CONGRESSIONAL BUDGET OFFICE
COST ESTIMATE

August 1, 2018

H.R. 589
Department of Energy Research and Innovation Act

As passed by the U.S. House of Representatives on January 24, 2017

SUMMARY

H.R. 589 would amend the objectives of several programs administered by the Department of Energy (DOE). Title IV of the legislation would direct DOE to establish a new nuclear research test reactor and would authorize the agency to allow private-sector entities to construct advanced experimental facilities on DOE land. Other provisions would establish a low-dose radiation research program and recodify DOE's authority to carry out activities through its Office of Science.

Assuming appropriation of the necessary amounts, CBO estimates that implementing H.R. 589 would cost $3.3 billion over the 2019-2028 period. CBO also estimates that the legislation would increase direct spending by $10 million over the 2019-2028 period; therefore, pay-as-you-go procedures apply. Enacting H.R. 589 would not affect revenues.

CBO estimates that enacting H.R. 589 would not increase net direct spending by more than $2.5 billion or on-budget deficits by more than $5 billion in any of the four consecutive 10-year periods beginning in 2029.

H.R. 589 contains no intergovernmental or private-sector mandates as defined in the Unfunded Mandates Reform Act (UMRA).

ESTIMATED COST TO THE FEDERAL GOVERNMENT

The estimated budgetary effect of H.R. 589 is shown in the following table. The costs of the legislation fall within budget functions 250 (general science, space, and technology) and 270 (energy).

	By Fiscal Year, in Millions of Dollars												
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2019-2023	2019-2028
INCREASES IN SPENDING SUBJECT TO APPROPRIATION													
Title IV, Nuclear Energy Innovation Capabilities													
Estimated Authorization Level	0	300	310	340	350	360	380	400	410	440	460	1,660	3,750
Estimated Outlays	0	90	183	255	314	343	359	376	391	410	431	1,185	3,152
Department of Energy Office of Science													
Estimated Authorization Level	0	18	18	19	19	20	20	21	21	21	22	94	199
Estimated Outlays	0	10	15	19	19	20	20	21	21	21	22	83	188
Total													
Estimated Authorization Level	0	318	328	359	369	380	400	421	431	461	482	1,754	3,949
Estimated Outlays	0	100	198	274	333	363	379	397	412	431	453	1,268	3,340
INCREASES IN DIRECT SPENDING													
Title IV, Nuclear Energy Innovation Capabilities													
Estimated Authorization Level	0	0	0	0	1	1	1	1	2	2	2	2	10
Estimated Outlays	0	0	0	0	1	1	1	1	2	2	2	2	10

BASIS OF ESTIMATE

For this estimate, CBO assumes the legislation will be enacted near the start of 2019 and that the estimated amounts will be appropriated each year. Estimated outlays are based on historical spending patterns for the affected activities.

Spending Subject to Appropriation

CBO estimates that implementing H.R. 589 would cost $3.3 billion over the 2019-2028 period subject to appropriation of the necessary amounts.

Title IV, Nuclear Energy Innovation Capabilities. Title IV would direct DOE to establish, by December 31, 2025, a new nuclear test reactor capable of producing high-energy neutrons to help researchers develop fuels and materials for fast reactors, a new class of advanced nuclear reactor. The legislation would require DOE to operate the test reactor as a federally sponsored research facility available to interested users, under certain conditions, to support the advancement of scientific or technical knowledge. Title IV also would authorize DOE to support the construction of experimental facilities, initiated by private entities, to test concepts related to advanced nuclear technologies. DOE would need to prepare certain reports, coordinate with the Nuclear Regulatory Commission (NRC) and other agencies, and facilitate the construction and operation of

the facilities by using the technical expertise and other resources of the national laboratories and other agencies.

CBO estimates that implementing title IV of H.R. 589 would cost $3.2 billion over the 2019-2028 period. That amount includes the estimated cost to establish the proposed fast test reactor and additional costs to operate and maintain other experimental facilities.

Fast Test Reactor. Most of the cost of title IV would be for the design, licensing, and construction of the test reactor. DOE is assessing the need for and potential costs of such a reactor but has not yet determined whether to build one. CBO expects that a significant increase in discretionary appropriations would be needed for DOE to meet the legislation's December 2025 deadline for establishing the reactor.

The costs of designing and constructing a fast test reactor are uncertain and would depend on its size and purpose, among other considerations. Using information from DOE related to potential concepts that such a facility might involve, CBO expects that building the reactor could cost as much as several billion dollars over a period of at least a decade. For this estimate, CBO estimates that planning and building a reactor would cost about $3 billion over the 2019-2028 period. Of that amount, roughly $400 million would support planning and research and development (R&D) during the first few years; the balance would be used to acquire materials and build the reactor.

Operation and Maintenance Expenses. DOE also would incur costs to administer, operate, and maintain both the proposed reactor and any additional experimental facilities pursued by nonfederal entities (discussed under "Direct Spending"). CBO expects that most of those costs would involve staffing for technical assistance, administrative support, and services related to securing facilities and managing reactor fuel and waste. DOE also might incur additional costs to provide facilities with materials and supplies, including fuel.

Because of the long period necessary to design, license, and build a test reactor, CBO expects that most operating and maintenance costs (which CBO estimates would average about $70 million annually) would occur after 2028. However, CBO expects that up to 10 experimental facilities would be finished before 2028 and the operation and maintenance costs would total about $150 million over the 2019-2028 period. That estimate reflects information from DOE and the nuclear industry on historical costs to operate and maintain other nuclear facilities. The estimate is uncertain, however; the nature and magnitude of costs would depend critically on the number of facilities constructed, their scope, and DOE's involvement.

This estimate does not include additional costs that the federal government might incur for liabilities relating to waste management or other activities for which DOE may be implicitly responsible. Such costs are uncertain and would depend on the details of

projects, but CBO expects most such costs would not occur until after 2028. Nor does this estimate include additional costs that the NRC would incur to support the design and licensing of nuclear facilities under the legislation. Over the next 10 years, CBO expects, the NRC will pursue activities under current law to increase its capacity to support the development and licensing of advanced nuclear technologies. On the basis of information from the NRC, CBO expects that implementing H.R. 589 would not alter the timing or magnitude of spending for those activities (which would be subject to appropriation) or the overall amount of fees that the NRC collects from entities it regulates to help offset the agency's costs.

Title III, Office of Science. DOE's Office of Science supports basic research in the physical sciences and operates a system of national scientific user facilities. Title III would largely codify its current activities in six program areas. The America Competes Reauthorization Act of 2010 last authorized the appropriation of $6 billion in 2013 for those purposes. The office received an appropriation of about $6.3 billion in 2018.

The act also would direct DOE to carry out a low-dose radiation research program that CBO expects would be similar to another DOE program that was terminated in 2016. Based on the amount of funding that program received in 2016, CBO estimates that implementing this provision would cost $83 million over the 2019-2023 period and $188 million over the 2019-2028 period.

Direct Spending

CBO estimates that enacting title IV of H.R. 589 would increase direct spending by $10 million over the 2019-2028 period. The title would authorize DOE to allow private entities to propose and fund the construction of certain facilities at federal laboratories and other DOE-owned sites. Participating entities, including those that have received federal funding, could build facilities that test and demonstrate concepts related to advanced technologies for nuclear reactors. Facilities would receive the financial indemnification protections available to other nuclear reactors under the Price-Anderson Act and could be used for commercial purposes if licensed by the NRC.

Budgetary Treatment. In CBO's view, the budgetary treatment of the program authorized in title IV would differ from most other federal R&D programs because that program would involve the financing and construction of facilities on federal land. Based on information from industry and government experts, CBO anticipates that the ownership and operation of these assets would be shared by the private sector and the government to varying degrees. For example:

- DOE owns the land, specialized infrastructure, and other materials that would be used by the facilities. Under certain circumstances, DOE could be liable for managing radioactive waste and other related risks;

- Because of the special features of nuclear materials, DOE would retain a significant degree of control over key aspects of the facilities' location, design, size, operations, and purpose and could potentially share in intellectual property rights;

- Some private projects may be classified as government-owned research facilities. In such cases, a project would be regulated by DOE instead of the NRC; and

- Some privately financed projects may be for the exclusive benefit of the sponsor whereas others could include features with more universal benefits.

In keeping with guidance in a 1967 report of the President's Commission on Budget Concepts, CBO records the costs and income of jointly owned and operated activities in the federal budget.[1] In CBO's view, although H.R. 589 specifies that such facilities would be financed by the private sector, cash flows stemming from transactions related to those facilities should be classified as federal direct spending because the transactions would not be contingent on any further legislation.

In CBO's view, proprietary facilities financed entirely with equity from private entities should have no net effect on direct spending because the cost of acquiring the facility would be fully offset by income from nonfederal sources. If projects provide public benefits, such as support for federal missions, CBO expects that they would be financed as public-private partnerships in which agencies would directly or indirectly pay a portion of the acquisition costs. In those cases, the net effect on direct spending would depend on the terms of the financing arrangements.

Estimated Costs. Under current law, DOE allows private entities, on a case-by-case basis, to build certain nuclear power demonstration facilities on DOE land.[2] Because of the time and resources needed to execute those arrangements, CBO expects that DOE's use of its existing authority will be limited to a few specialized projects. CBO anticipates that enacting title IV would expand opportunities for the construction of other facilities by standardizing the legal and regulatory framework for such transactions.

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1. Although the October 1967 *Report of the President's Commission on Budget Concepts* has no legal status, it is an authoritative statement on the scope of the federal budget. The commission recommended that "the budget should, as a general rule, be comprehensive of the full range of federal activities. Borderline agencies and transactions should be included … unless there are exceptionally persuasive reasons for exclusion (p. 25)." For more information, see Congressional Budget Office, *How CBO Determines Whether to Classify an Activity as Governmental When Estimating Its Budgetary Effects* (June 2017), www.cbo.gov/publication/52803.

2. In 2016, DOE entered into agreements with private entities to build and operate a small, 600 megawatt (MW), small modular reactor at the Idaho National Laboratory. The electricity generated will be marketed by an entity that is authorized to sell electricity to federal agencies through long-term contracts with the federal government. According to press accounts, the laboratory may use 17 percent of the reactor's capacity for R&D or other purposes.

Based on information from academic and industry experts, CBO estimates that up to 10 additional facilities would be built on DOE land over the 2019-2028 period under this legislation. Many of them probably would be small proprietary experiments funded entirely by private entities. CBO also anticipates that the legislation would facilitate the construction of new test and demonstration projects, which could cost over $100 million each.[3] Small test facilities—such as a 10 megawatt (MW) facility to demonstrate micronuclear reactor technologies—typically have limited potential to generate income from commercial users, suggesting that their financing would largely depend on the availability of private equity capital or alternative sources of income.

The extent and nature of federal support for facilities constructed under title IV is uncertain. Because of those uncertainties, CBO estimates that there is a 50 percent chance that the government would support the financing of at least one of the new test or demonstration facilities through alternative contractual arrangements that are not contingent on further legislation.[4] Federal participation in the financing of such facilities would be consistent with the government's longstanding support of nuclear energy R&D and with agencies' stated interest in using advanced nuclear power and fuel technologies for federal missions.[5] CBO estimates that facilities capable of testing or demonstrating technologies useful for the government would cost at least $50 million and that the federal share would be similar to the historical average of about 40 percent.[6] Thus, CBO estimates that implementing title IV would increase net direct spending by $10 million

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3. Historically test reactors generally have ranged from about 2 MW to 10 MW, and small demonstration projects have ranged from 11 MW to 75 MW. Investments in nuclear demonstration projects in the 1960s totaled about $4 billion (in 2017 dollars); the federal share averaged 42 percent. See Electric Power Research Institute, Program on Technology Innovation, *Government and Industry Roles in the Research, Development, Demonstration, and Deployment of Commercial Nuclear Reactors, Historical Review and Analysis* (December 2017), http://tinyurl.com/yc92jetu.

4. Financial support could be provided by DOE, the Department of Defense, or another agency that uses nuclear materials or energy. For examples of alternative financing, see SMR Start, *Policy Statement on U.S. Public-Private Partnerships for Small Modular Nuclear Reactors* (February 2017), http://tinyurl.com/y9yoxwkt (PDF, 429 KB); Kutak Rock and Scully Capital, *Purchasing Power Produced by Small Modular Reactors: Federal Agency Options* (submitted to the Department of Energy, January 2017), https://go.usa.gov/xUBUc; and Congressional Budget Office, *Third-Party Financing of Government Projects* (June 2005), www.cbo.gov/publication/16554.

5. Several reports suggest that development of advanced nuclear energy technologies will require government assistance and other risk-sharing arrangements. For example, see Idaho National Laboratory, ART Program, *Advanced Demonstration and Test Reactor Options Study* (prepared by Argonne National Laboratory, Idaho National Laboratory, and Oak Ridge National Laboratory for the Department of Energy Office of Nuclear Energy, January 2017), https://go.usa.gov/xUBU8; and Department of Energy, Secretary of Energy Advisory Board, *Report of the Task Force on the Future of Nuclear Power* (September 2016), https://go.usa.gov/xUBUM (PDF, 2.6 MB). Other work has examined the role of advanced nuclear energy technology in agency missions. For example, see Department of Defense, Defense Science Board, *Task Force on Energy Systems for Forward/Remote Operating Bases: Final Report* (August 2016), https://go.usa.gov/xUBP3 (PDF, 3 MB).

6. That cost is similar to the historical average for test reactors (in 2017 dollars) and would be equivalent to an overnight cost of $5,000 per kilowatt for a 10 MW facility.

over the 2019-2028 period. Given the time needed to develop, license, and finance such projects, CBO estimates that most of those costs would occur after 2023.

PAY-AS-YOU-GO CONSIDERATIONS

The Statutory Pay-As-You-Go Act of 2010 establishes budget-reporting and enforcement procedures for legislation affecting direct spending or revenues. The net changes in outlays that are subject to those pay-as-you-go procedures are shown in the following table.

CBO Estimate of Pay-As-You-Go Effects for H.R. 589, the Department of Energy Research and Innovation Act, as Passed by the House of Representatives on January 24, 2017. .

	By Fiscal Year, in Millions of Dollars												
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2018-2023	2018-2028
NET INCREASE IN THE DEFICIT													
Statutory Pay-As-You-Go Effect	0	0	0	0	1	1	1	1	2	2	2	2	10

INCREASE IN LONG-TERM DIRECT SPENDING AND DEFICITS

CBO estimates that enacting H.R. 589 would not increase net direct spending by more than $2.5 billion or on-budget deficits by more than $5 billion in any of the four consecutive 10-year periods beginning in 2029.

MANDATES

H.R. 589 contains no intergovernmental or private-sector mandates as defined in UMRA.

PREVIOUS CBO ESTIMATE

On June 12, 2017, CBO transmitted a cost estimate for S. 97, the Nuclear Energy Innovation Capabilities Act of 2017, as ordered reported by the Senate Committee on Energy and Natural Resources on March 30, 2017. That legislation is similar to title IV of H.R. 589, but for technical reasons, CBO’s estimates of the effects on direct spending differ.

Based on the information available in 2017 about the status of advanced energy technologies, CBO anticipated that the privately funded projects authorized to be built on DOE land would be large, multibillion dollar facilities that would require long lead times and additional appropriations for federal R&D. Given those conditions, CBO estimated that S. 97 would have no significant effect on direct spending through 2027. Although CBO still expects that direct spending for such large projects probably would occur after 2027, CBO updated its estimate for H.R. 589, as passed by the House of Representatives, to reflect newly available information about the feasibility of investments in smaller test and demonstration facilities over the 2019-2028 period.

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