

ing 30 000 or more liters per year. A “bare bones” system capable of producing 25–50 liters per hour will cost \$1 million to \$4 million and require a full-time operator. Cornell and Princeton Universities, the University of Florida, and a few others have such plants. Many top-tier research universities would probably meet the usage threshold, Elsesser says, and Texas A&M University is planning to build one.

Single investigators, or a few that share instruments, can purchase a liquefier capable of recycling 1 liter per hour for \$100 000–\$200 000, the societies’ report says. The capital investment can be recouped in three years or less. In one case, Carnegie Mellon University chemist Michael Hendrich has saved \$175 000 annually on liquid helium from an upfront investment of \$150 000 in a liquefier, the report notes.

Washington University’s Hayes says the upfront cost of liquefiers for her four NMR setups is “almost impossible.” Having multiple low-temperature researchers on campus, the university buys in volume, and investigators must coordinate buys and avoid wastage. Hayes’s cost to fill a 100-liter dewar is about \$13 a liter, whereas using a 60-liter container would cost \$19 a liter. But buying a larger container won’t produce savings if the helium sits around and boils off, and topping off instruments isn’t always a good idea, she notes.

APS and ACS have partnered with

the Defense Logistics Agency (DLA), part of the Department of Defense, to create a liquid helium purchasing program. As a broker, DLA increases the purchasing power of the program’s dozen university members. Since the program began in June, participants have received an average savings of 15% on their helium purchases, Elsesser says, with some reporting a 25% reduction.

Efforts to recruit additional universities to the DLA program continue, Elsesser says, but institutions’ existing contractual arrangements and other factors have kept more from signing on.

The BLM’s Hamak says the DLA “is starting to get universities and researchers to understand that the farther out you can put your order in, the cheaper you will get it.”

Adding a recirculating system to an instrument is an upfront expense that few investigators can afford. Beginning in 2014, NSF’s division of materials research has allocated \$2 million a year to help with recirculator purchases by grantees who spend \$20 000–\$30 000 annually on liquid helium. But that’s only enough to help 4–5 investigators per year, out of 60–70. The societies’ report recommends that a portion of the proceeds from helium sales from the federal reserve be set aside to help universities finance new helium recovery facilities and equipment requiring minimal helium recharges.

More buyers of new equipment are

demanding “dry” or “cryogen-free” closed systems that require little or no liquid helium replenishment, says Zuyu Zhao, executive vice president of Janis Research. But he notes that due to their mechanical refrigeration systems, those instruments can produce vibrations that make them unsuitable for some experiments.

The societies’ report recommends that BLM eliminate a “major helium requirement” of 7500 liters per year that they say prevents small scientific users from getting a discount on crude helium from the reserve. But that’s a misunderstanding, says Hamak: There is no minimum volume required to obtain the 20% discount; researchers simply have to find a helium supplier that will sell them refined reserve helium. That supplier is then required to purchase a comparable amount of crude helium from the reserve. In practice, however, a small buyer of liquid helium won’t save much after the cost of purifying and liquefying the crude gas is considered. “If your helium requirement is two 500-liter dewars per year, you probably won’t get much of a break,” notes Hamak.

The report also calls for BLM to establish a royalty in-kind program that will provide a source of helium to federal users, including grantees, from BLM-leased natural gas formations, once the reserve is closed. The BLM officials say they will begin that process this spring.

David Kramer

## With Trump in charge, uncharted waters lie ahead for science

Now that Congress and the White House are firmly in Republican control, President-elect Trump has a clear path to enact his science policy, when it emerges.

**A**lthough the incoming administration remains a virtual blank slate on most areas of science policy, Donald Trump’s campaign rhetoric and his selection of Oklahoma attorney general Scott Pruitt to head the Environmental Protection Agency point to keeping his campaign promises to roll back President Obama’s policies on climate change. Less certain, perhaps, is whether Trump will follow through on his pledge to tear up the landmark 2015 agreement that severely curtailed Iran’s nuclear ambitions in exchange for the lifting of international economic sanctions.

Compared with Obama, who for most of his two terms faced a hostile Congress, Trump enters office with both chambers firmly in the control of his own party. Thus, the president-elect should be able to implement his policies through legislation, which will put them on much firmer ground than the administrative actions Obama was forced to use to implement his climate change agenda. Trump will be able to undo many of Obama’s climate regulations without having to consult Congress.

Although Trump famously called climate change a hoax, in a 22 November

interview with the *New York Times* he had seemed to backpedal on his campaign promise to tear up the 195-nation climate change agreement that was reached in Paris last year. “There is some connectivity,” he said, between human activity and climate change, and he added that he had “an open mind” on the issue. In another possible sign he could be tempering his views, Trump and his daughter Ivanka Trump met former vice president and noted climate activist Al Gore on 5 December.

But Pruitt, who has sued the EPA to block implementation of Obama’s Clean Power Plan (CPP) to impose limits on carbon emissions from power plants, has questioned the link between human activities and climate change. Pruitt’s

appointment, which like Trump's other cabinet nominations will require Senate confirmation, drew an unusual rebuke from the nonpartisan American Association for the Advancement of Science. In a statement, AAAS CEO Rush Holt noted that virtually every leading scientific organization in the world has accepted climate change's anthropomorphic causes. "If a person jumped off a building because he said gravitation is only a theory, one would say he is delusional," Holt said. "So too, any policy maker who would base national policy on denial of climate science because there is 'debate' would be called dangerously irresponsible."

The Trump transition team touted a 7 December *Wall Street Journal* editorial that praised Pruitt for leading "the legal charge by the states against EPA abuses," including the CPP. Trump has populated the transition teams at EPA and other agencies, including the Department of Energy and NASA, with climate change doubters.

Jeffrey Holmstead, an EPA assistant administrator under President George W. Bush, represents states and fossil-fuel companies in litigation to overturn the CPP. He told reporters soon after the election that "there is no practical reason" for Trump to back out of the Paris agreement to cut carbon emissions, because it imposes no legal obligations on the US.

However he responds to the Paris agreement, Trump made clear his intention to nullify the CPP. In a 21 November YouTube video, he declared that he will "cancel job-killing restrictions on the production of American energy, including shale energy and clean coal."

David Goldston, director of government affairs at the Natural Resources Defense Council, says that multiple states and environmental organizations would challenge moves to rescind the CPP; he points to the Supreme Court finding that the EPA must regulate carbon dioxide as a pollutant. But Holmstead says the argument that EPA is legally required to follow the CPP "is a pretty uphill battle."

Trump might not have to rescind the CPP. The administrative action is now being litigated in the US Court of Appeals for the DC Circuit; a decision is expected around the time Trump takes office. At issue is whether the Obama administration exceeded its authority in imposing the new regulations without enabling legislation.

Although repeal of the CPP would



**PRESIDENT-ELECT DONALD TRUMP** has promised to rescind President Obama's Clean Power Plan, which would set limits on carbon dioxide emissions from coal-fired power plants.

represent a blow to the environmental community, the decline in US coal output from its mid 2000s peak is expected to continue due to economic forces, chiefly the low cost of natural gas. In a recent interview with the website *M Live*, for example, DTE Energy chairman Gerard Anderson said his company will continue to phase out coal regardless of regulations. The company has already shut down three coal-fired plants and plans to close another eight by 2030. "I don't know anybody in the country who would build another coal plant," said Anderson.

Trump's promise to cut regulations on oil and gas drilling is likely to encourage even more gas production, which will help ensure that prices remain low for some time.

### Iran agreement

Trump promised throughout the campaign to reject the 2015 Iran nuclear agreement and to reinstate economic sanctions. Daryl Kimball, executive director of the nonpartisan Arms Control Association, says that dismantling or renegotiating the agreement "would be a major foreign policy blunder of historic proportions." The agreement is working, he notes, and the Iranian nuclear program has been put "in a box." Moreover, the pact involves the world's four other major nuclear powers and the European Union, each of which would have to reimpose economic sanctions. "The Europeans are not going to go along, the Russians and Chinese aren't going to go along," says Kimball.

"If they don't go along, the sanctions aren't going to work."

Josh Zive, senior counsel at the lobbying firm Bracewell LLP, told reporters that because the deal allowed US companies to do business with Iran, scrapping it is likely to face significant opposition from firms that have already made investments. What's more, most of the economic sanctions the US has imposed on Iran remain in place despite the deal, said Zive, who predicts a "symbolic rejection" of the deal by the incoming president.

### An unknown quantity

Trump has had virtually nothing to say about other aspects of science or research. He has promised to dramatically increase defense spending and reinvigorate the nation's physical infrastructure while cutting taxes, protecting entitlements, and balancing the budget. "What are you going to do? The answer is you're going to cut other discretionary programs," which include R&D, says Michael Lubell, director of public affairs at the American Physical Society.

During the campaign, Trump said he will have every federal agency provide him with "a list of wasteful spending projects that we can eliminate in my first 100 days." And he promised to terminate funding for programs whose authorization has expired but that continue to receive annual appropriations. But entire agencies, including NASA, the National Institutes of Health, and NSF, have routinely operated for years under authorizations that have expired.



ANDREW HART (CC BY-SA 2.0)

In a 23 November letter, the heads of 29 scientific and higher-education organizations urged Trump to quickly appoint a science adviser “who is a nationally respected leader with the appropriate engineering, scientific, management, and policy skills necessary for this critically important role.” The letter said that “if we are to maintain America’s global leadership, and respond to the economic and security challenges currently facing the nation, we must build on our strong history of federal support for innovation, entrepreneurship, and science and technology.”

In a separate letter released 30 November, more than 2300 scientists from a wide range of disciplines urged Trump to appoint heads of federal agencies “with demonstrated track records of respecting science as a critical component of decision making.” The letter, shepherded by the Union of Concerned Scientists, noted that “decision makers and the public need to know what the best-available scientific evidence is, not what vested interests might wish it to be.” It urged the new administration to avoid meddling in the communication of scientific findings and called for “adequate resources to enable scientists to conduct research in the public interest and effectively and transparently carry out their agencies’ missions.”

## The new Congress

Despite the uncertainty, Congress has as at least as much to say as the White House on the level of spending for R&D. Although House and Senate appropriators

consider administration requests, they generally use the previous year’s spending level as a baseline when marking up new appropriations bills. That puts a damper on dramatic year-to-year changes. Moreover, appropriators have a tradition of bipartisanship that is largely absent from other congressional functions, and both parties have, for the most part, seen the value in basic research.

The House Appropriations Committee will have new leadership this year, as the term of its chairman, Representative Harold Rogers (R-KY), is limited by GOP rules. The next in line, Rodney Frelinghuysen (R-NJ), was friendly to the Department of Energy’s science programs, particularly the fusion energy program, as former chairman of the appropriations energy and water development subcommittee.

“I’m a great supporter of the National Science Foundation, and I’m always excited to visit NIH every year and see the things they do and collaborate with colleges and universities,” Frelinghuysen told *Scientific American*.

As for NASA, a recent *Space News* op-ed coauthored by former Science Committee chairman and current Trump space adviser Robert Walker lamented that the agency has “been largely reduced to a logistics agency concentrating on space station resupply and politically correct environmental monitoring.” Walker has said that NASA should set a goal of sending humans throughout the solar system by the end of the century, and he advocated that NASA shift funding from Earth and climate science to “deep space achievements.”

Walker told the *Guardian* in November that future Earth environmental monitoring missions should become the responsibility of other federal agencies. Earth science has been “heavily politicized,” he said, and NASA shouldn’t be conducting “politically correct environmental reporting.”

Those views are shared by House Science, Space, and Technology Committee chairman Lamar Smith (R-TX), who last year proposed cutting NASA’s \$1.9 billion Earth science program by \$300 million. But fellow Texas Republican John Culberson, who chairs the House appropriations subcommittee that oversees NASA, told *Science Insider* he’s confident there will continue to be strong support for Earth sciences in the new Congress.

David Kramer **PT**



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