

Race to the Moon for Nuclear Fuel

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NASA's planned moon base announced last week could pave the way for deeper space exploration to Mars, but one of the biggest beneficiaries may be the terrestrial energy industry.

Nestled among the agency's 200-point mission goals is a proposal to mine the moon for fuel used in fusion reactors -- futuristic power plants that have been demonstrated in proof-of-concept but are likely decades away from commercial deployment.

Helium-3 is considered a safe, environmentally friendly fuel candidate for these generators, and while it is scarce on Earth it is plentiful on the moon. As a result, scientists have begun to consider the practicality of mining lunar Helium-3 as a replacement for fossil fuels.

"After four-and-half-billion years, there should be large amounts of helium-3 on the moon," said Gerald Kulcinski, a professor who leads the Fusion Technology Institute at the University of Wisconsin at Madison.

Last year NASA administrator Mike Griffin named Kulcinski to lead a number of committees reporting to NASA's influential NASA Advisory Council, its preeminent civilian leadership arm.

The Council is chaired by *Apollo 17* astronaut Harrison Hagan "Jack" Schmitt, a leading proponent of mining the moon for helium 3.

Schmitt, who holds the distance record for driving a NASA rover on the moon (22 miles through the Taurus-Littrow valley), is also a former U.S. senator (R-New Mexico).

The Council was restructured last year with a new mission: implementing President Bush's "Vision for Space Exploration," which targets Mars as its ultimate destination. Other prominent members of the Council include ex-astronaut Neil Armstrong.

Schmitt and Kulcinski are longtime friends and academic partners, and are known as helium-3 fusion's biggest promoters.

At the Fusion Technology Institute, Kulcinski's team has produced small-scale helium-3 fusion reactions in the basketball-sized fusion device. The reactor produced one milliwatt of power on a continuous basis.

While still theoretical, nuclear fusion is touted as a safer, more sustainable way to generate nuclear energy: Fusion plants produce much less radioactive waste, especially if powered by helium-3. But experts say commercial-sized fusion reactors are at least 50 years away.

The isotope is extremely rare on Earth but abundant on the moon. Some experts estimate there are millions of tons in lunar soil -- and that a single Space-Shuttle load would power the entire United States for a year.

NASA plans to have a permanent moon base by 2024, but America is not the only nation with plans for a moon base. China, India, the European Space Agency, and at least one Russian corporation, *Energia*, have visions of building manned lunar bases post-2020.

Mining the moon for helium-3 has been discussed widely in space circles and international space conferences. Both China and Russia have stated their nations' interest in helium-3.

"We will provide the most reliable report on helium-3 to mankind," Ouyang Ziyuan, the chief scientist of China's lunar program, told a Chinese newspaper. "Whoever first conquers the moon will benefit first."

Russian space geologist Erik Galimov told the Russian *Izvestia* newspaper that NASA's plan to colonize the moon will "enable the U.S. to establish its control of the global energy market 20 years from now and put the rest of the world on its knees as hydrocarbons run out."

Schmitt told a Senate committee in 2003 that a return to the moon to stay would be comparable "to the movement of our species out of Africa."

The best way to pay for such a long-term mission, he said, would be to mine for lunar helium-3 and process it into a fuel for commercial fusion.

In a 1998 op-ed for *Space News*, Schmitt criticized the 1979 United Nations-sanctioned *Moon Treaty*, which forbids ownership of lunar territory by individuals or separate nations.

"The mandate of an international regime would complicate private commercial efforts," Schmitt wrote. "The Moon Treaty is not needed to further the development and use of lunar resources for the benefit of humankind -- including the extraction of lunar helium-3 for terrestrial fusion power."

Schmitt declined to comment for this article. But Kulcinski said their lunar helium-3 research is entirely separate from their NASA duties.

"The NAC is purely an advisory council to Dr. Griffin," he said. "It has very broad responsibilities dealing with science, exploration, human capital, education and operations, to name a few. Our appointments to this advisory committee have nothing to do with our specific research interests."

Kulcinski has been studying helium-3 fusion for more than 20 years. When his UW fusion team realized 15 years ago that helium-3 could be extracted from lunar soil, he called it a "rediscovery."

For years Kulcinski tried to convince NASA and the U.S. Department of Energy that they should take lunar helium-3 seriously and invest in its research, but was rebuffed, he said.

But NASA's "Global Exploration Strategy" (.xls) for the moon now states that among the 200 potential goals for future missions includes the study of lunar helium-3 for "fusion reactors on Earth" to "reduce Earth's reliance on fossil fuels."

However, there are those who doubt helium-3 could become the next super fuel. Jim Benson, founder of space contractor *SpaceDev*, which helped build *SpaceShipOne*'s engine and is a subcontractor of the Missile Defense Agency, said mining the moon for helium-3 doesn't pass the "net energy analysis" test. It would require more energy to retrieve helium-3 and bring it back than it would yield.

Just, sending mining equipment to the moon, and then returning processed helium-3 back to earth, would cost billions in rocket fuel, said Benson. "We just don't have a need for helium-3," he said. "It's not practical."

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