"very early stage but application-driven," and says that they "fall in the valley between curiosity-driven fundamental research, which might be supported by the National Science Foundation [or another government agency], and product-driven research that is supported by industry." Hartney also highlights the important role that ARPA-E plays in funding and proving out early stage energy technology ideas that "will then stimulate further private investment or point back to other promising approaches to pursue."

Indeed, despite being a relatively young agency, ARPA-E boasts some significant success. The National Academy of Sciences (NAS) completed an independent review of ARPA-E (mandated within ARPA-E's 2007 authorizing statute) in June 2017 and its summary states, "There are clear indicators that ARPA-E is making progress toward achieving its statutory mission and goals, and it cannot reasonably be expected to have completely fulfilled those goals given so few years of operation and the size of its budget."

The NAS report based its findings on ARPA-E data from February 2017, when the agency had provided approximately $1.5 billion in funding to more than 580 projects. As these projects matured, 56 have gone on to form new companies, 68 have led to partnerships with other government agencies for further development, and 74 have gone on to attract more than $1.8 billion in private-sector follow-on funding. In addition, over 1300 peer-reviewed journal articles and 208 patents have been generated as a result of ARPA-E projects.

Despite the success of ARPA-E, the agency has recently become a focus of debate within the US government. The Trump administration's budget request for fiscal year 2018 (FY2018) has called for complete elimination of ARPA-E. In the US Congress, lines are drawn between the House and Senate because the House's FY2018 energy appropriations bill aligns with the administration's request and eliminates funding for ARPA-E, while the Senate's version proposes a budget of $330 million—an 8% increase from the FY2017 enacted (appropriated) funding level. Senator Lamar Alexander (R-Tenn.), Chair of the Senate Energy and Water Development Appropriations Subcommittee, has been a strong supporter of ARPA-E, and during a recent hearing on the DOE budget he characterized ARPA-E as a "big success" and responded to the idea of eliminating it by saying, "that is not what we're going to do."

"One danger of even posturing the closure of ARPA-E is the signal it sends to a community that's already strapped for funding," Brown says. With budget negotiations dragging despite the fact that FY2018 officially started on October 1, 2017, the fate of ARPA-E and the important early stage research it funds continues to hang in the balance.

Jennifer A. Nekuda Malik

South Africa needs research plan for shale gas exploitation

South Africa needs a shale gas research plan aligned to government policy and included into the broader government research program driven by various departments and agencies, according to federal agencies.

Phil Mjwara, Director-General of the Department of Science and Technology (DST), told delegates at a conference on shale gas under way in Port Elizabeth in August, that the research plan could help develop expertise related to shale gas exploitation in South Africa.

The objective of the conference, titled "The Shale Gas Industry in South Africa: Toward a Science Action Plan," was to highlight critical reports on shale gas in South Africa, analyze the regulatory environment, consolidate common findings and recommendations, and provide a platform for debate.

"Some of the objectives of the plan should be to develop national technical capabilities in key focal areas, including pure science, engineering, and social science associated with shale gas exploitation," Mjwara said.

He added that international experience has shown that shale gas has numerous economic benefits. He pointed out that any scientific plan on shale gas must strike a healthy balance between environmental protection and economic benefit.

The two-day conference, hosted by the Academy of Science of South Africa (ASSAf) in partnership with the DST, followed the publication of ASSAf's report on *South Africa's Technical Readiness to Support the Shale Gas Industry*, and the Department of Environmental Affairs' report on *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks*.

Cyril O'Connor, from the University of Cape Town, head of the panel of experts for the ASSAf study, said that the amount of shale gas available in South Africa was still unclear, with estimates ranging between 20 trillion cubic feet (tcf) and over 400 tcf. It is thought that substantial volumes of such gas shales can be found in the main Karoo Basin.

He said that since shale gas exploitation requires the use of relatively large quantities of water, greater clarity is needed on the availability of alternative water sources such as underground saltwater.

Furthermore, South Africa is known to possess considerable reserves of shale gas and oil reserves in the Western, Northern, and Eastern Cape rock basin. ASSAf's Vice President, Barney Pityana, said, "This is because of the geology of the area, and the possibilities of economically available and advanced extractive technology mean that this industry is capable of development. It could provide a game changer for the South African economy, and could make a major contribution to South Africa's commitments in terms of climate change by limiting South Africa's reliance on the coal industry for its energy needs." □

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