

117TH CONGRESS  
1ST SESSION

**S.** \_\_\_\_\_

To promote focused research and innovation in quantum communications and quantum network infrastructure to bolster internet security, and for other purposes.

---

IN THE SENATE OF THE UNITED STATES

---

Mr. THUNE (for himself and Ms. HASSAN) introduced the following bill; which was read twice and referred to the Committee on \_\_\_\_\_

---

**A BILL**

To promote focused research and innovation in quantum communications and quantum network infrastructure to bolster internet security, and for other purposes.

1 *Be it enacted by the Senate and House of Representa-*  
2 *tives of the United States of America in Congress assembled,*

3 **SECTION 1. SHORT TITLE.**

4 This Act may be cited as the “Quantum Network In-  
5 frastructure and Workforce Development Act of 2021”.

6 **SEC. 2. DEFINITIONS.**

7 In this Act:

8 (1) ESEA DEFINITIONS.—The terms “elemen-  
9 tary school”, “high school”, “local educational agen-

1 cy”, and “secondary school” have the meanings  
2 given those terms in section 8101 of the Elementary  
3 and Secondary Education Act of 1965 (20 U.S.C.  
4 7801).

5 (2) APPROPRIATE COMMITTEES OF CON-  
6 GRESS.—The term “appropriate committees of Con-  
7 gress” has the meaning given such term in section  
8 2 of the National Quantum Initiative Act (15 U.S.C.  
9 8801).

10 (3) INTERAGENCY WORKING GROUP.—The term  
11 “Interagency Working Group” means the Inter-  
12 agency Working Group on Workforce, Industry, and  
13 Infrastructure under the Subcommittee on Quantum  
14 Information Science of the National Science and  
15 Technology Council.

16 (4) Q2WORK PROGRAM.—The term “Q2Work  
17 Program” means the Q2Work Program supported  
18 by the National Science Foundation.

19 (5) QUANTUM INFORMATION SCIENCE.—The  
20 term “quantum information science” has the mean-  
21 ing given such term in section 2 of the National  
22 Quantum Initiative Act (15 U.S.C. 8801).

23 (6) STEM.—The term “STEM” means science,  
24 technology, engineering, and mathematics.

1 **SEC. 3. QUANTUM NETWORKING WORKING GROUP REPORT**  
2 **ON QUANTUM NETWORKING AND COMMU-**  
3 **NICATIONS.**

4 (a) REPORT.—Not later than 3 years after the date  
5 of the enactment of this Act, the Quantum Networking  
6 Working Group within the Subcommittee on Quantum In-  
7 formation Science of the National Science and Technology  
8 Council shall submit to the appropriate committees of  
9 Congress a report detailing a plan for the advancement  
10 of quantum networking and communications technology in  
11 the United States.

12 (b) REQUIREMENTS.—The report under subsection  
13 (a) shall include—

14 (1) a framework for interagency collaboration  
15 on the advancement of quantum networking and  
16 communications research;

17 (2) a plan for interagency collaboration on the  
18 development and drafting of international standards  
19 for quantum communications technology, including  
20 standards relating to—

21 (A) quantum cryptography and post-quantum  
22 classical cryptography;

23 (B) network security;

24 (C) quantum network infrastructure;

25 (D) transmission of quantum information  
26 through optical fiber networks; and

1 (E) any other technologies considered ap-  
2 propriate by the Working Group;

3 (3) a proposal for the protection of national se-  
4 curity interests relating to the advancement of quan-  
5 tum networking and communications technology;

6 (4) recommendations to Congress for legislative  
7 action relating to the framework, plan, and proposal  
8 set forth pursuant to paragraphs (1), (2), and (3),  
9 respectively; and

10 (5) such other matters as the Working Group  
11 considers necessary to advance the security of com-  
12 munications and network infrastructure, remain at  
13 the forefront of scientific discovery in the quantum  
14 information science domain, and transition quantum  
15 information science research into the emerging  
16 quantum technology economy.

17 **SEC. 4. QUANTUM NETWORKING AND COMMUNICATIONS**  
18 **RESEARCH.**

19 (a) RESEARCH.—The Under Secretary of Commerce  
20 for Standards and Technology shall carry out research to  
21 facilitate the development and standardization of quantum  
22 networking and communications technologies and applica-  
23 tions, including research on the following:

24 (1) Quantum cryptography and post-quantum  
25 classical cryptography.

1           (2) Quantum repeater technology.

2           (3) Quantum network traffic management.

3           (4) Quantum transduction.

4           (5) Long baseline entanglement and  
5 teleportation.

6           (6) Such other technologies, processes, or appli-  
7 cations as the Under Secretary considers appro-  
8 priate.

9           (b) IMPLEMENTATION.—The Under Secretary shall  
10 carry out the research required by subsection (a) through  
11 such divisions, laboratories, offices and programs of the  
12 National Institute of Standards and Technology as the  
13 Under Secretary considers appropriate and actively en-  
14 gaged in activities relating to quantum information  
15 science.

16           (c) DEVELOPMENT OF STANDARDS.—For quantum  
17 technologies deemed by the Under Secretary to be at a  
18 readiness level sufficient for standardization, the Under  
19 Secretary shall provide technical review and assistance to  
20 such other Federal agencies as the Under Secretary con-  
21 siders appropriate for the development of quantum net-  
22 work infrastructure standards.

23           (d) AUTHORIZATION OF APPROPRIATIONS.—

24           (1) IN GENERAL.—There is authorized to be  
25 appropriated to the Scientific and Technical Re-

1 search and Services account of the National Insti-  
2 tute of Standards and Technology to carry out this  
3 section \$10,000,000 for each of fiscal years 2022  
4 through 2026.

5 (2) SUPPLEMENT, NOT SUPPLANT.—The  
6 amounts authorized to be appropriated under para-  
7 graph (1) shall supplement and not supplant  
8 amounts already appropriated to the account de-  
9 scribed in such paragraph.

10 **SEC. 5. ENERGY SCIENCES NETWORK.**

11 (a) IN GENERAL.—The Secretary of Energy (referred  
12 to in this section as the “Secretary”) shall supplement the  
13 Energy Sciences Network User Facility (referred to in this  
14 section as the “Network”) with dedicated quantum net-  
15 work infrastructure to advance development of quantum  
16 networking and communications technology.

17 (b) PURPOSE.—The purpose of subsection (a) is to  
18 utilize the Network to advance a broad range of testing  
19 and research, including relating to—

20 (1) the establishment of stable, long-baseline  
21 quantum entanglement and teleportation;

22 (2) quantum repeater technologies for long-  
23 baseline communication purposes;

24 (3) quantum transduction;

1 (4) the coexistence of quantum and classical in-  
2 formation;

3 (5) multiplexing, forward error correction,  
4 wavelength routing algorithms, and other quantum  
5 networking infrastructure; and

6 (6) any other technologies or applications deter-  
7 mined necessary by the Secretary.

8 (c) AUTHORIZATION OF APPROPRIATIONS.—There  
9 are authorized to be appropriated to the Secretary to carry  
10 out this section such sums as are necessary for each of  
11 fiscal years 2022 through 2026.

12 **SEC. 6. QUANTUM WORKFORCE EVALUATION AND ACCEL-**  
13 **ERATION.**

14 (a) IDENTIFICATION OF GAPS.—The National  
15 Science Foundation shall enter into an agreement with the  
16 National Academies of Sciences, Engineering, and Medi-  
17 cine to conduct a study of ways to support the next gen-  
18 eration of quantum leaders.

19 (b) SCOPE OF STUDY.—In carrying out the study de-  
20 scribed in subsection (a), the National Academies of  
21 Sciences, Engineering, and Medicine shall identify—

22 (1) education gaps, including foundational  
23 courses in STEM and areas in need of standardiza-  
24 tion, in elementary school, middle school, high  
25 school, and higher education curricula, that need to

1 be rectified in order to prepare students to partici-  
2 pate in the quantum workforce;

3 (2) the skills and workforce needs of industry,  
4 specifically identifying the cross-disciplinary aca-  
5 demic degrees or academic courses necessary—

6 (A) to qualify students for multiple career  
7 pathways in quantum information sciences and  
8 related fields;

9 (B) to ensure the United States is com-  
10 petitive in the field of quantum information  
11 science while preserving national security; and

12 (C) to support the development of quan-  
13 tum applications; and

14 (3) the resources and materials needed to train  
15 elementary, middle, and high school educators to ef-  
16 fectively teach curricula relevant to the development  
17 of a quantum workforce.

18 (c) REPORTS.—

19 (1) EXECUTIVE SUMMARY.—Not later than 1  
20 year after the date of enactment of this Act, the Na-  
21 tional Academies of Science, Engineering, and Medi-  
22 cine shall prepare and submit to the National  
23 Science Foundation, and programs or projects fund-  
24 ed by the National Science Foundation, an executive  
25 summary of progress regarding the study conducted



1 under subsection (a) that outlines the findings of the  
2 Academies as of such date.

3 (2) REPORT.—Not later than 2 years after the  
4 date of enactment of this Act, the National Acad-  
5 emies of Science, Engineering, and Medicine shall  
6 prepare and submit a report containing the results  
7 of the study conducted under subsection (a) to Con-  
8 gress, the National Science Foundation, and pro-  
9 grams or projects funded by the National Science  
10 Foundation that are relevant to the acceleration of  
11 a quantum workforce.

12 **SEC. 7. INCORPORATING QISE INTO STEM CURRICULUM.**

13 (a) IN GENERAL.—The National Science Foundation  
14 shall, through programs carried out or supported by the  
15 National Science Foundation, prioritize the better integra-  
16 tion of quantum information science and engineering (re-  
17 ferred to in this section as “QISE”) into the STEM cur-  
18 riculum for each grade level from kindergarten through  
19 grade 12.

20 (b) REQUIREMENTS.—The curriculum integration  
21 under subsection (a) shall include—

22 (1) methods to conceptualize QISE for each  
23 grade level from kindergarten through grade 12;

24 (2) methods for strengthening foundational  
25 mathematics and science curricula;

1           (3) age-appropriate materials that apply the  
2           principles of quantum information science in STEM  
3           fields;

4           (4) recommendations for the standardization of  
5           key concepts, definitions, and curriculum criteria  
6           across government, academia, and industry; and

7           (5) materials that specifically address the find-  
8           ings and outcomes of the study conducted under sec-  
9           tion 6 and strategies to account for the skills and  
10          workforce needs identified through the study.

11          (c) COORDINATION.—In carrying out this section, the  
12          National Science Foundation, including the STEM Edu-  
13          cation Advisory Panel and the Advancing Informal STEM  
14          Learning program and through the National Science  
15          Foundation’s role in the National Q–12 Education Part-  
16          nership and the Q2Work Program, shall coordinate with  
17          the Office of Science and Technology Policy, EPSCoR eli-  
18          gible universities, and any Federal agencies or working  
19          groups determined necessary by the National Science  
20          Foundation.

21          (d) REVIEW.—In implementing this section, the Na-  
22          tional Science Foundation shall review and provide nec-  
23          essary updates to the related report entitled “Key Con-  
24          cepts for Future QIS Learners” (May 2020).

1 **SEC. 8. QUANTUM EDUCATION PILOT PROGRAM.**

2 (a) IN GENERAL.—The National Science Founda-  
3 tion, through the National Science Foundation’s role in  
4 the National Q–12 Education Partnership and the  
5 Q2Work Program, and in coordination with the Direc-  
6 torate for Education and Human Resources, shall carry  
7 out a pilot program, to be known as the “Next Generation  
8 Quantum Leaders Pilot Program”, to provide funding for  
9 the education and training of the next generation of stu-  
10 dents in the fundamental principles of quantum mechan-  
11 ics.

12 (b) REQUIREMENTS.—

13 (1) IN GENERAL.—In carrying out the pilot  
14 program required by subsection (a), the National  
15 Science Foundation shall—

16 (A) publish a call for applications through  
17 the National Q–12 Education Partnership  
18 website (or similar website) for participation in  
19 the pilot program from elementary schools, sec-  
20 ondary schools, and State educational agencies;

21 (B) coordinate with educational service  
22 agencies, associations that support STEM edu-  
23 cators or local educational agencies, and part-  
24 nerships through the Q–12 Education Partner-  
25 ship, to encourage elementary schools, sec-

1           ondary schools, and State educational agencies  
2           to participate in the program;

3           (C) accept applications for a period of 5  
4           months in advance of the academic year in  
5           which the program shall begin;

6           (D) select elementary schools, secondary  
7           schools, and State educational agencies to par-  
8           ticipate in the program, in accordance with  
9           qualifications determined by the Interagency  
10          Working Group, in coordination with the Na-  
11          tional Q–12 Education Partnership; and

12          (E) in coordination with the National Q–  
13          12 Education Partnership, identify qualifying  
14          advanced degree students, or recent advanced  
15          degree graduates, with experience in the field of  
16          quantum information science to provide feed-  
17          back and assistance to educators selected to  
18          participate in the pilot program.

19          (2) PRIORITIZATION.—In selecting program  
20          participants under paragraph (1)(D), the Director of  
21          the National Science Foundation shall give priority  
22          to elementary schools, secondary schools, and local  
23          educational agencies located in jurisdictions eligible  
24          to participate in the Established Program to Stimu-  
25          late Competitive Research (commonly known as

1 “EPSCoR”), including Tribal and rural elementary,  
2 middle, and high schools in such jurisdictions.

3 (c) CONSULTATION.—The National Science Founda-  
4 tion shall carry out this section in consultation with the  
5 Interagency Working Group.

6 (d) REPORTING.—

7 (1) REPORT AND SELECTED PARTICIPANTS.—  
8 Not later than 180 days after the date of enactment  
9 of this Act, the Director of the National Science  
10 Foundation shall submit to Congress a report on the  
11 educational institutions selected to participate in the  
12 pilot program required under subsection (a), speci-  
13 fying the percentage from nontraditional geog-  
14 raphies, including Tribal or rural school districts.

15 (2) REPORT ON IMPLEMENTATION OF CUR-  
16 RICULUM.—Not later than 2 years after the date of  
17 enactment of this Act, the Director of the National  
18 Science Foundation shall submit to Congress a re-  
19 port on implementation of the curricula and mate-  
20 rials under the pilot program, including the feasi-  
21 bility and advisability of expanding such pilot pro-  
22 gram to include additional educational institutions  
23 beyond those originally selected to participate in the  
24 pilot program.

1           (e) AUTHORIZATION OF APPROPRIATIONS.—There is  
2 authorized to be appropriated such funds as may be nec-  
3 essary to carry out this section.

4           (f) TERMINATION.—This section shall cease to have  
5 effect on the date that is 3 years after the date of the  
6 enactment of this Act.