(2) supporting curriculum and workforce development in quantum information science and engineering; and

(3) fostering innovation by bringing industry perspectives to quantum research and workforce development, including by leveraging industry knowledge and resources.

(d) Requirements

(1) In general

An institution of higher education or an eligible nonprofit organization (or a consortium thereof) seeking funding under this section shall submit an application to the Director of the National Science Foundation at such time, in such manner, and containing such information as the Director may require.

(2) Applications

Each application under paragraph (1) shall include a description of—

(A) how the Center will work with other research institutions and industry partners to leverage expertise in quantum science, education and curriculum development, and technology transfer;

(B) how the Center will promote active collaboration among researchers in multiple disciplines involved in quantum research, including physics, engineering, mathematics, computer science, chemistry, and material science;

(C) how the Center will support long-term and short-term workforce development in the quantum field;

(D) how the Center can support an innovation ecosystem to work with industry to translate Center research into applications; and

(E) a long-term plan to become self-sustaining after the expiration of funding under this section.

(e) Selection and duration

(1) In general

Each Center established under this section is authorized to carry out activities for a period of 5 years.

(2) Reapplication

An awardee may reapply for additional, subsequent periods of 5 years on a competitive, merit-reviewed basis.

(3) Termination

Consistent with the authorities of the National Science Foundation, the Director of the National Science Foundation may terminate an underperforming Center for cause during the performance period.

(f) Funding

The Director of the National Science Foundation shall allocate up to $10,000,000 for each Center established under this section for each of fiscal years 2019 through 2023, subject to the availability of appropriations. Amounts made available to carry out this section shall be derived from amounts appropriated or otherwise made available to the National Science Foundation.

(Pub. L. 115–368, title III, § 302, Dec. 21, 2018, 132 Stat. 5100.)

SUBCHAPTER IV—DEPARTMENT OF ENERGY QUANTUM ACTIVITIES

§ 8851. Quantum information science research program

(a) In general

The Secretary of Energy shall carry out a basic research program on quantum information science.

(b) Program components

In carrying out the program under subsection (a), the Secretary of Energy shall—

(1) formulate goals for quantum information science research to be supported by the Department of Energy;

(2) leverage the collective body of knowledge from existing quantum information science research;

(3) provide research experiences and training for additional undergraduate and graduate students in quantum information science, including in the fields of—

(A) quantum information theory;

(B) quantum physics;

(C) quantum computational science;

(D) applied mathematics and algorithm development;

(E) quantum networking;

(F) quantum sensing and detection; and

(G) materials science and engineering;

(4) coordinate research efforts funded through existing programs across the Department of Energy, including—

(A) the Nanoscale Science Research Centers;

(B) the Energy Frontier Research Centers;

(C) the Energy Innovation Hubs;

(D) the National Laboratories;

(E) the Advanced Research Projects Agency; and

(F) the National Quantum Information Science Research Centers; and

(5) coordinate with other Federal departments and agencies, research communities, and potential users of information produced under this section.

(Pub. L. 115–368, title IV, § 401, Dec. 21, 2018, 132 Stat. 5101.)

§ 8852. National Quantum Information Science Research Centers

(a) Establishment

(1) In general

The Secretary of Energy, acting through the Director of the Office of Science (referred to in this section as the ''Director''), shall ensure that the Office of Science carries out a program, in consultation with other Federal departments and agencies, as appropriate, to establish and operate at least 2, but not more than 5, National Quantum Information Science Research Centers (referred to in this section as ''Centers'') to conduct basic research to accelerate scientific breakthroughs in quantum information science and technology and to support research conducted under section 8851 of this title.

(2) Requirements

(A) Competitive, merit-reviewed process

The Centers shall be established through a competitive, merit-reviewed process.

(B) Applications

An eligible applicant under this subsection shall submit to the Director an application at such time, in such manner, and containing such information as the Director determines to be appropriate.

(C) Eligible applicants

The Director shall consider applications from National Laboratories, institutions of higher education, research centers, multi-institutional collaborations, and any other entity that the Secretary of Energy determines to be appropriate.

(b) Collaborations

A collaboration that receives an award under this section may include multiple types of research institutions and private sector entities.

(c) Requirements

To the maximum extent practicable, the Centers developed, constructed, operated, or maintained under this section shall serve the needs of the Department of Energy, industry, the academic community, and other relevant entities to create and develop processes for the purpose of advancing basic research in quantum information science and improving the competitiveness of the United States.

(d) Coordination

The Secretary of Energy shall ensure the coordination, and avoid unnecessary duplication, of the activities of each Center with the activities of—

(1) other research entities of the Department of Energy, including—

(A) the Nanoscale Science Research Centers;

(B) the Energy Frontier Research Centers;

(C) the Energy Innovation Hubs; and

(D) the National Laboratories;

(2) institutions of higher education; and

(3) industry.

(e) Duration

(1) In general

Each Center established under this section is authorized to carry out activities for a period of 5 years.

(2) Reapplication

An awardee may reapply for additional, subsequent periods of 5 years. The Director shall approve or disapprove of each reapplication on a competitive, merit-reviewed basis.

(3) Termination

Consistent with the authorities of the Department of Energy, the Secretary of Energy may terminate an underperforming Center for cause during the performance period.

(f) Funding

The Secretary of Energy shall allocate up to $25,000,000 for each Center established under this section for each of fiscal years 2019 through 2023, subject to the availability of appropriations. Amounts made available to carry out this section shall be derived from amounts appropriated or otherwise made available to the Department of Energy.

(Pub. L. 115–368, title IV, § 402, Dec. 21, 2018, 132 Stat. 5101.)

§ 8853. Department of Energy quantum network infrastructure research and development program

(a) In general

The Secretary of Energy (referred to in this section as the ''Secretary'') shall carry out a research, development, and demonstration program to accelerate innovation in quantum network infrastructure in order to—

(1) facilitate the advancement of distributed quantum computing systems through the internet and intranet;

(2) improve the precision of measurements of scientific phenomena and physical imaging technologies;

(3) develop secure national quantum communications technologies and strategies;

(4) demonstrate quantum networking utilizing the Department of Energy's Energy Sciences Network User Facility; and

(5) advance the relevant domestic supply chains, manufacturing capabilities, and associated simulations or modeling capabilities.

(b) Program

In carrying out this section, the Secretary shall—

(1) coordinate with—

(A) the Director of the National Science Foundation;

(B) the Director of the National Institute of Standards and Technology;

(C) the Chair of the Subcommittee on Quantum Information Science of the National Science and Technology Council established under section 8813(a) of this title; and

(D) the Chair of the Subcommittee on the Economic and Security Implications of Quantum Science;

(2) conduct cooperative research with industry, National Laboratories, institutions of higher education, and other research institutions to facilitate new quantum infrastructure methods and technologies, including—

(A) quantum-limited detectors, ultra-low loss optical channels, space-to-ground connections, and classical networking and cybersecurity protocols;

(B) entanglement and hyper-entangled state sources and transmission, control, and measurement of quantum states;

(C) quantum interconnects that allow short range local connections between quantum processors;

(D) transducers for quantum sources and signals between optical wavelength regimes, including telecommunications regimes and quantum computer-relevant domains, including microwaves;

(E) development of quantum memory buffers and small-scale quantum computers that