Number One Element: Geologic Hydrogen

BY RACHAEL KVAPIL | FEB 10, 2025 | ARCTIC, ENERGY, MAGAZINE, SCIENCE

Hydrocarbons are the backbone of Alaska's energy wealth. Oil and natural gas, composed of carbon molecules studded with hydrogen atoms, continue to shape the state's future. But the state's rocks may also hold a simpler, cleaner resource.

More than 100 people gathered at UAF in October to discuss the potential of geologic hydrogen. This process, different from industrially produced hydrogen, is still in its infancy. However, this isn't stopping key players from sharing information in hopes of discovering a breakthrough that will lead to a viable commercial product.

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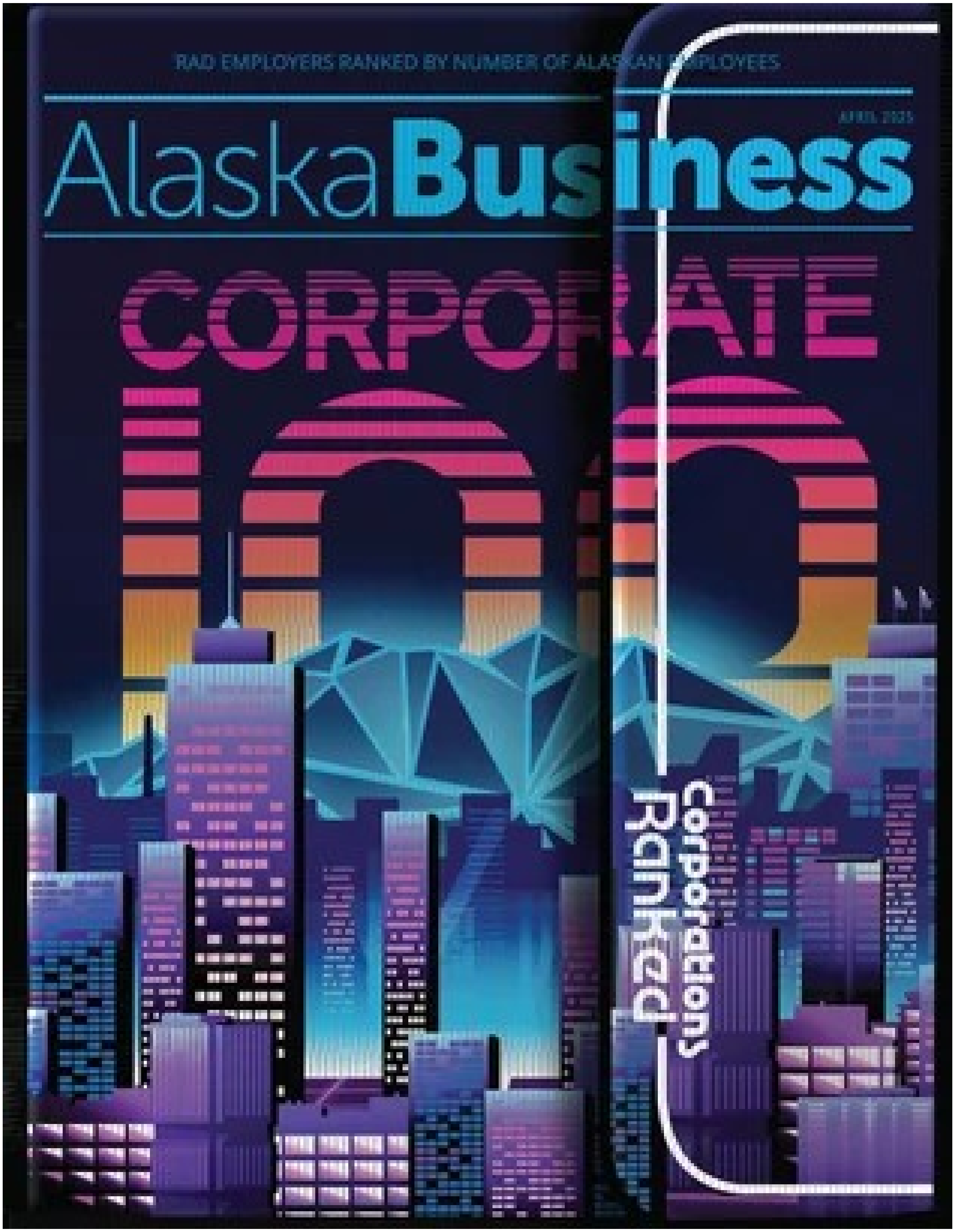
Next Generation Energy

The first internal combustion engine in 1806 burned hydrogen. Ever since, the most abundant chemical element in the universe has held potential as the next big energy storage medium. The gas doesn't count as an energy source, exactly, because humans need to add energy to make it. Either hydrogen is stripped from methane in natural gas or, less commonly, separated from water molecules. When hydrogen recombines with oxygen, some of that energy is released for useful work.

Geologic hydrogen, though, is an energy source. The hydrogen gas forms naturally by geological processes deep within the Earth. Deposits formed from these processes can be accessed and recovered by drilling. Because of its purity, geologic hydrogen is referred to as “natural,” “gold,” or “white” hydrogen.

“It's hard to find a single resource that could have such a big impact on our world in the way of helping our energy transition to move forward,” said Dr. Mark Myers, Commissioner of the US Arctic Research Commission, during his opening remarks at the Geologic Hydrogen Workshop 2024 hosted by UAF.



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f ers says that Arctic communities need additional sources other than electricity to meet energy demands, so the distribution of geologic hydrogen has the potential to fuel areas that don't have access to oil or gas.

in ough geological settings conducive to natural hydrogen may exist in Alaska and the broader Arctic regions, geologists have yet to fully study and assess their potential. The workshop was a step forward in determining what is needed to develop a sustainable research effort in Alaska and identify the policies and regulations required for research, exploration, and development. Presenters also outlined the utility, economics, storage, and transportation realities that are part of making natural hydrogen a viable fuel source in a competitive energy market.

Michael Sfraga, Ambassador-At-Large for Arctic Affairs with the US Department of State, says energy plays a significant role in the national strategy for the Arctic region. This strategy comprises sustainable economic development, environment and climate, national security, and international cooperation and governance. In his opening remarks to conference attendees, he identified seven drivers of change in the Arctic that also affect other parts of the world: climate, commerce, commodity, connectivity, community, cooperation, and competition. As he expounded on these drivers, he pointed to recent events that disrupted the energy industry, such as the war in Ukraine. Likewise, he emphasized working together to navigate these seven Cs so everyone benefits from resource development.

“Energy filters through everything my department has addressed,” Sfraga said. “In meeting with allies and friends, energy comes up in every discussion. That’s why this is really important.”

Rallying for Research

The cross-section of presenters covered the spectrum of energy stakeholders. Representatives from private industry, Alaska Native organizations, government, and regulatory and resource management agencies attended alongside international experts on geologic hydrogen and Alaska geology. Researchers from the US Geological Survey gave multiple presentations that touched on different aspects of geologic hydrogen, such as systems, generation, Alaska composition and distribution, and current research. Other presenters included the US Department of Energy National Laboratories, the US Department of Energy Advanced Research Projects Agency-Energy (ARPA-E), The University of Texas at Austin’s Bureau of Economic Geology, Cornell University, Alaska Department of Natural Resources Geological and Geophysical Surveys, and the Geological Survey of Finland.

Much of the discussion surrounding the identification of geological hydrogen sources was technical and benefitted from background knowledge of the processes. However, presenters provided multiple visuals to illustrate their research and projections.

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Much of the information presented was technical and required a background knowledge of the chemical and geological processes by which natural hydrogen can be continuously generated. In a nutshell, certain rocks can undergo mineralogical and chemical reduction (an atom gains electrons) or oxidation (losing electrons) when they encounter water. The process called serpentinization moves iron-rich rock from the oceanic crust up through tectonic processes, and when it meets with water, iron is released while water is reduced to hydrogen. Much of what is known about the geological characteristics that create these reactions in Alaska is based on what has been found in Canada, Russia, Australia, Germany, New Zealand, and other places with similar geologic conditions.

At least fifty companies are actively exploring and extracting geologic hydrogen, yet the most talked-about producer is Bourakébougou, a village in Mali. Locals drilling a water well in 1987 accidentally discovered a deposit when a villager sparked an explosion by lighting a cigarette near a breeze emanating from the hole. The breeze turned out to be a steady stream of natural hydrogen gas. To prevent additional accidents, the hole was cemented shut until 2012, when a Canadian company now known as Hydroma tapped the hydrogen to supply residents with electricity. From 2017 to 2019, Hydroma drilled twenty-four wells in the Bourakébougou fields.

Though many workshop presenters referred to the Bourakébougou as an example of what’s possible, they also were realistic about the discovery and scale of the project. The shallow reservoir layer provides 5 to 50 tons of natural hydrogen per year (the equivalent of 0.3 to 3 barrels of oil per day) and less power output than a tenth of a single medium-sized wind turbine. However, this finding and other prospects in Albania and France spurred additional research and exploration in Europe, Asia, Scandinavia, South America, and Australia.

“The United States is late to the game,” said US Geological Survey Research Geologist Geoffrey Ellis in his presentation on the historical contexts of geologic hydrogen and an overview of the rest of the world.

“All of this is still in its infancy… The Department of Energy is focused on stimulation and engineering. We are not looking at exploration at the time.”

—DOUGLAS WICKS, PROGRAM DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY-ENERGY f

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Dollars for Drilling

Intermixed with scientific presentations were additional conversations about upcoming funding for research and exploration. ARPA-E has provided pockets of funding through its Geologic Hydrogen Exploratory Topics project categories. In February, ARPA-E funded $20 million for sixteen projects across eight states that focus on accelerating the natural subsurface generation of hydrogen. The awarded projects are from a mix of universities, national labs, and private businesses conducting early-stage research and development to advance low-cost, low-emissions hydrogen. All the funding recipients awarded since 2023 are in the Lower 48.

“All of this is still in its infancy,” said Douglas Wicks, ARPA-E program director, in his presentation. “The Department of Energy is focused on stimulation and engineering. We are not looking at exploration at the time.”

Several companies operating in Alaska are funding their own research into hydrogen conversion, generation, storage, and exportation. Representatives from Alyeschem, Amp Energy, Treadwell Development, and Stillwater Critical Minerals presented different theoretical models, cost analyses, and timelines that forecasted the market feasibility of geologic hydrogen anywhere from ten to twenty or more years in the future.

Economics and logistics aside, there are other challenges that producers, legislators, and other entities will need to tackle before major exploration occurs in Alaska. The first is land ownership. Regional and village corporations collectively own 44 million acres, much of which contain geological formations well-suited for natural hydrogen. The circumstances in which exploration occurs on Native lands remain to be seen. Likewise, the regulations that guide drilling, production, and transportation are undefined. Key Alaskan legislators who attended the conference say the state’s experience developing oil and gas regulation will guide the process, but it doesn’t necessarily mean the results will be the same.

Ultimately, experts agree that it will take a big find or a decrease in exploration costs before leaders invest significantly in geologic hydrogen. They encouraged everyone to keep moving forward with research and development so that everyone is ready when the opportunity comes.

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