrial CCS project that sequesters 1 $MtCO_2/yr$ of CO_2 and 2) the Red Trail Energy CCS project in North Dakota that sequesters 0.18 $MtCO_2/yr$ of CO_2.[3] Both geologic CO_2 storage projects currently inject CO_2 captured from ethanol production facilities.

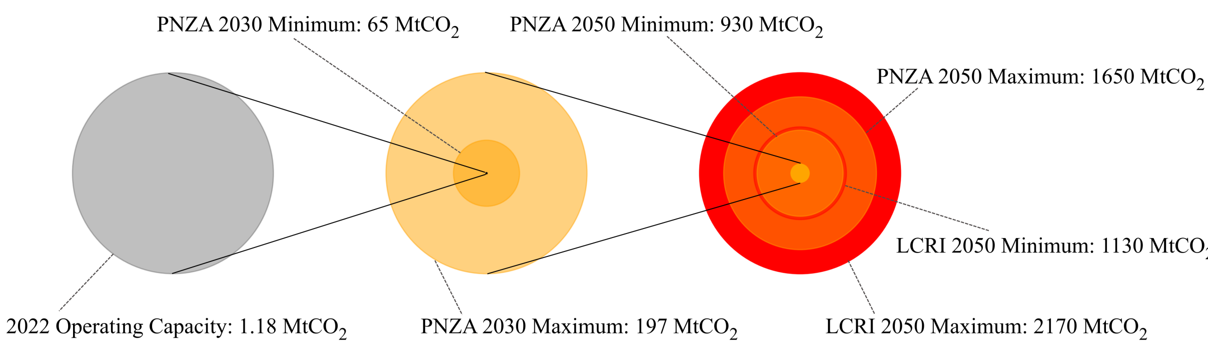

Figure 1: Quantity of CO_2 Geologically Stored in the USA in Net-Zero Pathways That Do Not Exclude Geologic CO_2 Storage from the Model Scenario Ex-Ante. *Operating capacity in 2022 was taken from the Global CCS Institute[3], Princeton Net Zero America (PNZA) data was taken from Larson et al. (2020)[1], and the Low-Carbon Resources Initiative (LRCI) data was taken from EPRI and GTI Energy (2022)[2]. 2030 estimates are not available from the LCRI study because it was focused on 2050.*

These net-zero studies indicate that the US will need to increase the deployment of geologic CO_2 storage infrastructure by at least one order of magnitude by 2030 and by multiple orders of magnitude by mid-century. For comparison, the projected quantities of CO_2 storage shown in Figure 1 range up to about three times the amount of US oil production on a volume-equivalent basis. While the two current saline-CCS projects could increase their annual injection capacity (e.g., the Illinois Industrial CCS project is permitted for a maximum of 6 $MtCO_2/yr$[4]), thousands more CO_2 injection wells will need to be drilled across the country to reach the net-zero goals shown in Figure 1. For example, assuming each injection well has a capacity between 0.5 to 1 Mt

CO_2/yr, reaching net-zero may require drilling at hundreds more wells by 2030, and thousands more wells by 2050.

1.2 Reaching Net-Zero Requires Nationwide Site-Screening as Part of a Coordinated Effort

While drilling and operating thousands of CO_2 injection wells is necessary to reach net-zero, deploying this scale of infrastructure is challenging. First, while saline formations underly approximately half of North America, the characteristics of these formations are inherently uncertain and vary geospatially[5–7], so the cost and capacity can change from one location to another. In other words, just because saline formations exist in a given location does not necessarily mean the geology is well-suited for CO_2 storage. Second, reducing the uncertainty in the formation characteristics through data collection (e.g., drilling a well) or site characterization efforts is time consuming and expensive. Finally, in addition to geology, the optimal location of geologic CO_2 storage can be heavily influenced by other factors (e.g., environmental justice, the CO_2 capture process). For example, our prior work has demonstrated that when CO_2 is being captured from electric power plants, it is possible that injecting CO_2 in more expensive geology may be less-costly overall if it avoids building new electric transmission.[8]

Given these challenges, deploying thousands of CO_2 capture and storage projects to reach net-zero will require a coordinated effort across all sectors of the economy. A first step in this effort is nationwide screening, where the cost and capacity of geologic CO_2 storage is estimated at hundreds-of-thousands of potential sites across the entire country.

There are two challenges to screening the entire country for geologic CO_2 storage. First, CO_2 injection is a highly complex subsurface process, and simulating it requires full-physics models that are computationally expensive, potentially requiring hours per simulation. But simulations requiring hours per site are too long if one needs to simulate CO_2 injection across hundreds-of-thousands of potential sites in nationwide site screening. Screening tools require faster methods than full-physics simulations, but the usefulness of the screening tool may be negated if the faster methods come at the expense of too many simplifying assumptions. Second, screening the entire USA requires a nationwide database of geologic properties (e.g., depth, thickness, porosity, permeability) to apply to the screening tool. While there are multiple existing geologic databases that span the USA[9–11], our prior work found that none of them are suitable for nationwide screening given their incompleteness (e.g., at least one geologic property is missing from over 90% of the geographic extent of the NATCARB database)[12]. As a result of these two challenges, a robust nationwide screening of geologic CO_2 storage has never been completed.

1.3 Solution: SCO_2T^{PRO}

In this paper, we address these challenges with SCO_2T^{PRO}, the professional version of the Sequestration of CO_2 Tool, and provide the first-ever nationwide cost and capacity screening estimates for geologic CO_2 storage. SCO_2T^{PRO} is a novel screening tool that was developed through groundbreaking peer-reviewed science[8,12–15]. It addresses the first challenge for nationwide screening by using novel reduced order models (ROMs), developed by applying machine learning algorithms to reservoir simulation data. The latest SCO_2T^{PRO} ROMs approximate full-physics reservoir simulations with unmatched accuracy and yet can calculate thousands of estimates—injection rates, storage capacities, and costs—in a second. Consequently, the software can rapidly explore hundreds-of-thousands of sites, including uncertainty and sensitivity analysis. We apply this software to a nationwide database of geologic properties that we developed for the purpose of nationwide site screening at a 10x10 km resolution. To our knowledge, it is the first complete, realistic, database of geologic properties built for site-screening geologic CO_2 storage across the country at this fine of a resolution.

2. Results

2.1 Nationwide Cost and Capacity of Geologic CO_2 Storage

Figure 2 shows the nationwide estimate of the cost and capacity of CO_2 storage using the SCO_2T^{PRO} software and geologic database. For this study, it was not possible to include data for every plausible storage reservoir in every location across the entire country, and viable storage reservoirs may exist in areas where no resource is shown. A primary reason for this lack of coverage (e.g., Nevada, Arizona) is simply that sufficient geologic data does not exist in a form that can be readily processed into a nationwide database at this time. Despite this reality, the database currently contains geologic reservoir properties and SCO_2T^{PRO} cost and capacity estimates for more than 119 reservoirs covering more than 2.1 million km^2 across the continental United States. As more primary data is collected (e.g., by drilling stratigraphic wells and interpreting the cores) and/or digitized (e.g., from newly found sources of previously collected primary data) the geographic coverage of SCO_2T^{PRO} will expand. Given the speed of SCO_2T^{PRO}, computation time will not be an issue as more geologic data is added to the database. For example, it took an "everyday" computer about a minute to estimate the cost and capacity results mapped in Figure 2.

Figure 2 shows that the CO_2 storage resource is not evenly distributed across the country, as some regions have no CO_2 storage potential and in other regions, the cost and capacity of CO_2 storage can vary widely. For example, the Gulf Coast has extensive high capacity and low-cost reservoirs while Appalachia has relatively low storage capacities and moderate to high costs. These regional differences are driven by geology: there are numerous geologic formations with high reservoir quality across the Gulf Coast region, but substantially fewer in Appalachia. This difference does not mean that low-cost storage is not possible in locations like Appalachia, or that everywhere in the Gulf Coast will provide low-cost storage, but rather that widespread low-cost storage is more likely to be available in the Gulf Coast compared to Appalachia. As reaching net-zero will require management of carbon across the entire country, Figure 2 suggests that some regions (e.g., Appalachia) will likely need to consider carbon management approaches outside of geologic CO_2 storage in saline formations to reach net-zero, such as transportation via pipeline or geologic storage in shale formations shale.

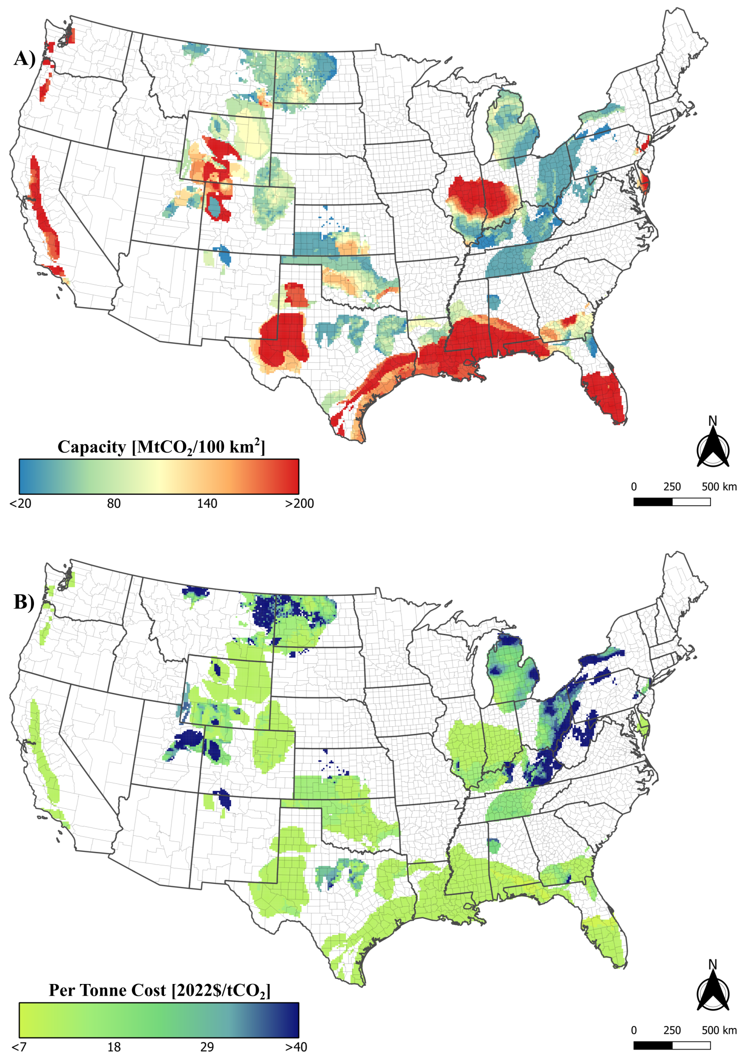

Figure 2: Nationwide Cost and Capacity of Geologic CO_2 Storage in Dedicated Saline Formations. *The per tonne costs were levelized assuming a 30-year financing period and a 15% discount rate. See Sections 5.2 and 5.3 of the Appendix for more information on the geologic database and the assumptions used within the SCO_2T^{PRO} software, respectively.*

Figure 3 shows supply curves for geologic CO_2 storage in the USA using the nationwide screening data mapped in Figure 2. In addition to the scenario mapped in Figure 2, additional scenarios of financing assumptions were used. Specifically, three discount rate scenarios (3.15%, 7%, 15%) and two financing periods (30 years and 10 years) were considered. Per tonne costs are levelized costs, thus are a function of these financing assumptions. Our scenarios were chosen to represent the range of possibilities considered. For the discount rate, some of our past work[8] has used 3.15%, while 7% is the default discount rate used in EPRI's US-REGEN model that was used for the LRCI study[2], and 15% is the discount rate that industry often considers appropriate for geologic CO_2 storage given the nascence of the sector. Our project financing period scenarios were chosen because 30 years is a typical length assumed for carbon management projects, but real-world projects are likely to only be financed for about a decade particularly given the period over which tax credits are available (e.g., the 45Q tax credits are currently available for only 12 years for a given project).

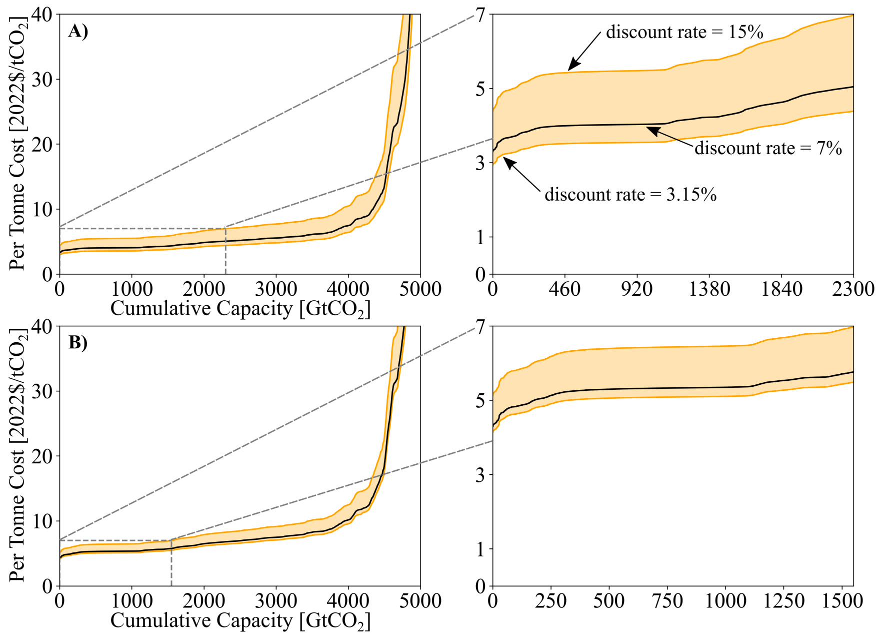

Figure 3. Geologic CO_2 Storage Supply Curve in the United States Assuming 30 Years CO_2 Injection. *In A) the finance period is 30 years while in B) the finance period is only 10 years.*

Figure 3 suggests that there are several orders of magnitude more capacity of low-cost CO_2 storage than is needed to reach net-zero. For example, regardless of the financing assumptions, there are over 1,500 $GtCO_2$ of capacity at an annualized cost less than \$7/tCO_2. This is equivalent to hundreds of years of stationary CO_2 emissions in the United States. So, while Figure 2 demonstrates the country's low-cost capacity is not uniformly distributed across the United States, Figure 3 demonstrates that with sufficient geospatial planning and coordination, a lack of low-cost CO_2 storage should not be a limiting constraint to reaching net-zero.

Figure 3 also demonstrates the impact of financing assumptions. For example, the financing period and the discount rate can change the cost of CO_2 storage by \$1/tCO_2 to \$2/tCO_2, which is substantial considering that lowest-cost options are less than \$7/tCO_2.

2.2 Breaking Down the Cost of CO_2 Storage

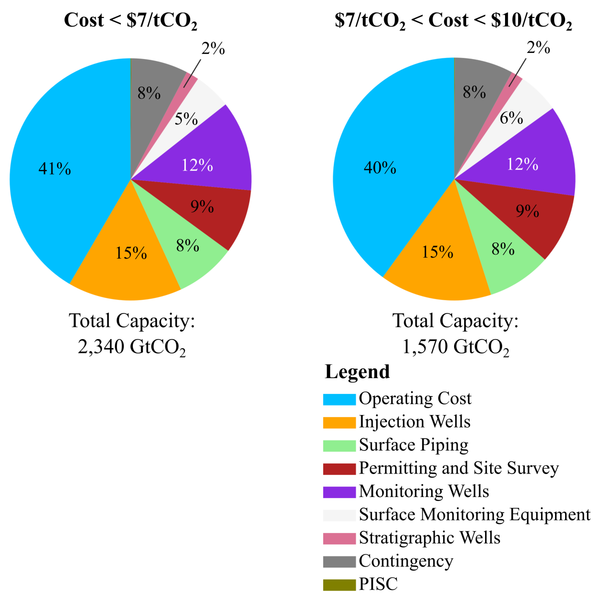

Figure 4. Average Per Tonne Cost Breakdown for Three Cost Ranges. *These results assume a 30-year financing period and a 15% discount rate.*

Figure 4 shows the relative contributions of individual cost components to the total averaged per tonne cost for three different ranges of cost. The relative contributions are similar across the three ranges, and the largest contributor is operating cost, about 40% of the average total. The operating cost is the sum of all annual expenditures incurred every year of CO_2 injection (e.g., air and soil surveys, maintenance on wells, taxes and insurance, pore space use costs). Consequently, after the finance period, the per tonne cost will decrease because the capital costs have been paid off. For example, if the per tonne cost is $7/t$CO_2$ at the start of the project and the operating cost is 40%, the per tonne cost will decrease to $2.8/t$CO_2$ (40% of $7/t$CO_2$) after the finance period.

3. Screening for Geologic CO_2 Storage

Maximum well injectivity is the upper bound rate that CO_2 can be injected into the subsurface. Maximum injectivity, along with capacity, are used to estimate the annualized cost of CO_2 storage with SCO_2T^{PRO} (see Section 5.1 in the Appendix for more information on how SCO_2T^{PRO} provides screening estimates). Figure 5 shows the per tonne cost as a function of both the capacity and the maximum injectivity. Each data point plotted is a single 10x10km grid cell from the geodatabase. In both subplots, orange data points indicate per tonne costs less than $7/t$CO_2$.

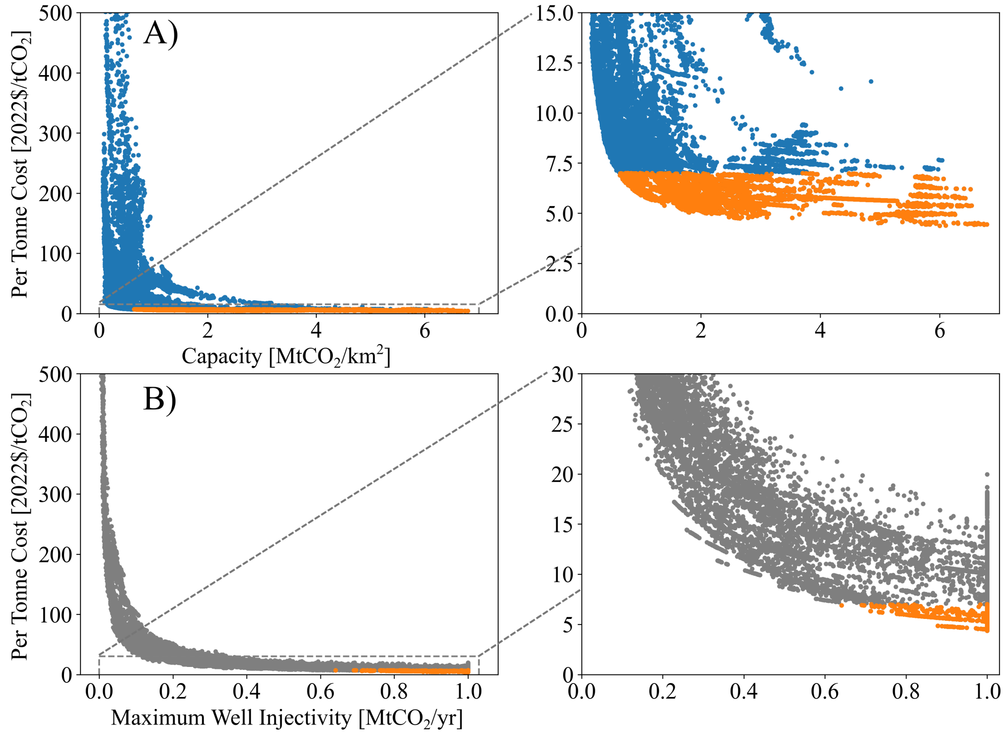

Figure 5. Per Tonne Cost as a Function of Capacity (A) and Injectivity (B). *In all subplots, the orange data indicates the portion of the data with annualized cost below \$7/tCO_2. Costs assume a 30-year finance period and 15% discount rate.*

Figure 5 demonstrates that knowledge of injectivity and capacity alone are insufficient for identifying low-cost CO_2 storage. Figure 5A shows that very high capacity generally indicates a low-cost location, but low capacity does not necessarily indicate a high-cost location. For example, costs can be below \$7/tCO_2 even when the capacity is below 1 MtCO_2/km^2. Further, Figure 5B shows that a low maximum injectivity generally indicates a high-cost location but high maximum injectivity does not always indicate a low-cost location. For example, costs can range up to ~\$20/tCO_2 even if the maximum injectivity is 1 MtCO_2/yr. Following our prior work[15], we set the maximum injectivity at 1 MtCO_2/yr because CO_2 injection wells are currently designed using diameters that support a maximum injection rate of 1 MtCO_2/yr.

Figure 6 shows histograms of each geologic input parameter that is an input to SCO$_2$T^{PRO}, along with maximum injectivity. In all subplots, data from the entire country is shown in blue and only the portion of the geologic database with costs less than \$7/tCO_2 are shown in orange.

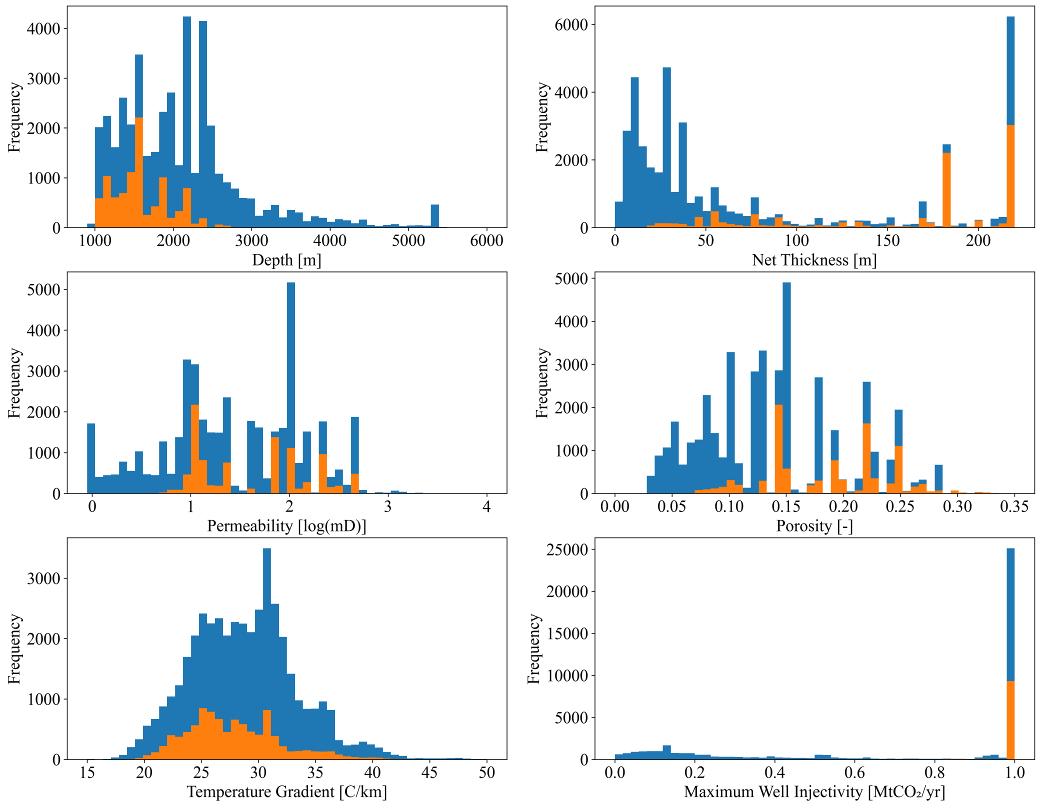

Figure 6. Histograms of Each Subsurface Parameter and Maximum Injectivity. *In all subplots, the orange data indicates the portion of the data with a per tonne cost below \$7/t*CO_2*. Costs assume a 30-year finance period and 15% discount rate.*

Figure 6 shows that the distribution of each geologic parameter range similar maximums and minimums, regardless of if the cost is less than \$7/tCO_2 or not. For example, across the entire country, the net thickness of saline formations can range from anywhere from <10 meters to above 200 meters, while the range of net thicknesses in locations with low-cost range from ~20 meters to above 200 meters. Depth is the only exception: depths can range between 900 and 5,000 meters across the country, but low-cost locations are always shallower than ~2,500 meters. Our prior work demonstrated that shallow reservoirs were generally less costly than deeper reservoirs when injectivity was limited to 1 MtCO_2/yr[15]. As shown in Figure 6, the 1 MtCO_2/yr injectivity constraint was limiting for nearly all the low-cost reservoirs visualized in orange.

Overall, Figure 6 demonstrates that no single geologic variable can be used as a proxy for cost because cost is a complex function of multiple inter-related geologic conditions. Even knowing that depth must be less than ~2,500 meters is of limited value because, as shown in Figure 6, there are more locations with depths below ~2,500 meters where the cost is greater than \$7/tCO_2 compared to below \$7/tCO_2. In other words, Figure 6 demonstrates the crucial importance of both the SCO_2T^{PRO} software and the nationwide SCO_2T^{PRO} geologic database for screening geologic CO_2 storage.

4. Conclusions and Implications

In this study, we used SCO_2T^{PRO} to conduct the first nationwide cost and capacity screening of geologic CO_2 storage. We find that:

1. There is tremendous capacity for low-cost geologic storage in the United States, but this capacity is not uniformly distributed across the country (Figure 2; Figure 3).
2. Financing assumptions (i.e., discount rate, finance period) can change the per tonne cost by several dollars per tonne, but low-cost storage was below $7/t$CO_2$ across all financing assumptions considered (Figure 3). Annual operating costs accounted for ~40% of the total per tonne cost, which was the single largest component (Figure 4).
3. Knowledge of injectivity, capacity, or reservoir properties (e.g., depth, permeability) alone are insufficient for identifying low-cost CO_2 storage (Figure 5; Figure 6).

As discussed in the introduction, thousands of CO_2 injection wells across the United States will be needed to reach a net-zero carbon economy. Accomplishing this scale of infrastructure deployment will require a coordinated effort across all sectors of the economy, of which this study is an initial step. Our results suggest two primary implications for the future steps toward reaching net-zero:

- First, similar to how "hard to decarbonize" sectors of the economy are being prioritized for technological development[16], "hard to sequester" areas of the country (e.g., Appalachia) should also be prioritized for decarbonization planning. Reaching net-zero requires addressing CO_2 emissions across the entire country, but widespread low-cost CO_2 storage is likely unavailable in "hard to sequester" locations due to the quality of subsurface resources. Despite this fact, prior geospatial analyses have suggested that "hard to sequester" locations are attractive for CO_2 storage because these studies assumed that CO_2 storage was equally viable anywhere a sedimentary basin formation exists[17,18]. Future analysis should discontinue relying on outlines of sedimentary basins (e.g., the NATCARB database) as justification for sufficient geologic CO_2 storage resources. For example, some of our initial investigations that apply the nationwide SCO_2T^{PRO} geodatabase to nationwide geospatial planning suggest that transporting CO_2 away from Appalachia via pipelines is substantially lower cost than storing it within the region, and is the only likely pathway under current and future tax credits.[19]

- Second, preliminary site-characterization activities should go beyond capacity and injectivity to also consider cost. Preliminary site-characterization typically results in a capacity and sometimes injectivity estimate, and that information is used to down-select sites for more detailed and expensive characterization. Here we demonstrate that these intermediate results are not always robust indicators of low-cost resources. As cost is a crucial metric for determining a potential site's viability, additional efforts on subsequent characterization may be wasted by not considering cost earlier in the down-selection process.

5. Appendix

5.1 About the SCO_2T^{PRO} Software

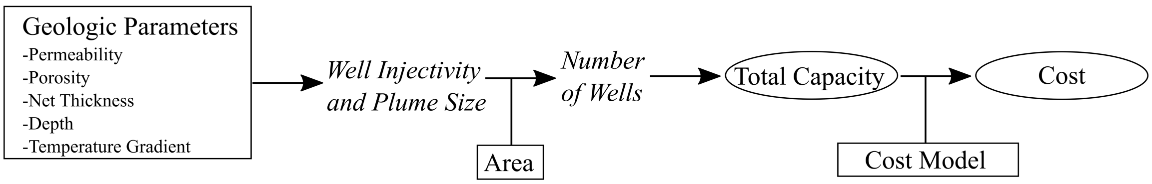

Figure 7. SCO_2T^{PRO} Workflow. *Squares indicate inputs, italic words indicate intermediate inputs, and ovals indicate screening outputs. There are more inputs (e.g., discount rate) than shown here, and this overview intentionally only shows the geologic parameter inputs for simplicity.*

Figure 7 shows the workflow of SCO_2T^{PRO}. Using the input geologic properties, the software estimates the well injectivity and the subsurface footprint of CO_2 referred to as "plume size." These calculations are made using the ROMs. The number of wells is estimated using the plume size and the area available for CO_2 storage, which is then combined with the injectivity to define the total capacity of the site. Lastly, all the intermediate outputs are applied to a cost model to estimate the annualized cost of CO_2 storage.

While the overall framework shown in Figure 7 remains unchanged from our most recent SCO_2T^{PRO} publication[12], all other aspects of the software have been substantially improved. First, SCO_2T^{PRO} was previously developed in Microsoft Excel using VBA MACROS, and we have completely redeveloped the software as an object-oriented library using the Julia programming language. Julia was chosen specifically for its speed, and the object-oriented library enables the software to be easily used in a variety of applications (e.g., cloud-based decision support, uncertainty analysis). Second, we have also developed new ROMs using new reservoir simulation data. Our prior work relied on ROMs developed using the FEHM reservoir simulator, and we now use the STOMP reservoir simulator for data as this is one of EPA's preferred simulators for Class VI well permit applications. Further, we have used novel machine learning algorithms and performance metrics to create substantially improved ROMs.

5.2 About the Nationwide SCO_2T^{PRO} Geologic Database

As shown in Figure 7, SCO_2T^{PRO} requires a variety of geologic reservoir properties as inputs for site screening, but as previously mentioned, no single publicly available dataset of saline storage reservoirs suitable for nationwide screening of storage costs and capacities exists.[12] Existing nationwide datasets lack coverage and spatial variability, limiting the ability to create meaningful regional assessments and screen for the most prospective storage sites within a given region. For this study, we created a first-of-its-kind nationwide database through identifying, interpreting, vetting, and compiling suitable geologic data from a wide variety of sources. These sources include but are not limited to: United States Geological Survey (USGS) National Geologic CO_2 Storage Assessment[10,20], NATCARB CO_2 storage database[11,21], Regional Carbon Sequestration Partnership products[22], State Geological Surveys (e.g., Bowersox and Willams (2014)[23]), reports and data from CCS pilots such as CarbonSAFE projects[24] and RCSP demonstrations (e.g., Battelle (2011)[25]), academic publications, and datasets we generated through interpretations of publicly available oil and gas well data available from state regulators/agencies.

Building a database that accounts for every single plausible option for CO_2 storage across the United States is a never-ending pursuit because: 1) the United States is a large geographic area that contains hundreds to thousands of geologic formations that could potentially serve as CO_2 storage reservoirs, 2) each reservoir requires a considerable amount of time and effort to characterize, and 3) little to no data are available for many potential reservoirs. As a result, the database developed for this study focused on key reservoirs that were identified and prioritized based on a variety of criteria (i.e., literature review, data availability, locations of CO_2 storage pilot projects, preliminary SCO_2T^{PRO} analysis). We will continue to develop and enhance the database over time to continue to provide the screening estimates needed to reach net-zero.

5.3 Assumptions Used Within SCO_2T^{PRO}

In addition to the geologic inputs shown in Figure 7, there are additional user inputs that give flexibility to the engineering and site-level assumptions that impact cost, such as the number of monitoring wells drilled per injection well. Overall, this allows SCO_2T^{PRO} to provide detailed cost results, like those shown in Figure 4. In our prior work, we investigated the sensitivity of cost to engineering and site-level assumptions.[8] Based off that work and additional learnings (e.g., conversations with other industrial stakeholders), we used the following assumptions in this paper: 9-inch diameter injection well; 10 old oil and gas wells that must be plugged prior to CO_2 injection per 10x10km grid cell; 1 backup CO_2 injection well per primary CO_2 injection well; 1 above-zone monitoring well per injection well; and 2 in-zone monitoring wells per injection well. All costs are reported in 2022 dollars.

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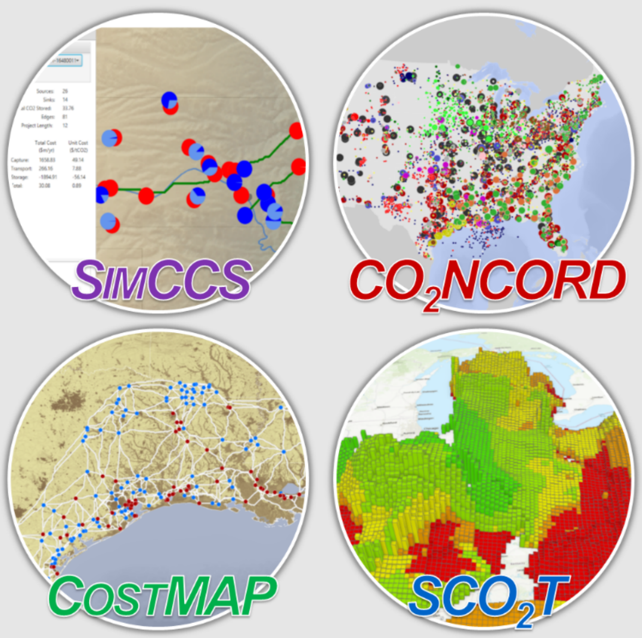
7. About Carbon Solutions

Carbon Solutions (carbonsolutionsllc.com) is a mission-driven, fast-growing small business focused on low-carbon energy **Research & Development** and **Software & Services**. Energy applications include CO_2 capture and storage (CCS), direct air capture (DAC), energy storage, geothermal energy, wind energy, the hydrogen economy, and energy equity. Carbon Solutions was launched in 2021 and currently has around 30 employees with more than 50 projects to date. In addition, Carbon Solutions has around 25 expert energy consultants that cover the entire CCS value chain.

The company currently leads and participates in around a dozen DOE-funded R&D projects in a diverse range of areas, including CO_2 capture-transport-storage, energy storage, wind energy, geothermal energy, and next-generation carbon-negative power fueled by coal waste and biomass (carbonsolutionsllc.com/rd-projects). The company has developed unique award-winning, industry-leading SimCCS^{PRO} to understand, analyze, and support decisions for CO_2 capture, transport, and storage, including when, where, and how much CO_2 to capture and store, when and how to route CO_2 pipelines, and to assess economics across the entire CCS value chain.



***SimCCS^{PRO}* is the world's leading software to optimally understand how and when to optimize CO_2 capture, transport, and storage investments. SimCCS has won two prestigious R&D 100 Awards and is the most-used and most-cited CCS infrastructure software.**

***CO_2NCORD* is a dynamic software and database that characterizes thousands of CO_2 capture opportunities across the United States. The software uniquely fuses and analyzes CO_2 emissions data from multiple data sources and develops unique approaches to calculate capturable CO_2 and advanced capture economics.**

***CostMAP* is the most advanced CO_2 pipeline routing and cost tool, combining multiple geographies—such as population, land cover, lane ownership environmental challenges, social impacts, topography, existing rights of way, etc.—to produce custom-weighted pipeline routes and potential networks.**

***SCO_2T* is a dynamic CO_2 sequestration screening tool for identifying potential CO_2 storage sites based on dynamic CO_2 injection and dynamic plume evolution coupled with advanced economics.**