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SENATE

REPORT
115–251

ADVANCED NUCLEAR ENERGY TECHNOLOGIES ACT

MAY 21, 2018.—Ordered to be printed

Ms. MURKOWSKI, from the Committee on Energy and Natural Resources, submitted the following

R E P O R T

[To accompany S. 1457]

The Committee on Energy and Natural Resources, to which was referred the bill (S. 1457) to amend the Energy Policy Act of 2005 to direct the Secretary of Energy to carry out demonstration projects relating to advanced nuclear reactor technologies to support domestic energy needs, having considered the same, reports favorably thereon with an amendment and recommends that the bill, as amended, do pass.

The amendment is as follows:

Beginning on page 2, strike line 9 and all that follows through page 4, line 5 and insert the following:

> "(1) ADVANCED NUCLEAR REACTOR.—The term 'advanced nuclear reactor' means a nuclear fission or fusion reactor, including a prototype plant (as defined in sections 50.2 and 52.1 of title 10, Code of Federal Regulations (or successor regulations)), with significant improvements compared to the most recent generation of fission reactors, including improvements such as—
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> "(A) additional inherent safety features;
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> "(B) a significantly lower levelized cost of electricity;
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> "(C) lower waste yields;
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> "(D) improved fuel performance;
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> "(E) increased tolerance to loss of fuel cooling;
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> "(F) enhanced reliability;
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> "(G) increased proliferation resistance;
>
> "(H) increased thermal efficiency;
>
> "(I) reduced consumption of cooling water;

"(J) the ability to integrate into electric applications and nonelectric applications;

"(K) modular sizes to allow for deployment that corresponds with the demand for electricity; or

"(L) operational flexibility to respond to changes in demand for electricity and to complement integration with intermittent renewable energy.

"(2) DEMONSTRATION PROJECT.—The term 'demonstration project' means an advanced nuclear reactor operated—

"(A) as part of the power generation facilities of an electric utility system; or

"(B) in any other manner for the purpose of demonstrating the suitability for commercial application of the advanced nuclear reactor.

"(b) PURPOSE.—The purpose of this section is to direct the Secretary, as soon as practicable after the date of enactment of this section, to advance the research and development of domestic advanced, affordable, and clean nuclear energy by—

"(1) demonstrating different advanced nuclear reactor technologies that could be used by the private sector to produce—

"(A) emission-free power at a levelized cost of electricity of $60 per mWh or less;

PURPOSE

The purpose of S. 1457 is to amend the Energy Policy Act of 2005 to direct the Secretary of Energy to carry out demonstration projects relating to advanced nuclear reactor technologies to support domestic energy needs.

BACKGROUND AND NEED

Civil nuclear power today relies on light water technology that was originally developed in the 1950s for use in U.S. Navy submarines. Although there was ample experience in designing, constructing, and operating these light water reactors, by the 1960s scientists were exploring advanced non-light-water reactor designs that have potential advantages over light water reactors in proliferation resistance, thermal efficiency, reliability, fuel utilization, nuclear waste yields, inherent safety features, and non-commercial applications. Between 1951 and 1974, the U.S. Atomic Energy Commission (AEC) experimented on light water and advanced non-light-water nuclear reactors, taking more than 52 reactors from paper concept to demonstration at the AEC's National Reactor Testing Station, which is now the Idaho National Laboratory.

Advanced nuclear technologies face significant challenges in research, development, demonstration, and commercialization. Competitor nations are rapidly developing and demonstrating advanced reactor technologies—especially Russian and China. In order for today's ascending nuclear developers to succeed in commercializing their technologies, in a globally relevant timeframe, significant collaboration between with the Department of Energy (DOE) and its National Laboratories will be required. This collaboration will re-

quire the federal government, the research community, and private industry to establish audacious, yet attainable, advanced reactor goals. Alignment between the three sectors will send a strong and coherent signal that the U.S. is serious about re-establishing global leadership in nuclear technology.

DOE has unique authorities under the Atomic Energy Act. The DOE is responsible for maintaining nuclear research capabilities, knowledge, and a skilled workforce through support of nuclear research and development activities.

LEGISLATIVE HISTORY

S. 1457 was introduced by Senators Flake and Booker on June 28, 2017. The Subcommittee on Energy conducted a hearing on S. 1457 on October 3, 2017.

An identical bill, H.R. 5260, was introduced by Representative Higgins in the House of Representatives on March 13, 2018, and referred to the Science, Space, and Technology Committee.

The Committee on Energy and Natural Resources met in open business session on March 8, 2018, and ordered S. 1457 favorably reported, as amended.

COMMITTEE RECOMMENDATION

The Senate Committee on Energy and Natural Resources, in open business session on March 8, 2018, by majority voice vote of a quorum present, recommends that the Senate pass S. 1457, if amended as described herein.

COMMITTEE AMENDMENT

During its consideration of S. 1457, the Committee adopted an amendment to the bill. The amendment modifies section 2(a) to clarify the definition of "advanced nuclear reactor" contained in the new section 640(a)(1) to the Energy Policy Act of 2005 (Public Law 109–58). The amendment further modifies the new section 640(b)(1)(A) to include the levelized cost of electricity and lower the amount to $60 per megawatt-hours or less. The amendment is further described in the section-by-section analysis.

SECTION-BY-SECTION ANALYSIS

Section 1. Short title

Section 1 sets forth a short title.

Section 2. Advanced Nuclear Reactor And Development Goals

Section 2(a) amends subtitle B of title VI of the Energy Policy Act of 2005 (Public Law 109–58) by adding at the end a new section 640 titled "Advanced Nuclear Reactor Research and Development Goals."

The new section 640(a) provides for definitions of relevant terms.

The new subsection (b) states the purpose of the section.

The new subsection (c) requires the Secretary to enter into one or more agreements to carry out at least four advanced nuclear reactor demonstration projects prior to September 30, 2028. This subsection also specifies requirements for carrying out the demonstration projects, including design diversity and cost-effectiveness; ap-

plying the cost-share requirements contained in section 988 of the underlying Act; identifying potential sites with the private sector; and aligning specific activities with priorities.

The new section 640(d) directs the Secretary to establish goals for advanced nuclear reactor-related research that support the program's objectives; coordinate with private industry to advance design demonstrations; and ensure that research activities and programs meet certain requirements.

Section 2(b) amends the table of contents of the Energy Policy Act of 2005.

COST AND BUDGETARY CONSIDERATIONS

The Congressional Budget Office estimate of the costs of this measure has been requested but was not received at the time the report was filed. When the report is final, it will be available at *www.cbo.gov*.

REGULATORY IMPACT EVALUATION

In compliance with paragraph 11(b) of rule XXVI of the Standing Rules of the Senate, the Committee makes the following evaluation of the regulatory impact which would be incurred in carrying out S. 1457.

The bill is not a regulatory measure in the sense of imposing Government-established standards or significant economic responsibilities on private individuals and businesses.

No personal information would be collected in administering the program. Therefore, there would be no impact on personal privacy.

Little, if any, additional paperwork would result from the enactment of S. 1457, as ordered reported.

CONGRESSIONALLY DIRECTED SPENDING

S. 1457, as reported, does not contain any congressionally directed spending items, limited tax benefits, or limited tariff benefits as defined in rule XLIV of the Standing Rules of the Senate.

EXECUTIVE COMMUNICATIONS

The testimony provided by the Department of Energy at the October 3, 2017, hearing on S. 1457 follows:

TESTIMONY OF DEPUTY GENERAL COUNSEL BERNARD MCNAMEE, U.S. DEPARTMENT OF ENERGY, BEFORE THE U.S. SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES SUBCOMMITTEE ON ENERGY

Nuclear energy is a key part of our diverse energy mix, providing essential reliability and resiliency services for our grid. Early-stage research into advanced reactors, including advanced small modular reactor technologies (SMRs), is a key part of the DOE's goal to enable the development of safe, clean and affordable nuclear power options. The Department recognizes the potential transformational value that advanced SMRs can provide to the Nation's economic, energy security and environmental outlook.

Nuclear energy is clean, reliable, and safe, but the nuclear power industry needs to continue to innovate.

Advanced reactors, including small modular reactors, hold great promise as a clean, reliable, and secure power source for our nation. The Department recognizes that advanced reactors face challenges to ultimately achieving commercialization. Accordingly, the Department plans to partner with nuclear technology developers, including those involved with existing fleet, small modular reactor and other advanced reactor designs, in cost-shared early-stage research and development.

In addition to cost-shared early-stage research and development, as well as specific funding opportunities, the Administration supports prioritized investments in nuclear energy research infrastructure to enable private sector innovation.

CHANGES IN EXISTING LAW

In compliance with paragraph 12 of rule XXVI of the Standing Rules of the Senate, changes in existing law made by the original bill, as reported, are shown as follows (existing law proposed to be omitted is enclosed in black brackets, new matter is printed in italic, existing law in which no change is proposed is shown in roman):

ENERGY POLICY ACT OF 2005 (PUBLIC LAW 109–58)

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SECTION 1. SHORT TITLE; TABLE OF CONTENTS

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TITLE VI—NUCLEAR MATTERS

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Subtitle B–General Nuclear Matters

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Sec. 639. Conflicts of interest relating to contracts and other arrangements.

Sec. 640. Advanced nuclear reactor research and development goals.

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SEC. 639. CONFLICTS OF INTEREST RELATING TO CONTRACTS AND OTHER ARRANGEMENTS.

Section 170A b. of the Atomic Energy Act of 1954 (42 U.S.C. 2210a(b)) is amended—

(1) by redesignating paragraphs (1) and (2) as subparagraphs (A) and (B), respectively, and indenting appropriately;

(2) by striking "b. The Commission" and inserting the following:

"b. Evaluation.—

"(1) IN GENERAL.—Except as provided in paragraph (2), the Nuclear regulatory commission"; and

(3) by adding at the end the following:

"(2) NUCLEAR REGULATORY COMMISSION.—Notwithstanding any conflict of interest, the Nuclear Regulatory Commission may enter into a contract, agreement, or arrangement with the Department of Energy or the operator of a Department of Energy facility, if the Nuclear Regulatory Commission determines that—

"(A) the conflict of interest cannot be mitigated; and

"(B) adequate justification exists to proceed without mitigation of the conflict of interest.".

SEC. 640. ADVANCED NUCLEAR REACTOR RESEARCH AND DEVELOPMENT GOALS.

(a) DEFINITIONS.—In this section:

(1) ADVANCED NUCLEAR REACTOR.—The term "advanced nuclear reactor" means a nuclear fission or fusion reactor, including a prototype plant (as defined in sections 50.2 and 52.1 of title 10, Code of Federal Regulations (or successor regulations)), with significant improvements compared to the most recent generation of fission reactors including improvements such as—

(A) additional inherent safety features;

(B) a significantly lower levelized cost of electricity;

(C) lower waste yields;

(D) improved fuel performance;

(E) increased tolerance to loss of fuel cooling;

(F) enhanced reliability;

(G) increased proliferation resistance;

(H) increased thermal efficiency;

(I) reduced consumption of cooling water;

(J) the ability to integrate into electric applications and nonelectric applications;

(K) modular sizes to allow for deployment that corresponds with the demand for electricity; or

(L) operational flexibility to respond to changes in demand for electricity and to complement integration with intermittent renewable energy.

(2) DEMONSTRATION PROJECT.—The term "demonstration project" means an advanced nuclear reactor operated—

(A) as part of the power generation facilities of an electric utility system; or

(B) in any other manner for the purpose of demonstrating the suitability for commercial application of the advanced nuclear reactor.

(b) PURPOSE.—The purpose of this section is to direct the Secretary, as soon as practicable after the date of enactment of this section, to advance the research and development of domestic advanced, affordable, and clean nuclear energy by—

(1) demonstrating different advanced nuclear reactor technologies that could be used by the private sector to produce—

(A) emission-free power at a levelized cost of electricity of $60 per mWh or less;

(B) heat for industrial purposes or synthetic fuel production;

(C) remote or off-grid energy supply; or

(D) backup or mission-critical power supplies;

(2) developing goals for nuclear energy research programs that would accomplish the goals of the demonstration projects carried out under subsection (c);

(3) identifying research areas that the private sector is unable or unwilling to undertake due to the cost of, or risks associated with, the research; and

(4) facilitating the access of the private sector—

(A) to Federal research facilities; and

(B) to the results of research funded by the Federal Government.

(c) DEMONSTRATION PROJECTS.—

(1) IN GENERAL.—During the period beginning on the date of enactment of this section and ending on September 30, 2028, the Secretary shall, to the maximum extent practicable, enter into 1 or more agreements to carry out not fewer than 4 advanced nuclear reactor demonstration projects.

(2) REQUIREMENTS.—In carrying out demonstration projects under paragraph (1), the Secretary shall—

(A) seek to include diversity in designs for the advanced nuclear reactors demonstrated under this section, including designs using various primary coolants;

(B) seek to ensure that—

(i) the long-term cost of electricity or heat for each design to be demonstrated under this subsection is cost-competitive in the applicable market; and

(ii) the cost-competitiveness of each design to be demonstrated under this subsection is verified by an external review of the proposed design;

(C) enter into cost-sharing agreements with partners in accordance with section 988 for the conduct of activities relating to the research, development, and demonstration of private-sector advanced nuclear reactor designs under the program;

(D) work with private sector partners to identify potential sites, including Department-owned sites, for demonstrations, as appropriate; and

(E) align specific activities carried out under demonstration projects carried out under this subsection with priorities identified through direct consultations between

(i) the Department;

(ii) National Laboratories;

(iii) traditional end-users (such as electric utilities);

(iv) potential end-users of new technologies (such as petrochemical companies); and

(v) developers of advanced nuclear reactor technology.

(d) GOALS.—

(1) IN GENERAL.—The Secretary shall establish goals for research relating to advanced nuclear reactors facilitated by the Department that support the objectives of the program for demonstration projects established under subsection (c).

(2) COORDINATION.—In developing the goals under paragraph (1), the Secretary shall coordinate, on an ongoing basis, with

members of private industry to advance the demonstration of various designs of advanced nuclear reactors.

(3) REQUIREMENTS.—In developing the goals under paragraph (1), the Secretary shall ensure that—

(A) research activities facilitated by the Department to meet the goals developed under this subsection are focused on key areas of nuclear research and deployment ranging from basic energy to full-design development, safety evaluation, and licensing;

(B) research programs designed to meet the goals emphasize—

(i) resolving materials challenges relating to radiation damage or corrosive coolants; and

(ii) qualification of advanced fuels;

(C) activities are carried out that address near-term challenges in modeling and simulation to enable accelerated design and licensing;

(D) related technologies, such as electrochemical processing or fuel recycling that could reduce nuclear waste volumes or half lives, are developed;

(E) infrastructure, such as a versatile fast neutron source or molten salt testing facility, to aid in research are constructed;

(F) basic knowledge of non-light water coolant physics and chemistry is improved; and

(G) advanced manufacturing and construction techniques and materials are investigated to reduce the commercialization cost of advanced nuclear reactors.

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