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ENERGY TRANSITION

Digging Into the US Gulf Coast's 'Salt Real Estate' for Hydrogen Storage

Researchers are building a comprehensive database of hundreds of salt domes to help expand subsurface hydrogen storage in the US.

March 30, 2023 By Trent Jacobs
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Core sample taken from a salt dome in Texas. *Source: University of Texas Bureau of Economic Geology.*

Researchers from The University of Texas (UT) at Austin’s Bureau of Economic Geology are spearheading efforts to expand hydrogen storage in salt domes and caverns along the US Gulf Coast.

The initiative is part of the bureau’s State of Texas Advanced Resource Recovery (STARR) program that is building a comprehensive database of the region’s more than 600 salt domes found both onshore and offshore.

However, not every site is ideal for storage, so STARR is assembling new tools to help with the early site characterization and screening process. The list includes new modeling workflows, protocols for salt-core descriptions, seismic/petrophysical characterizations, and new ways to estimate injection/withdrawal schemes.

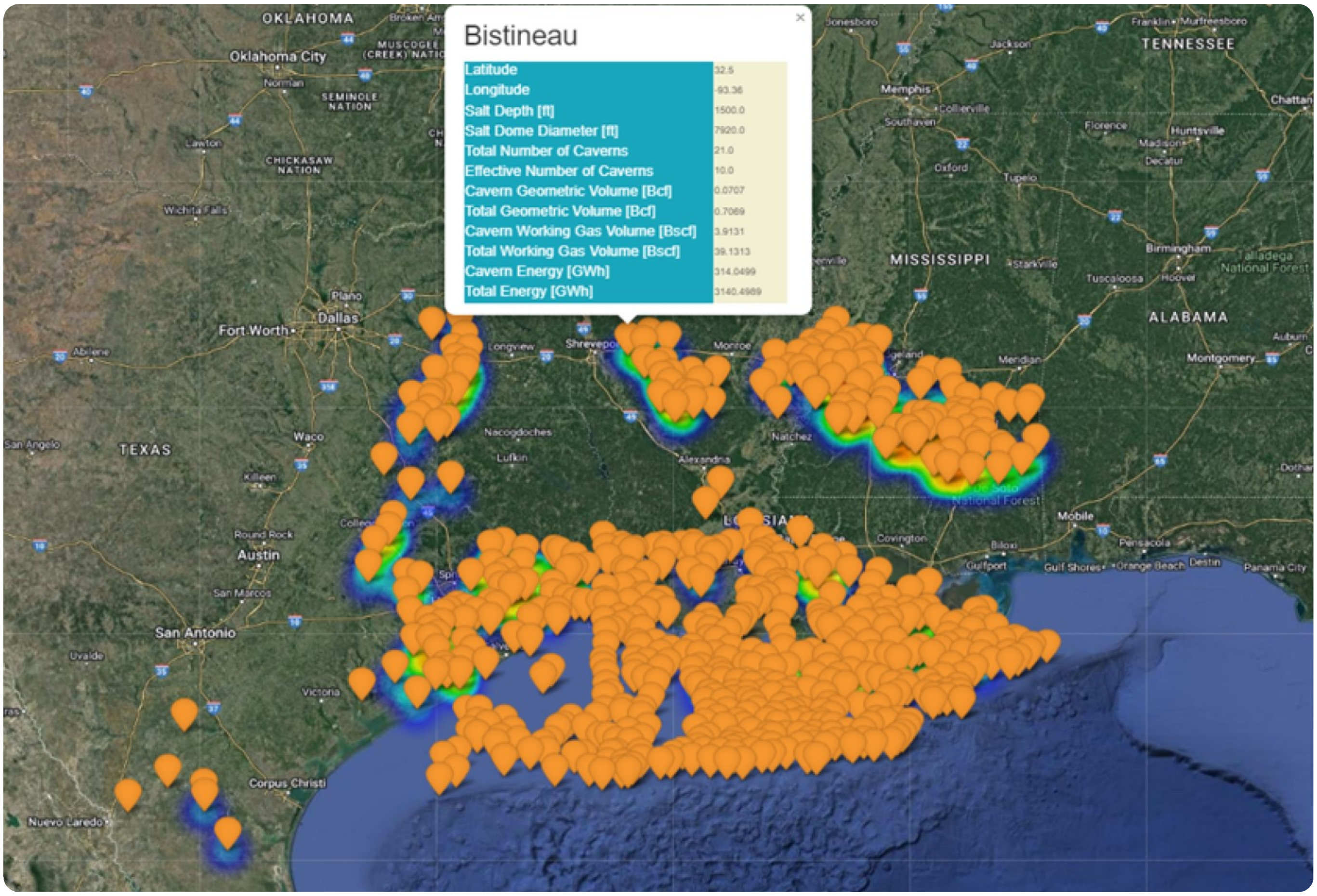
Lorena Moscardelli, a geoscientist and the director of the STARR program, emphasized that "each dome and each cavern is unique" and added, "a single dome can have 60 to 70 caverns, which speaks to the importance of proper subsurface characterization in conjunction with appropriate engineering approach."

The Gulf Coast's hydrogen infrastructure includes in Texas the world's only three salt domes used for hydrogen storage, but they are almost entirely dedicated to supplying refineries and petrochemical plants with the feedstock.

Moscardelli believes the recent raft of "green" and "blue" hydrogen projects being planned across the region could change that. If enough hydrogen is produced to replace a meaningful share of natural gas used, she said the storage requirements “would be overwhelming” and that “surface tanks won’t be an economically feasible solution at this scale.”

Helping to illustrate, separate research from the bureau recently estimated that if new hydrogen projects displaced the equivalent of just 1% of US natural gas consumption in 2019, an additional 100 Bcf of storage capacity would be needed. Currently, just 5 to 8 Bcf of storage exists along the Gulf Coast.

locations in Utah where a major government-backed project plans to store hydrogen produced using wind and solar power in two 4.5-million bbl salt caverns.



Screenshot showing an interactive map of salt dome locations in Texas, Louisiana, Mississippi, and in the Gulf of Mexico. Users can click each icon and see basic information (e.g., depth, diameter, number of caverns, etc.) and a heat map indicating hydrogen storage potential. *Source: The University of Texas at Austin Bureau of Economic Geology/State of Texas Advanced Resource Recovery.*

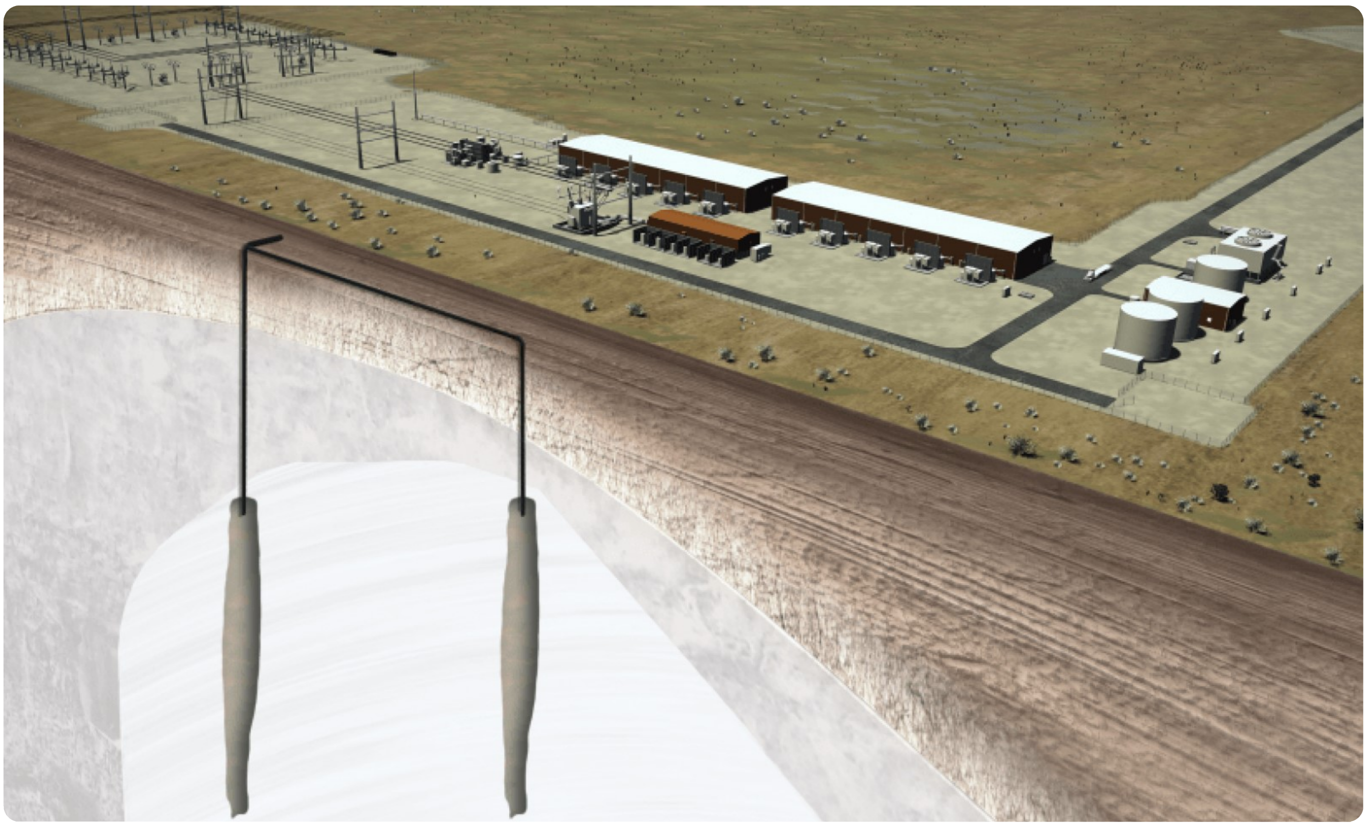
With Salt or On the Rocks?

While the potential seems ripe, salt domes and caverns are often described as “geographically constrained,” which is another way of saying they are not an option in many other parts of the US and for much of the world. This relative scarcity has prompted others at UT and elsewhere to launch parallel research into the unproven concept of storing hydrogen in porous media formations, i.e., depleted gas reservoirs and saline aquifers.

Reservoir rocks are far more abundant and have larger storage capacities than salt domes. But given the

"There are a whole lot more technical uncertainties with hydrogen storage within porous media than within manmade caverns in salt domes," which can be planned and commissioned in less than 5 years, she said.

Moscardelli also pointed out that in addition to storing hydrogen, salt formations have a decades-long track record of storing oil and gas, including at the US Strategic Petroleum Reserve.



A proposed 220-MW electrolyzer facility that will run on intermittent renewable power to produce hydrogen plans to use two salt caverns for storage in Delta, Utah. In June 2022, the US Department of Energy loaned project developer Advance Clean Energy Storage more than half a billion dollars to construct the facility. *Source: Advanced Clean Energy Storage.*

Meanwhile, the challenges involved with injecting hydrogen into porous media being studied include how the tiny molecule rapidly migrates within a reservoir system along with its potential to cause chemical and microbial reactions. Each issue may lead to product loss, but the latter may simultaneously generate unwanted byproducts such as toxic hydrogen sulfide gas.

Leopoldo Ruiz Maraggi, a reservoir engineer working with STARR to help develop new flow models, noted that the nature of salt domes negates or substantially mitigates these risk factors. He describes

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Another advantage over reservoir rocks is that it is much easier to store nearly pure hydrogen inside salt formations, which should avoid the need for surface separation or dehydration. Further bolstering the business case is that salt caverns enable gas to flow on demand, which some consider to be critical in meeting the timely needs of power plants.

As Ruiz Maraggi explained, “In a salt cavern, you simply have a void and thus less resistance for fluid flow compared to porous media. This means that we can achieve larger injection and withdrawal rates.”

But there are some unknowns involved with salt formations.

For instance, while salt domes are commonly thought to be inert to hydrogen, this is only partly true. They can contain mineralogical heterogeneities that could negatively react with hydrogen and impact storage potential which Moscardelli said underscores the "need to pursue detailed subsurface characterizations.”

Additionally, the small number of domes storing hydrogen today are generally considered backup for refinery shutdowns and as such may be used only once or twice annually.

In a hypothetical green hydrogen scenario, a salt cavern may need to be filled up and drawn down several times a year to feed a power plant. The pressure and temperature dynamics this introduces will impact the overall capacity of a cavern, which is one reason STARR says its advancements on modeling are needed.

The group plans to share more about its ongoing research in a series of soon-to-be-published peer-reviewed papers covering various aspects of hydrogen storage in manmade salt caverns.

TOPICS ENERGY TRANSITION | RESERVOIR CHARACTERIZATION

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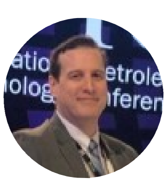

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