New reports illuminate clean energy supply chain challenges and opportunities

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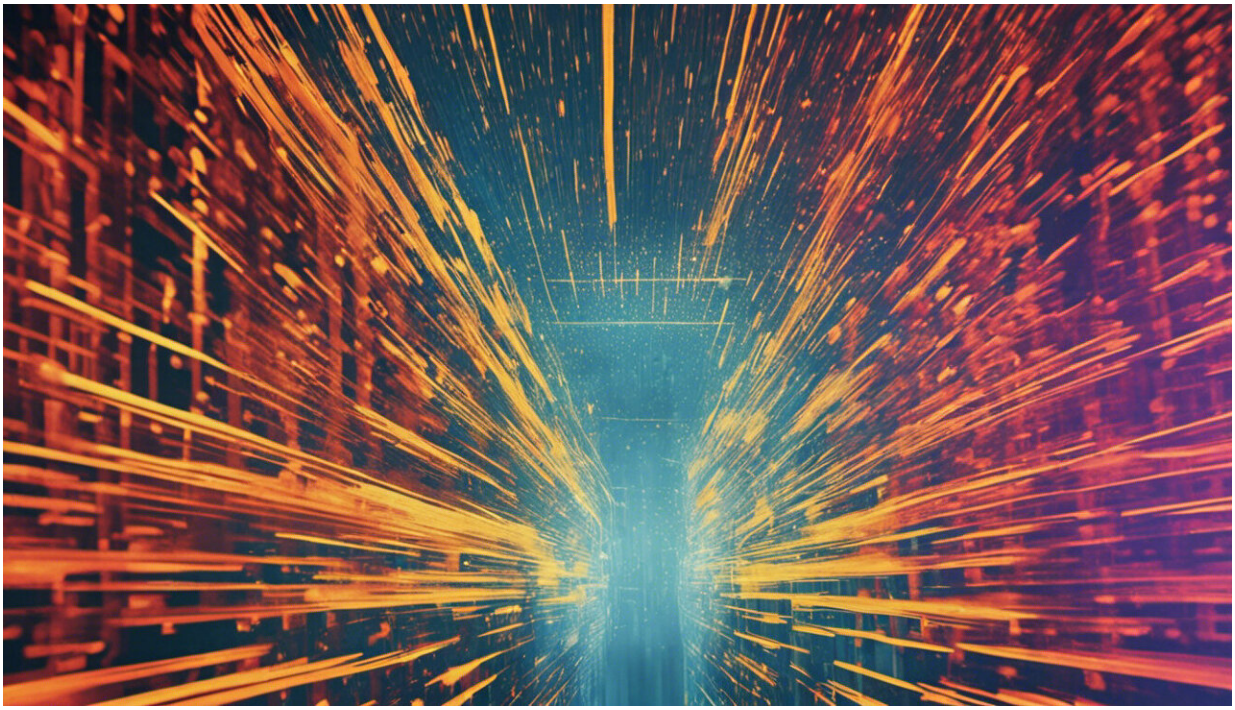

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The U.S. effort to build a domestic supply of clean energy often begins with critical materials produced in far-off—and geopolitically sensitive—countries. Researchers at the U.S. Department of Energy's (DOE) Argonne National Laboratory recently contributed to a series of reports aimed at securing America's clean energy supply chain and

minimizing potential disruptions.

The DOE reports delve into 12 areas where the U.S. needs to ensure the availability of materials for clean energy sources such as wind turbines, fuel cells and solar panels. Some of these materials are rare earth minerals used in magnets that drive wind turbines, for example, or precious metals used in batteries for electric vehicles and electricity storage on the grid.

The U.S. needs a consistent and affordable supply of these materials to decarbonize its economy by 2050. Decarbonization, which includes zeroing out the use of fossil fuels, is necessary not only to avoid the worst effects of climate change but also to bolster the nation's energy security.

Experts from Argonne, other federal agencies, DOE national labs, universities and the private sector collaborated on the supply chain deep dive assessment reports, which were produced in response to the 2021 Executive Order on America's Supply Chains. DOE tapped Argonne for its expertise in rare earth supply chain analysis, battery technologies, hydrogen energy and other pertinent areas.

"We need a well-diversified and secure supply of critical materials to meet our decarbonization goals," said Braeton Smith, a principal energy economist at Argonne who led the lab's cross-cutting research contributions. "That requires us to look across the entire energy industrial base to identify potential shortages or disruptions."

In particular, Argonne researchers led the investigation and writing for two of the supply chain reports, "Rare Earth Permanent Magnets" and "Platinum Group Metal Catalysts," and technical contributions for the report "Competitiveness and Commercialization of Energy Technologies." They also provided input on several other reports in the

series.

China dominates the global supply chain for rare earth metals and magnets, controlling 92% of magnet manufacturing in 2020. Rare earth magnets help power wind turbine generators, especially for offshore turbines, and they go into traction motors for electric vehicles. Demand for rare earth magnets is only expected to grow as the U.S. continues to expand clean energy.

Scientists at Argonne have found in previous research that rare earth supply disruptions can have impacts that last well beyond a short-term event, creating price increases that vary depending on the specific material. They discovered these patterns using the Global Critical Materials (GCMat) model, which can be used to simulate future market developments and anticipate risks. GCMat relies on a simulation method called agent-based modeling, where the "agents" represent producers, consumers and other players in a market who are making decisions.

"A number of efforts to add magnet manufacturing and rare earth material processing capabilities are under way, both domestically and globally," said Matthew Riddle, assistant energy scientist at Argonne. "In the reports, we highlighted a variety of these efforts to improve supply chain resilience."

Platinum group metals, for which the U.S. is heavily dependent on imports, are catalyst agents that make chemical reactions happen more efficiently. Both platinum and iridium are important for producing "green hydrogen" for fuel cells by deriving the hydrogen from water instead of natural gas. Iridium is one of the rarest of these metals and is not produced in the U.S.

"The problem is not necessarily focused just on mining raw material," Smith said. "The U.S. also lacks midstream production, where we can

separate out and refine some of these important materials once they are mined."

The DOE reports capture the current supply chain landscape in detail, identifying key risks and opportunities. Another hurdle is limited data across the supply chain.

"One of the challenges to analyzing critical material supply chains is the lack of publicly available data, particularly on process steps that happen after mining occurs," said Diane Graziano, an Argonne chemical engineer.

The platinum group metals report recommended that the U.S. compile detailed information on suppliers and manufacturers, which could help prioritize catalyst investments.

In addition to boosting domestic refining and manufacturing for critical materials, other potential ways to bolster the supply chain include finding cheaper and more abundant substitute materials and increasing the ability to recover and recycle materials from end-of-life batteries and other sources.

The competitiveness and commercialization report looks at strategies for bringing innovative technologies to market and enhancing U.S. competitiveness in the clean energy industry. To that end, it presents a six-step economic analysis framework that includes demand forecasting, policy analysis and scenario analysis.

"It's not a perfect crystal ball. But conducting this end-to-end economic analysis of the supply chain, from mining through to recycling, helps us understand potential sources of competitive advantage for the U.S. and how to sustain them," said Allison Bennett Irion, systems engineer and director of supply chain research at Argonne.

Argonne experts who worked on the DOE reports as authors and contributors, in addition to Smith, Graziano, Riddle and Bennett Irion, are Matthew Earlam, Chukwunwike Iloeje, Autumn Kaiser, Iain Hyde, Di-Jia Liu and Pingping Sun.

Provided by Argonne National Laboratory