U.S. National Science Foundation
Evaluation and Assessment Capability

# Portfolio Analysis of NSF Skilled Technical Workforce Investments

May 2026


A report from the Evaluation and Assessment Capability of the National Science Foundation.

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### Data

Data from this study is available to NSF licensees as a restricted-use file. For more information, please contact: eac@nsf.gov.

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## Abstract

Section 10314 of the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act, Public Law 117-167, requires a public-facing portfolio analysis of the U.S. National Science Foundation (NSF) investments in the skilled technical workforce (STW). Between fiscal years 2018 and 2024, NSF made over 1,400 awards for work focused on advancing the STW. This report describes the results of the analysis: total awards and investments, geographic distribution, institution characteristics, and common topics and themes of STW-related awards.

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## Executive Summary

Section 10314 of the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act calls for a public-facing portfolio analysis of the U.S. National Science Foundation's (NSF) "skilled technical workforce (STW) investments across all Directorates in the areas of education, research, infrastructure, data collection, and analysis." The CHIPS and Science Act defines the STW as **workers who use significant levels of STEM knowledge in their jobs and do not have a bachelor's degree.** To meet the CHIPS and Science Act requirements, the portfolio analysis presented in this report describes NSF investments in STW-related programs and awards that align with the legislation.

A literature review identified NSF efforts related to the STW in the United States. NSF invests in data collection and analysis to understand the STW as a sector of the science, technology, engineering, and mathematics (STEM) workforce using the National Center for Science and Engineering Statistics (NCSES). Through NCSES, NSF collects data and produces analyses that are the most comprehensive sources of existing information available about the STW. For example, NCSES established a STW Initiative to guide efforts to measure and understand the STW, and has fielded a pilot study in 2022 through the National Training, Education, and Workforce Survey (NTEWS), collecting data on the educational and training characteristics of the STW.[1] NSF investments in the NCSES 2022 NTEWS Pilot and the STW Initiative represent a substantial contribution to the current understanding of the STW. NSF also invests in the STW through funding opportunities that support education, research, and infrastructure. This report uses a combination of methods to examine NSF awards related to the STW that were made to researchers between fiscal year (FY) 2018 and FY 2024. Descriptive quantitative analysis focused on STW-related awards and funding, the geographic distribution of NSF's STW-related awards, and the characteristics of awarded institutions. Qualitative analysis generated themes related to the STW from NSF award abstracts.

**Examples of the types of activities funded by STW-related awards include:**

- Creating education and training programs covering areas such as cybersecurity, semiconductors, and robotics for use at community colleges to prepare students for STEM careers;
- Mentoring and outreach programs for students in order to prepare a future technical workforce in the fields of physics, computer science, and mathematics; and
- Studying use of emerging technology in the construction industry.

Key findings of the award analysis are described below.

[1] Skilled Technical Workforce Initiative | NSF - National Science Foundation

### NSF invested $1.9 billion in STW-related awards from FY 2018 to FY 2024.

- NSF funded over 1,400 STW-related awards between FY 2018 and FY 2024.
- The number of STW-related awards increased by 50% from FY 2018 (179 awards) to FY 2024 (269 awards).

### On average, NSF makes a greater proportion of STW-related awards in states with higher concentrations of workers who have not attained a bachelor's degree and work in STEM occupations.

- Awardees from all 50 U.S. states, the District of Columbia, and three U.S. territories received STW-related awards between FY 2018 and FY 2024, although the share of NSF awards that are STW-related varies by state.

### From FY 2018 to FY 2024, the number of STW-related awards increased by 72% in jurisdictions in the Established Program to Stimulate Competitive Research (EPSCoR).

- NSF's EPSCoR program strives to enhance the research competitiveness of targeted U.S. jurisdictions (state, territory, or commonwealth) by strengthening STEM capacity and capability.
- In non-EPSCoR jurisdictions, the number of STW-related awards increased by 46% from FY 2018 to FY 2024.

### About 80% of STW-related awards were made to associate's colleges or doctoral universities.

- The number of STW-related awards made to associate's colleges decreased between FY 2018 and FY 2021 before increasing from FY 2022 to FY 2024.
- Between FY 2018 and FY 2024, the number of STW-related awards made to doctoral institutions increased by 92%, from 62 to 119 awards.

### Emerging Research Institutions (ERIs) received more STW-related awards than non-ERIs every year from FY 2018 to FY 2024.

- ERIs are defined as institutions that have expended less than $50 million in federal research funding.
- The number of STW-related awards made to ERIs increased by 49% between FY 2022 and FY 2024, from 103 awards to 153 awards.

### STW-related awards commonly include partnerships with institutions such as community colleges and industry-specific training and workforce development programs.

- Construction and manufacturing are examples of industries commonly supported by STW-related award activities.

# 1. Introduction

As science, technology, engineering, and mathematics (STEM) continue to evolve in the United States, opportunities for individuals to become involved in the STEM labor force have increased. This growth challenges the existing parameters used to define the STEM labor force and, as a result, requires new analysis to better understand the characteristics of individuals contributing to scientific advancement. Section 10314 of the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act calls for a public-facing portfolio analysis of the U.S. National Science Foundation's (NSF) "skilled technical workforce (STW) investments across all Directorates in the areas of education, research, infrastructure, data collection, and analysis." To meet the CHIPS and Science Act requirements, the portfolio analysis presented in this report describes NSF investments in STW across the areas listed in the legislation.

In 2018, the Innovations in Mentoring, Training, and Apprenticeships Act was enacted into law. The Act emphasized improvements in associate degree and certificate programs in STEM, as well as applied learning experiences (i.e., apprenticeships and internships). Alongside STW-related initiatives, the Act also called for the National Center for Science and Engineering Statistics (NCSES) to "coordinate with agencies in exploring the feasibility of expanding its surveys to include the collection of data on certain skilled technical workers who use STEM knowledge in their jobs." NCSES, a principal statistical agency within NSF, is charged with providing objective information on U.S. science, technology, and innovation. NCSES is also responsible for gathering, analyzing, and disseminating statistical data on the science and engineering (S&E) workforce. Given this, NCSES is one of the leading sources of data and analysis about the STW, and NCSES analyses were integrated into the literature review that informed the current portfolio analysis. Key findings from NCSES analyses are listed below.

- A traditional view of the STEM workforce has included individuals with at least a bachelor's degree who are working in S&E occupations. The 2021 National Science Board (NSB) Science and Engineering Indicators report, which is produced by NCSES, expanded that definition to include all education levels (NSB 2021). In doing so, the report signaled the importance of including the STW as part of the STEM workforce.
- NCSES frames the STW as one possible pathway to STEM employment that meets the continued growing demand for STEM workers and complements the pathways provided by postsecondary education. NCSES estimates that more than half of the STEM workforce is made up of workers without bachelor's degrees (20 million workers, as compared to 16 million STEM workforce members with bachelor's degrees or higher). Thus, the STW is a vital part of the STEM workforce and should be studied as such (NSB 2021).

- NCSES analysis finds that workers without a bachelor's degree in STEM occupations earn higher median salaries and experience lower unemployment rates than workers without a bachelor's degree in other occupations (NSB 2020).

NCSES's STW-related data collection and analysis are funded by NSF and thus represent NSF's investment in understanding and characterizing the STW. NCSES has developed and fielded the 2022 National Training, Education, and Workforce Survey (NTEWS) to provide data on the educational and training characteristics of the nation's workforce, with a focus on the STW.[2] Although results from the NTEWS are not available as of the writing of this report, prior NCSES analyses describe the size and characteristics of the STW. NSF directly funds these efforts in order to provide a rigorous and robust analysis of the STW.

In addition to NCSES data collection and analysis, NSF has engaged with the STW through activities including but not limited to:

- Funding flagship programs (e.g., the Advanced Technological Education [ATE] and Experiential Learning for Emerging and Novel Technologies [ExLENT] programs) and initiatives such as the Established Program to Stimulate Competitive Research (EPSCoR) to build and expand S&E learning opportunities; and
- Creating the Technology, Innovation and Partnerships (TIP) Directorate in 2022, which leads the Regional Innovation Engines program and aims to increase participation in STEM across targeted regions of the United States.

NCSES defines the STW in alignment with the CHIPS and Science Act: The STW comprises workers who use significant levels of STEM knowledge in their jobs and do not have a bachelor's degree. To capture the breadth of NSF investments in the STW, this report applies NCSES's definition of the STW to NSF's STW-related investments and expands it to include awards made to institutions such as doctoral degree-granting universities and associate degree-granting colleges. NSF invests in the STW in large part through training programs that move potential employees toward gaining certifications and licenses that enable them to work in STEM fields; awards supporting these types of activities are included in this analysis.

This report contains the following sections:

- Overview of STW-related programs and awards, including portfolio size and grant funding as compared to NSF-wide awards, overall and by FY;

[2] More information on the NTEWS pilot data and results: https://ncses.nsf.gov/surveys/national-training-education-workforce/2022.

- Descriptive analysis of STW-related programs and awards, including results from the quantitative analyses on the number of STW-related awards and how they are distributed across geography and institution types;
- Results from the qualitative analysis to identify common content and themes across STW-related awards; and
- Conclusions and limitations.

## 2. Overview of STW-Related Programs and Awards

### A. STW-Related Portfolio

The portfolio analysis generated a list of STW-related programs and awards. Between FY 2018 and FY 2024, NSF made 1,408 STW-related awards, and the cumulative total award amount was $1.9 billion in inflation-adjusted terms ($1.7 billion in unadjusted terms; Figure 1). The STW-related portfolio represents 3.4% of NSF award obligations and 1.8% of NSF awards over this period.

***Figure 1. STW-Related Awards and All NSF Awards, FY 2018-FY 2024***

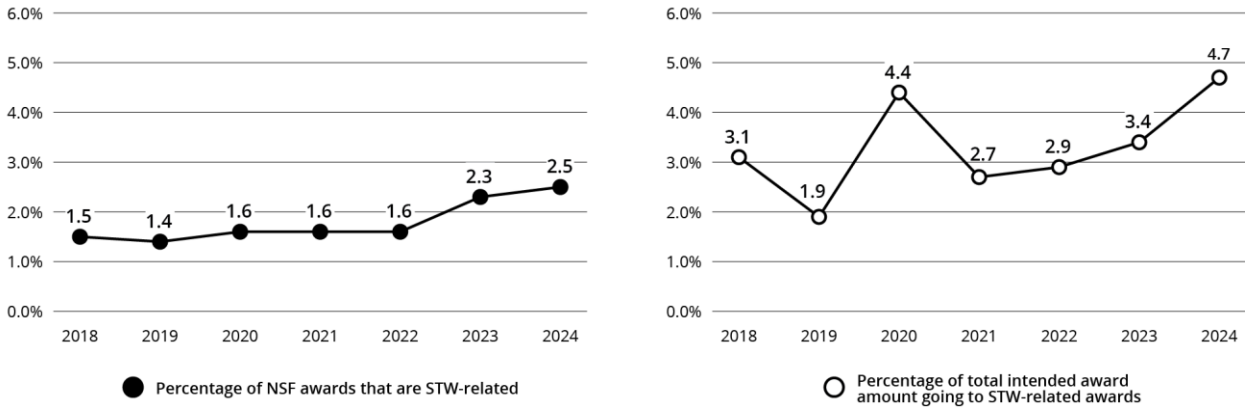
| Content Area | Total Intended Award Amount (in billions) | Number of Awards |
|---|---|---|
| NSF STW-Related Awards | $1.9 | 1,408 |
| NSF (overall) | $56.6 | 79,104 |

Note: Total grant funding was adjusted to FY 2024 dollars using the Consumer Price Index for All Urban Consumers. STW = skilled technical workforce; FY = fiscal year.
Source: NSF By the Numbers Award Obligation and New Awards Funded; NSF Data Lake as of January 31, 2025.

### B. Trends in STW-Related Awards

Between FY 2018 and FY 2022, the percentage of NSF awards that were STW-related remained relatively constant, with increases in FY 2023 and FY 2024 (Figure 2). The number of NSF awards that were STW-related decreased by 12% between FY 2018 and FY 2019 before increasing by 22% in FY 2020. In FY 2021 and FY 2022, the number of STW-related awards decreased by 5% each year, but because the number of NSF-wide awards also decreased in these years, the percentage of NSF awards that were STW-related remained constant. The largest increase in STW-related awards was in FY 2023 (49% increase from FY 2022). The percentage of dollars NSF invested in STW-related awards varied across the study period and is highest in FY 2024. The largest increase in funding for STW-related awards is between FY 2019 and FY 2020, when funding for these awards tripled because of several new large awards. In FY 2024, STW-related awards represented 2.5% of all NSF awards and received 4.7% of NSF award obligations.

***Figure 2. Percentage of STW-Related Awards and Funding by Fiscal Year, FY 2018-FY 2024***




Note: Total grant funding was adjusted to FY 2024 dollars using the Consumer Price Index for All Urban Consumers. STW = skilled technical workforce; FY = fiscal year.
Source: NSF By the Numbers Award Obligation and New Awards Funded; NSF Data Lake as of January 31, 2025.

## 3. Descriptive Analysis of STW-Related Programs and Awards

### A. Geographic Distribution

*NSF makes a greater proportion of STW-related awards in states with higher concentrations of workers who have not attained a bachelor's degree and work in STEM occupations.*

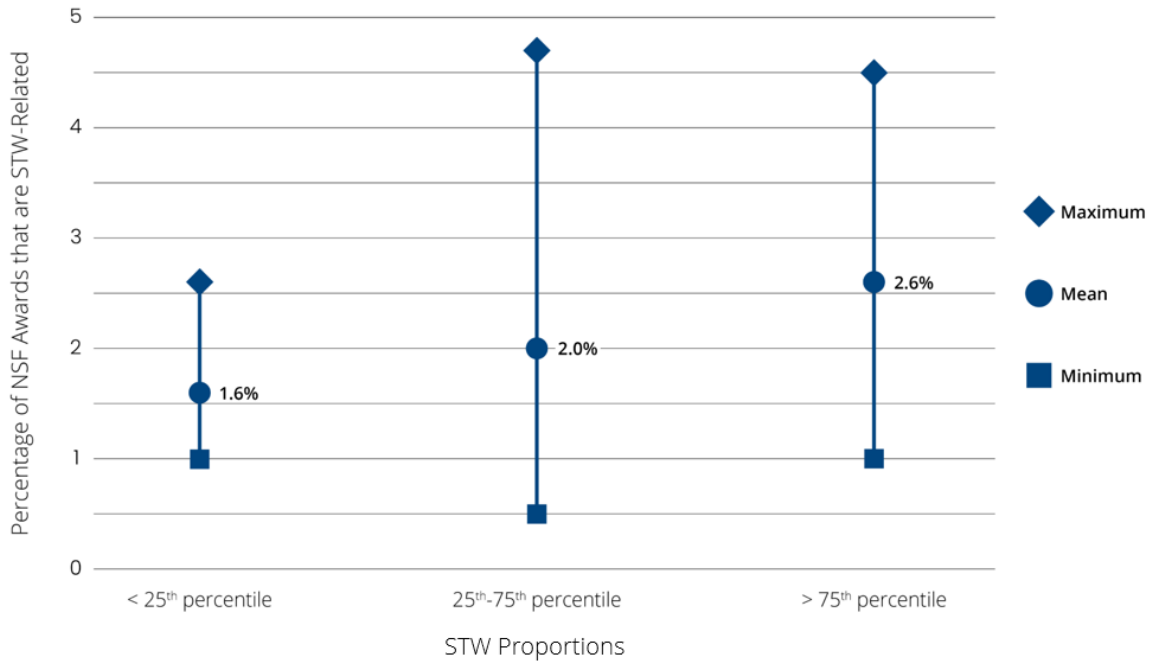
A recent NSB report (NSB 2024) examines the STW as a percentage of a state's total workforce, where the STW is defined as workers who have not attained a bachelor's degree and are employed in a STEM occupation (that is, an occupation that uses science, engineering, mathematics, and/or technology in the primary functions of the job, according to the NSB report). In all 50 states, the STW comprises at least 10% of the state's total workforce; in the District of Columbia, the STW comprises 3% of the total workforce. The report divides states into three categories based on the proportion of the state's total workforce that the STW represents. The three categories group these workforce proportions as:

- Below the 25th percentile (3.3%-12.0% of the state's total workforce);
- Between the 25th and 75th percentiles (12.1%-14.7%); and
- Above the 75th percentile (14.8%-17.1%).

In states with an STW workforce proportion below the 25th percentile, the percentage of NSF awards in the state that are STW-related ranges from 1.0% to 2.6%. In states with an STW workforce proportion between the 25th and 75th percentiles, the percentage of NSF awards that are STW-related ranges from 0.5% to 4.7%. In states with an STW workforce proportion above the 75th percentile, the percentage of NSF awards that are STW-related ranges from

1.0% to 5.0%. On average, in states with the lowest concentrations of workers without a bachelor's degree in STEM occupations, 1.6% of NSF awards are STW-related. In states with the highest concentrations of workers without a bachelor's degree in STEM occupations, an average of 2.6% of NSF awards are STW-related—63.0% higher than in states with the lowest concentrations of workers without a bachelor's degree in STEM occupations. That is, NSF investments in the STW align with the composition of states' workforces. For example, in Arkansas, North Dakota, and South Dakota, the percentages of workers who do not hold a bachelor's degree and work in a STEM occupation are above the 75th percentile (see Figure 3) and STW-related awards in those jurisdictions represent more than 3.0% of all NSF awards (see Figure 4).

***Figure 3. Percentage of STW-Related Awards by Concentration of Workers in STW, FY 2018-FY 2024***

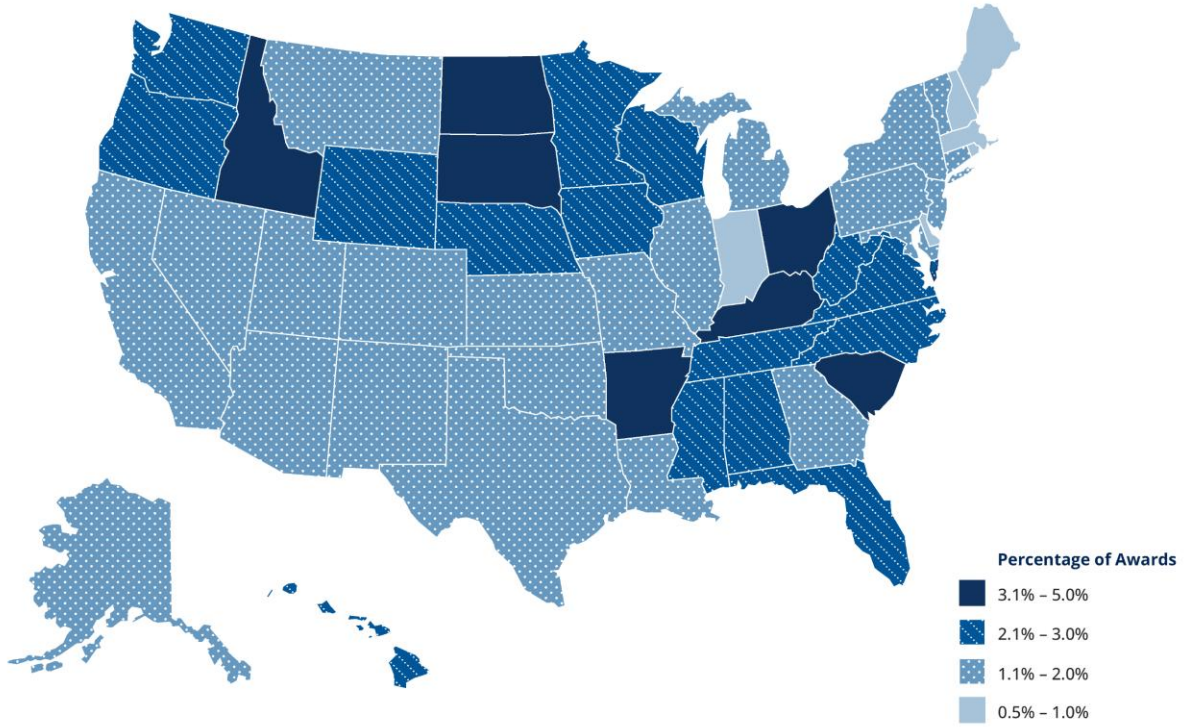



Note: States with STW proportion < 25th percentile (3.3%-12.0%): California, Colorado, Connecticut, District of Columbia, Hawaii, Illinois, Maryland, Massachusetts, Nevada, New Jersey, New York, Virginia; states with STW workforce proportion 25th-75th percentile (12.1%-14.7%): Arizona, Delaware, Florida, Georgia, Idaho, Kansas, Kentucky, Louisiana, Maine, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Mexico, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Vermont, Washington; states with STW workforce proportion > 75th percentile (14.8%-17.1%): Alabama, Alaska, Arkansas, Indiana, Iowa, Mississippi, Nebraska, North Dakota, Oklahoma, South Dakota, West Virginia, Wisconsin, Wyoming.
Source: NSB 2024; NSF Data Lake as of January 31, 2025.

*NSF awardees from all 50 U.S. states, the District of Columbia, and three U.S. territories received at least one STW-related award between FY 2018 and FY 2024.*

The distribution of NSF awards varies by state; California received over 50 times as many awards as Wyoming between FY 2018 and FY 2024. To account for state-level variation in NSF awards received, which correlates with state population, Figure 4 shows the proportion of all NSF awards in a state that are STW-related (rather than the distribution of STW-related awards, which mirrors the distribution of all NSF awards). The proportion of NSF awards within each state that are STW-related varied across the United States. STW-related awards represented the smallest share of NSF awards in Rhode Island (0.5%). From FY 2018 to FY 2024, the proportion of NSF awards that are STW-related was 1.0% or less in 6 states, between 1.1% and 2.0% in 22 states and the District of Columbia, and between 2.1% and 3.0% in 15 states. In seven states (Arkansas, Idaho, Kentucky, North Dakota, Ohio, South Carolina, and South Dakota) and three U.S. territories, more than 3.0% of NSF awards between FY 2018 and FY 2024 were STW-related, with the highest proportions of STW-related awards in American Samoa (50.0%; 1 STW-related award and 2 total NSF awards), Puerto Rico (5.3%; 9 STW-related awards and 169 total NSF awards), and Arkansas (5.0%; 17 STW-related awards and 337 total NSF awards).

***Figure 4. STW Awards as a Share of Total NSF Awards by State, FY 2018-FY 2024***




Note: The share of NSF awards that are STW-related in the District of Columbia (2.0% of all NSF awards in DC), American Samoa (50.0%), Puerto Rico (5.3%), and the U.S. Virgin Islands (4.5%) are not shown. No STW-related

awards had a primary place of performance in Guam or the Northern Mariana Islands. STW = skilled technical workforce; FY = fiscal year.
Source: NSF Data Lake as of January 31, 2025.

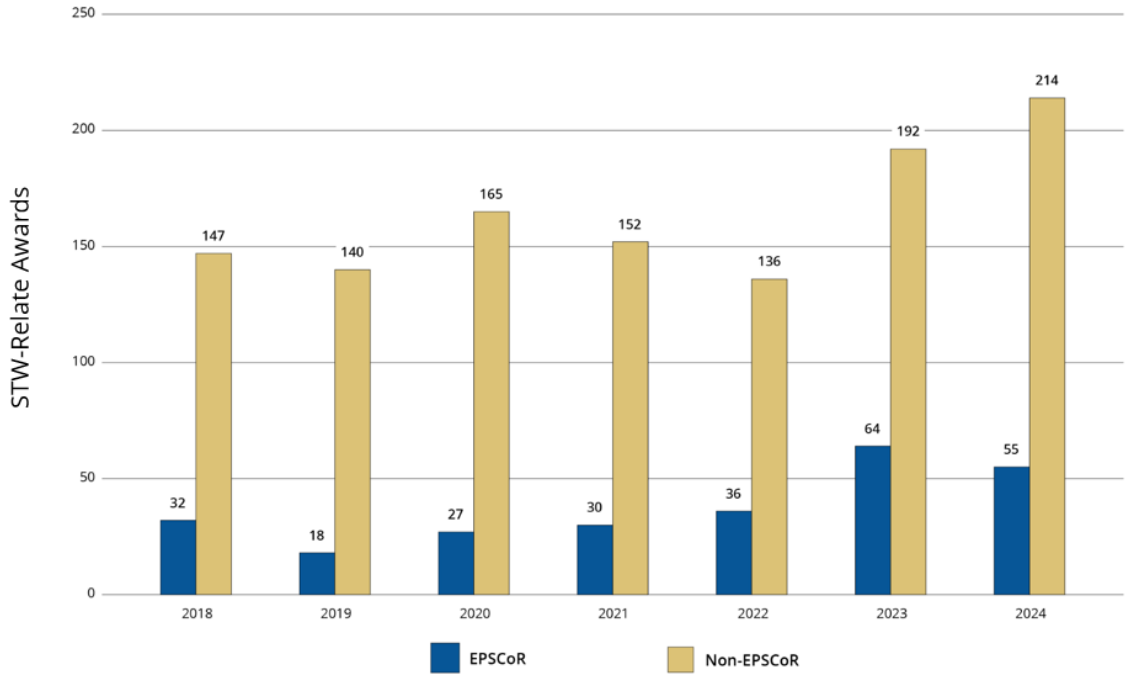
### *In every year between FY 2018 and FY 2024, non-EPSCoR states received more STW-related awards than EPSCoR states.*

NSF's EPSCoR program strives to enhance the research competitiveness of targeted U.S. jurisdictions (state, territory, or commonwealth) by strengthening STEM capacity and capability. A jurisdiction is eligible to participate in NSF's EPSCoR program if their most recent five-year level of total NSF funding is less than or equal to 0.75% of the total NSF budget (excluding EPSCoR funding and NSF funding to other federal agencies).[3] EPSCoR provides funding to institutions in jurisdictions that receive a disproportionately small percentage of NSF funding for research and development.

From FY 2018 to FY 2024, the number of STW-related awards made to EPSCoR jurisdictions increased by 72%, from 32 awards in FY 2018 to 55 awards in FY 2024 (Figure 5). The number of STW-related awards made to non-EPSCoR jurisdictions increased by 46%, from 147 in FY 2018 to 214 in FY 2024.

[3] Specifically, jurisdictions that have been established in the EPSCoR program and whose share of total NSF funding is above 0.75% but less than 0.80% are allowed to remain EPSCoR-eligible for up to five years.

***Figure 5. STW-Related Awards by FY and Jurisdiction Type, FY 2018-FY 2024***




Note: STW = skilled technical workforce; FY = fiscal year.
Source: NSF Data Lake as of January 31, 2025.

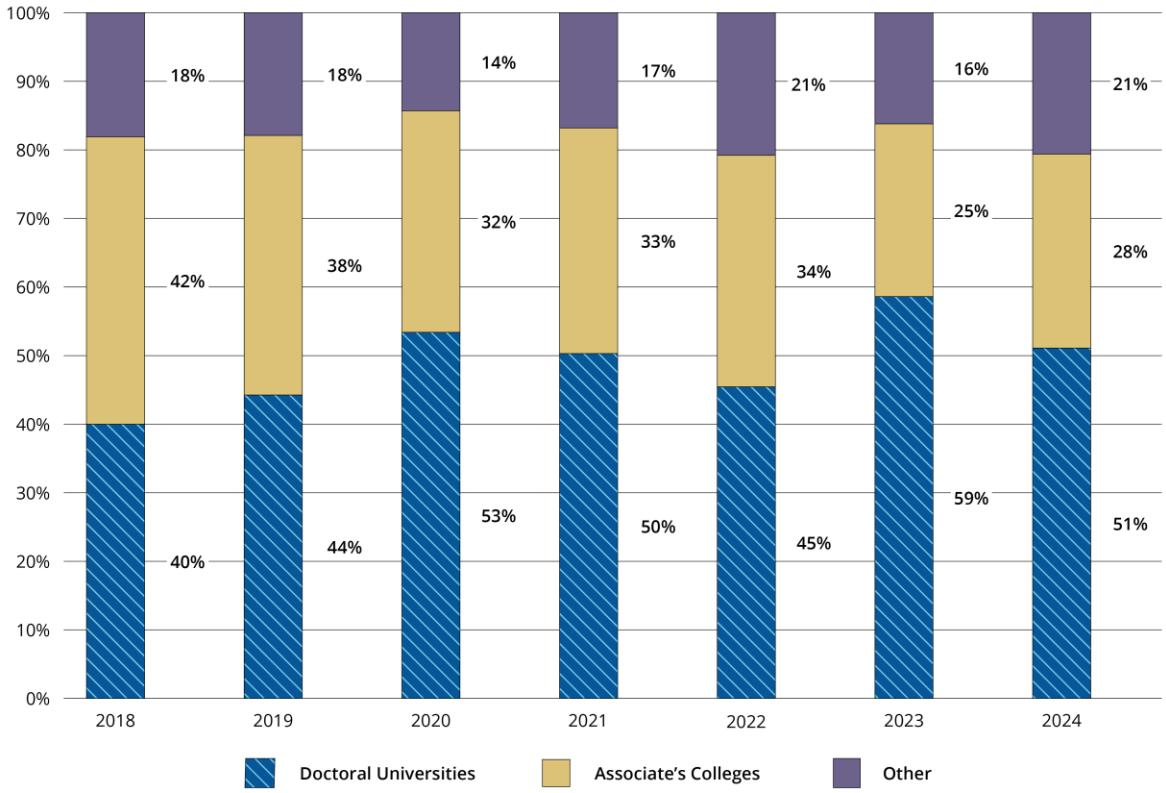
## B. Institution Characteristics

*Overall, approximately 80% of STW-related awards were made to associate's colleges or doctoral universities.*

Institution designations are based on the American Council on Education's Carnegie Basic Classifications (IU CPR, n.d.). The Carnegie Classification is the leading framework for describing characteristics of U.S. higher education institutions. It divides institutions into six categories: doctoral universities, master's colleges and universities, baccalaureate colleges, baccalaureate/associate's colleges, associate's colleges, and special focus institutions.

Figure 6 shows that most STW-related awards were made to associate's colleges (institutions at which the highest level of degree awarded is an associate degree) or doctoral universities (institutions that conferred at least 20 research doctoral degrees or at least 30 professional practice doctoral degrees in at least two programs). In all years, except FY 2018, doctoral universities received the largest percentage of STW-related awards. The percentage of STW-related awards made to associate's colleges decreased from 42% to 28% between FY 2018 and FY 2024.

***Figure 6. Distribution of STW-Related Awards by Institution Type, FY 2018-FY 2024***



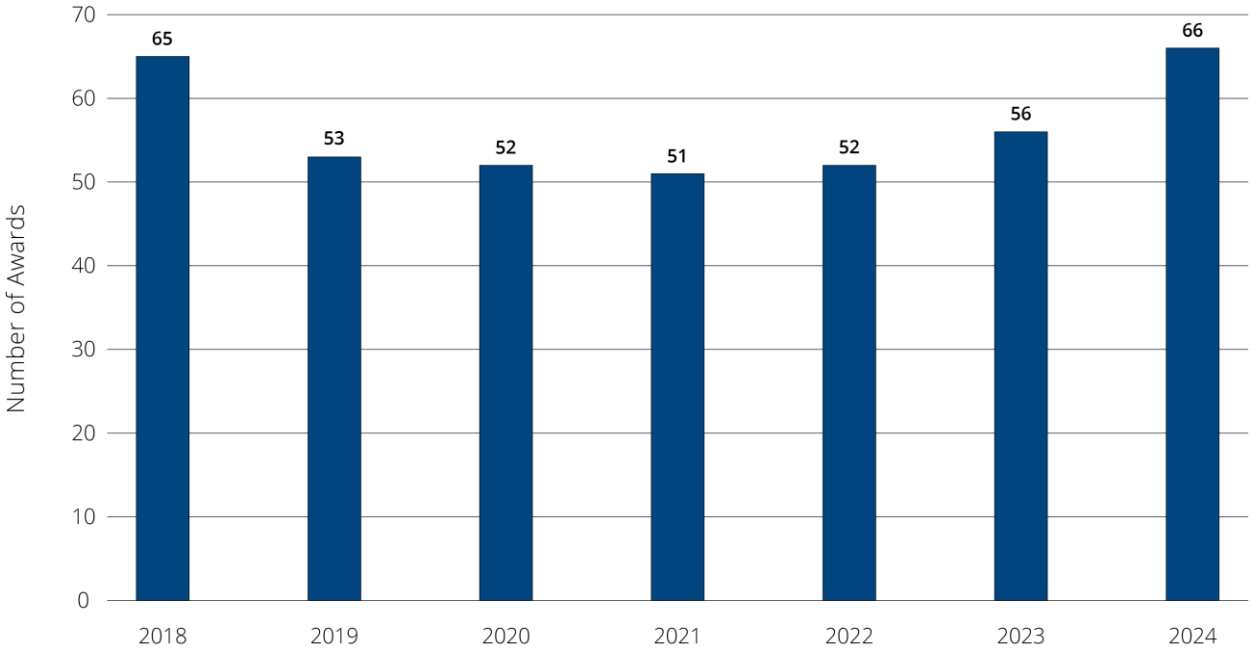

Note: STW = skilled technical workforce; FY = fiscal year. "Other" includes master's colleges and universities, baccalaureate colleges, baccalaureate/associate's colleges, and special focus institutions. Institutions outside the Carnegie universe (not accredited or nondegree-granting institutions) are excluded from this figure.
Source: NSF Data Lake as of January 31, 2025; 2021 Basic Carnegie Classification of Institutions of Higher Education.

### *The number of STW-related awards to associate's colleges decreased between FY 2018 and FY 2021 before increasing from FY 2021 to FY 2024.*

Carnegie Classifications subdivide associate's colleges by the percentage of associate degrees conferred in career and technical programs, where related employment opportunities do not require a higher credential. However, analysis based on these subdivisions of associate's colleges did not show a discernable pattern over time. Therefore, we present results for associate's colleges at the aggregate level.

Figure 7 shows the number of STW-related awards made between FY 2018 and FY 2024 to associate's colleges. Although the number of STW-related awards made to associate's colleges is similar in FY 2018 and FY 2024, there is variation across this period. The largest change in a single year was between FY 2018 and FY 2019, when the number of STW-related awards made to associate's colleges fell by 18%, from 65 to 53 awards. STW-related awards made to associate's colleges increased in each of the last 3 years in this period, beginning in FY 2022.

***Figure 7. STW-Related Awards to Associate's Colleges, FY 2018-FY 2024***

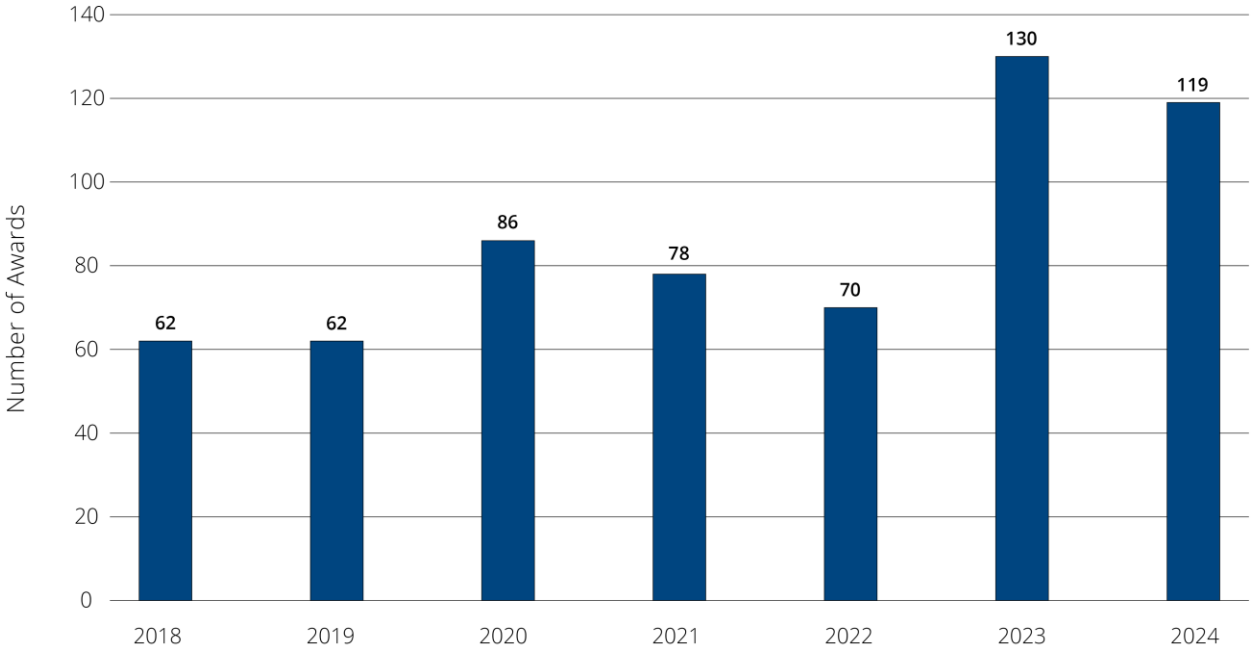



Note: STW = skilled technical workforce; FY = fiscal year.
Source: NSF Data Lake as of January 31, 2025; 2021 Basic Carnegie Classification of Institutions of Higher Education.

### *The number of STW-related awards to doctoral institutions increased by 92%, from 62 to 119 awards between FY 2018 and FY 2024.*

Figure 8 shows the number of STW-related awards made to doctoral institutions between FY 2018 and FY 2024. The largest increase in STW-related awards made to doctoral institutions in a single year occurred between FY 2022 (70 awards) and FY 2023 (130 awards), representing an increase of 86%.

***Figure 8. STW-Related Awards to Doctoral Institutions, FY 2018-FY 2024***



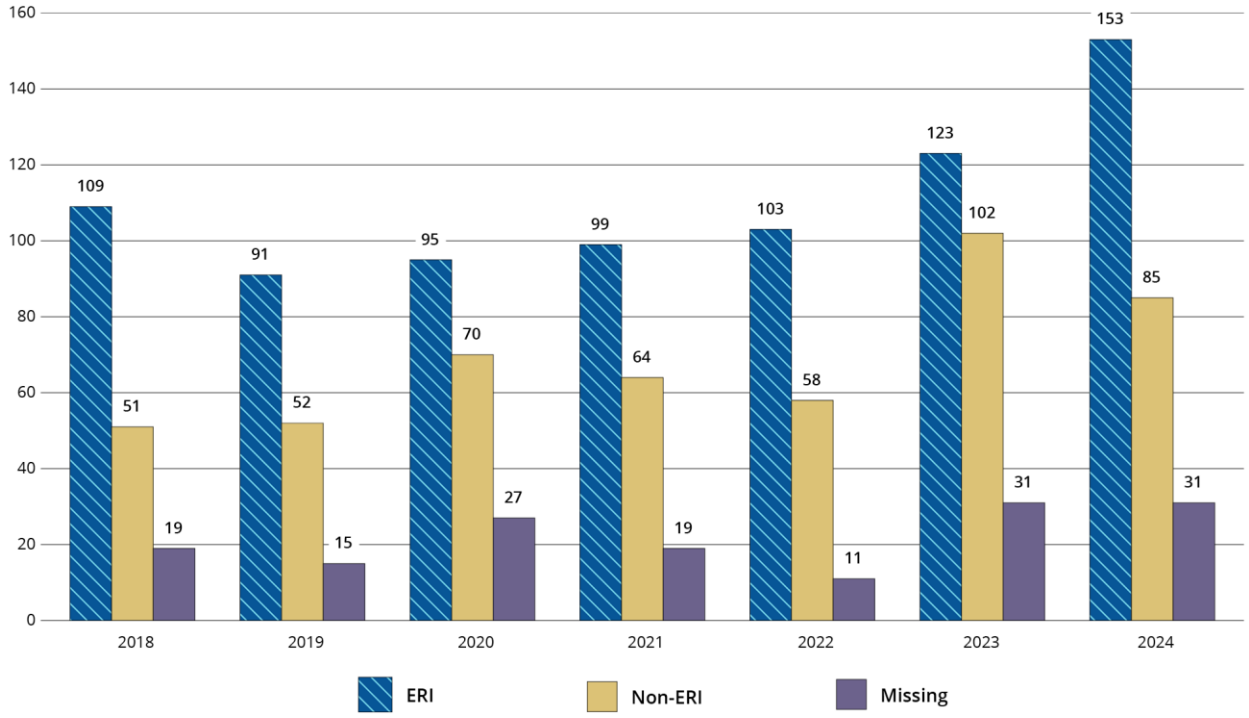

Note: STW = skilled technical workforce; FY = fiscal year.
Source: NSF Data Lake as of January 31, 2025; 2021 Basic Carnegie Classification of Institutions of Higher Education.

### *Emerging Research Institutions[4] (ERIs) received more STW-related awards than non-ERIs every year from FY 2018 to FY 2024.*

The number of STW-related awards made to ERIs increased by 40%, from 109 awards in FY 2018 to 153 awards in FY 2024 (Figure 9). The number of STW-related awards made to non-ERIs increased by 67%, from 51 in FY 2018 to 85 in FY 2024.

[4] An ERI is an institution of higher education with an established undergraduate or graduate program that have expended less than $50 million in federal research funding. ERI designations are based on research expenditures for academic year 2022, the most recent available in NSF administrative data, and reported federal research funding is adjusted for inflation to FY 2022 dollars. Missing data in Figure 9 captures cases where ERI status could not be determined or is not applicable. 2022 administrative data were the most recent data at the time the analysis was conducted.

***Figure 9. STW-Related Awards by Institution ERI Status, FY 2018-FY 2024***




## 4. Award Content and Themes

NSF invests in the STW by granting awards for the advancement and growth of the STW, as well as by supporting and conducting research and data collection to understand the characteristics of the STW. STW-related awards are made across all Directorates, with the content of the awards aligned with Directorate research areas. NSF administrative data does not contain variables that consistently identify STW-related awards. Because the award abstract summarizes the most pertinent information about the type of work being done under the award, the award analysis used a keyword search of award abstracts and program information to identify STW-related awards. Awards using keywords related to the STW or made under programs focused on advancing the STW were identified as STW investments.

NSF's STW-related award abstracts vary across the Foundation, although training and workforce development programs are common. STW-related keywords and abstracts were analyzed to identify common themes. Activities described in award abstracts that were STW-related were then grouped into four themes: institution-based training, experiential learning opportunities, industry-specific workforce development, and analysis. Figure 10 lists examples, within each thematic group, of the types of activities described in abstracts of STW-related awards. These examples are synthesized across awards and do not represent specific awards.

***Figure 10. Examples of STW-Related Activities Described in Award Abstracts, FY 2018-FY 2024***

| Thematic Groups | STW-Related Activities |
|---|---|
| Institution-Based Training | • Creating education and training material to be used at community colleges to prepare students for STEM careers<br>• Preparing students from two-year colleges for geoscience careers<br>• Incorporating training for high school, community college, and higher learning institutions into program objectives to prepare students for careers related to the subject area being studied |
| Experiential Learning Opportunities | • Mentorship, outreach, and workforce training programs for high school and community college students in order to prepare a future technical workforce<br>• Recruitment and training of students in data collection and research to support environmental resilience<br>• Development of workshops in cooperation with vocational education programs<br>• Workforce development through partnerships between industry, state and local governments, community/technical colleges, and four-year universities |
| Industry-Specific Workforce Development | • Creating and distributing resources to train biotechnicians<br>• Workforce development for data science<br>• Development of certification and training programs for manufacturing technicians<br>• Upskilling the semiconductor engineering workforce<br>• Partnering with industry stakeholders to create a pipeline of workers proficient in AI |
| Analysis | • Studying the use of emerging technology in the construction industry<br>• Quantum information science and engineering workforce analysis |

## 5. Conclusions and Limitations

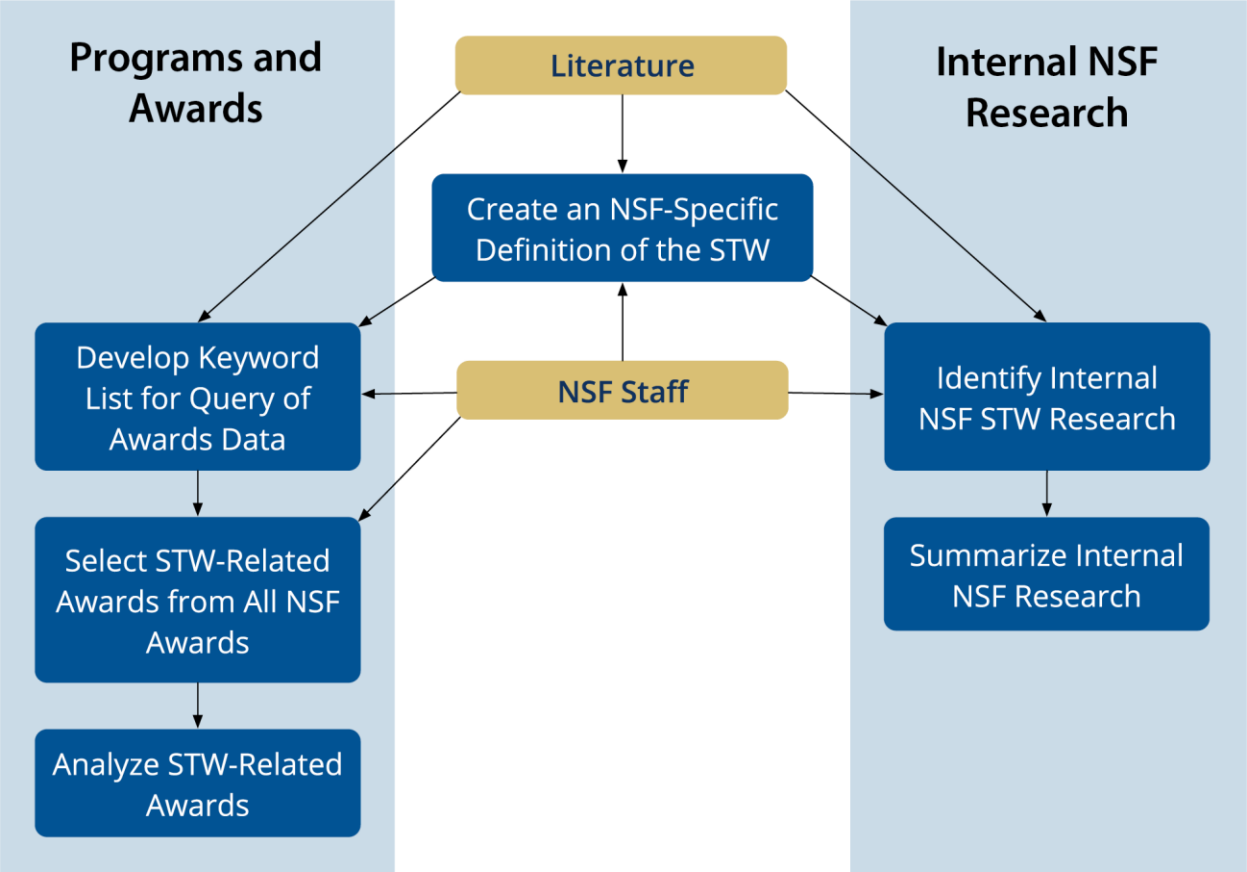
NSF awards related to the STW represent a relatively small proportion of all NSF awards, but the number of STW-related awards and the amount of funding given to those awards has grown in recent fiscal years. STW-related awards are made across all states and institution types, though in general, doctoral degree-granting institutions and emerging research institutions receive the most STW-related awards. In addition to awards, NSF investments in the NCSES STW Initiative represent a substantial contribution to the current understanding of the STW. This analysis is a foundational study of NSF award investments in the STW. If analysis of STW investments is of continued interest, systematically determining which awards are related to the STW and including this information in NSF's award database would facilitate future analysis.

## Appendix A. Methodology Details

This section describes the methods and data used to define and analyze NSF's STW-related awards from FY 2018 to FY 2024. It then describes the methods and data used to identify NSF's internal research efforts related to the STW.

Figure A.1 summarizes the process, which used literature and consultation with NSF staff to create an NSF-specific definition of the STW. This definition informed both the analysis of awards and internal NSF research.

***Figure A.1. Summary of Methods for Identifying and Analyzing STW-Related Awards***



## A. Defining NSF's Investments in the STW

The first step in the portfolio analysis was to determine which NSF investments to include. Because this report represents the first analysis undertaken of NSF's investments in the STW, there was not a consistent definition of the STW that NSF Directorates applied across their programs. Based on findings from the literature review and consultations with NSF staff, different Directorates have different areas of focus that contribute to their investments in the STW. For example, the Directorate for Computer and Information Science and Engineering (CISE) may invest in training cyber information professionals while the Directorate for STEM Education (EDU) invests in providing work experiences such as internships and job shadowing.

The CHIPS and Science Act (§10312) defines the STW as "workers with high school diplomas and two–year technical training or certifications who employ significant levels of STEM knowledge in their jobs." In an iterative and consultative process, this working definition was reviewed with NSF Directorate staff to ensure that each Directorate's STW-related work would be sufficiently captured by that definition. Directorate staff provided feedback that ensured the working definition captured the breadth of STW investments across the agency. Based on the feedback received, the definition was expanded. Because NSF invests heavily in workforce development, NSF staff suggested including trainees as well as workers that hold a bachelor's degree but are working in a technical capacity where their degree is not required.

## B. Award Analysis

### 1. Developing Criteria (Keywords and Programs) for Query of Awards Data

Findings from the literature review informed an initial list of keywords (e.g., "associate degree" or "certifications and licenses") to include in the planned search of award abstracts to identify STW-related awards. NSF Directorate staff (i.e., subject matter experts) provided feedback and added terms to create a more comprehensive keyword list.

The types of STW investments vary across NSF Directorates and Offices. Other than in the EDU Directorate, NSF staff indicated that the keyword "workforce development" was potentially over-identifying awards that were not truly related to the STW. Therefore, any award where the abstract contained the keyword "workforce development" only once and did not contain any other STW-related keywords was excluded from the analysis.

In EDU, staff indicated that awards with abstracts containing "workforce development" once but not containing any other STW-related keywords represented EDU's STW investments. As noted, when developing the definition of NSF investments, the types of STW investments vary by Directorate, so this broader criterion was used to select EDU awards for inclusion in the portfolio. In the EDU Directorate, an award using the keyword "workforce development" one or

more times is considered STW-related. Figure A.2 lists the keywords used to identify STW-related awards.

***Figure A.2. Keywords Used to Identify STW-Related Awards***

| Keywords | | |
|---|---|---|
| associate degree | reskill | vocational certificate |
| associates degree | skill standards | work experience |
| career pathway development | skilled technical | work experience program |
| certifications and licenses | skilled technical work | workforce development* |
| cyber information professional | skilled technical worker | middle skill |
| developing workforce | skilled technical workforce | nondegree credential |
| high school diploma | skilled technician | occupational license |
| industry recognized certification | technical workforce | postsecondary educational certificate |
| job shadowing | two year technical | |
| knowledge skills and abilities | upskill | |
| ksa | vocational certificate | |

Note: *Based on Directorate feedback, the keyword "workforce development" must be mentioned multiple times in the abstract for an award to be included in the analysis, except for awards in EDU, which need only include the keyword once in the abstract to be included in the analysis.

All keywords are listed in lowercase text and with punctuation removed to reflect the text processing that was done in preparation for the keyword search.

Additionally, NSF's public-facing website and internal NSF videos describing each Directorate identified two NSF programs that directly benefit the STW: Advanced Technological Education (ATE) in EDU and Experiential Learning for Emerging and Novel Technologies (ExLENT) in TIP. Awards made under these programs were identified as STW-related, regardless of the keywords in the abstract.

EDU staff also identified programs in the award list that focused on K-12 and graduate student education. Because these student populations are not part of the target STW population, all awards made under those programs were excluded from the analysis, regardless of the keywords in the award abstracts.

### 2. Obtaining and Processing Award Data

NSF maintains a complete record of award metadata in an internal Data Lake database. This record includes the date an award decision was made; the NSF Directorate, division, and program making the award; the intended award amount; and the awarded institution. It also includes a short abstract describing the nature of the work to be completed under the award. This database is the most comprehensive and up-to-date resource for NSF award data and can

be used to systematically query information about awards. The awards represent NSF's investments in research, education, and infrastructure.

The analysis relied on award abstracts for awards made between FY 2018 and FY 2024, as found in the NSF Data Lake. The beginning of the analysis period was chosen to coincide with the Innovations in Mentoring, Training, and Apprenticeships Act, which serves as the precursor to the CHIPS and Science Act. Award abstracts and program element codes (which indicate the NSF program making the award) were used to identify STW-related awards. The award abstract text was processed by removing punctuation and making all text lowercase to simplify the keyword search. Occurrences of each keyword in each award abstract were counted, and awards were included in the STW portfolio if the award abstracts included at least one STW-related keyword, or if the award was made under the ATE or ExLENT programs.

To substantiate the list of awards, staff across all Directorates reviewed a subset of awards to confirm whether the award should be included in the STW portfolio.

### 3. Analyzing STW-Related Awards

Qualitative and quantitative analysis were applied to analyze STW-related awards. Qualitative analysis identified broad categories of research activities that are described in STW-related award abstracts.

The quantitative descriptive analysis included describing the portfolio size across fiscal years and an examination of geographic distribution of awards by state. Finally, institution characteristics were analyzed in terms of institution type and ERI status.

## C. Internal NSF Research

The literature review and feedback received during consultation with Directorate staff highlighted additional investments that NSF makes in the STW through NCSES data collection and analysis efforts. Public-facing NCSES results, including reports published by the National Science Board (NSB), served as data used to assess these investments.

Additionally, NSF requires that investigators who are receiving grant funding report data about grant accomplishments using standardized Research Performance Progress Reports. This requirement represents additional NSF investment in data collection.

## Appendix B. Data Tables

***Figure B.1. Percentage of STW-Related Awards and Funding by Fiscal Year, FY 2018-FY 2024 (Figures 1 and 2)***

| Category | FY 2018 | FY 2019 | FY 2020 | FY 2021 | FY 2022 | FY 2023 | FY 2024 |
|---|---|---|---|---|---|---|---|
| STW-related award count | 179 | 158 | 192 | 182 | 172 | 256 | 269 |
| All NSF award count | 11,716 | 11,251 | 12,171 | 11,347 | 10,970 | 11,058 | 10,591 |
| Percentage of awards that are STW-related | 1.5% | 1.4% | 1.6% | 1.6% | 1.6% | 2.3% | 2.5% |
| STW-related award amount (in billions) | $0.2 | $0.1 | $0.3 | $0.2 | $0.3 | $0.3 | $0.4 |
| All NSF award amount (in billions) | $7.4 | $7.7 | $7.8 | $8.1 | $8.5 | $8.7 | $8.4 |
| Percentage of total intended award amount going to STW-related awards | 3.1% | 1.9% | 4.4% | 2.7% | 2.9% | 3.4% | 4.7% |

Note: Award amounts are rounded and therefore percentages and totals given are approximate.

***Figure B.2. Percentage of STW-Related Awards by Concentration of Workers in STW, FY 2018-FY 2024 (Figure 3)***

| STW Workforce Proportion | Minimum STW Awards as a Share of Total NSF Awards | Mean STW Awards as a Share of Total NSF Awards | Maximum STW Awards as a Share of Total NSF Awards |
|---|---|---|---|
| < 25th percentile | 1.0% | 1.6% | 2.6% |
| 25th-75th percentile | 0.5% | 2.0% | 4.7% |
| > 75th percentile | 1.0% | 2.6% | 5.0% |

***Figure B.3. STW Awards as a Share of Total NSF Awards by State, FY 2018-FY 2024 (Figure 4)***

| State | STW Awards as a Share of Total NSF Awards | Percent Grouping |
|---|---|---|
| Alabama | 2.5% | 2.1%-3.0% |
| Alaska | 1.9% | 1.1%-2.0% |
| Arizona | 1.4% | 1.1%-2.0% |
| Arkansas | 5.0% | 3.1%-5.0% |
| California | 1.4% | 1.1%-2.0% |
| Colorado | 1.6% | 1.1%-2.0% |
| Connecticut | 1.3% | 1.1%-2.0% |
| Delaware | 0.6% | 0.5%-1.0% |
| Florida | 2.7% | 2.1%-3.0% |
| Georgia | 1.4% | 1.1%-2.0% |
| Hawaii | 2.3% | 2.1%-3.0% |
| Idaho | 3.3% | 3.1%-5.0% |
| Illinois | 1.3% | 1.1%-2.0% |
| Indiana | 1.0% | 0.5%-1.0% |
| Iowa | 2.4% | 2.1%-3.0% |
| Kansas | 2.0% | 1.1%-2.0% |
| Kentucky | 4.2% | 3.1%-5.0% |
| Louisiana | 1.7% | 1.1%-2.0% |
| Maine | 0.9% | 0.5%-1.0% |
| Maryland | 1.7% | 1.1%-2.0% |
| Massachusetts | 1.0% | 0.5%-1.0% |
| Michigan | 1.5% | 1.1%-2.0% |
| Minnesota | 2.4% | 2.1%-3.0% |
| Mississippi | 2.2% | 2.1%-3.0% |
| Missouri | 1.9% | 1.1%-2.0% |
| Montana | 1.4% | 1.1%-2.0% |
| Nebraska | 2.2% | 2.1%-3.0% |
| Nevada | 1.4% | 1.1%-2.0% |
| New Hampshire | 1.0% | 0.5%-1.0% |
| New Jersey | 1.5% | 1.1%-2.0% |
| New Mexico | 1.7% | 1.1%-2.0% |
| New York | 1.5% | 1.1%-2.0% |
| North Carolina | 2.2% | 2.1%-3.0% |
| North Dakota | 4.1% | 3.1%-5.0% |
| Ohio | 4.0% | 3.1%-5.0% |
| Oklahoma | 1.3% | 1.1%-2.0% |
| Oregon | 2.2% | 2.1%-3.0% |

| State | STW Awards as a Share of Total NSF Awards | Percent Grouping |
|---|---|---|
| Pennsylvania | 1.2% | 1.1%-2.0% |
| Rhode Island | 0.5% | 0.5%-1.0% |
| South Carolina | 4.7% | 3.1%-5.0% |
| South Dakota | 3.6% | 3.1%-5.0% |
| Tennessee | 2.7% | 2.1%-3.0% |
| Texas | 1.5% | 1.1%-2.0% |
| Utah | 1.4% | 1.1%-2.0% |
| Vermont | 1.7% | 1.1%-2.0% |
| Virginia | 2.6% | 2.1%-3.0% |
| Washington | 2.3% | 2.1%-3.0% |
| West Virginia | 2.5% | 2.1%-3.0% |
| Wisconsin | 2.9% | 2.1%-3.0% |
| Wyoming | 2.4% | 2.1%-3.0% |

***Figure B.4. STW-Related Awards by FY and Jurisdiction Type, FY 2018-FY 2024 (Figure 5)***

| FY | EPSCoR Status | Number of STW-Related Awards |
|---|---|---|
| 2018 | EPSCoR | 32 |
| 2018 | Non-EPSCoR | 147 |
| 2019 | EPSCoR | 18 |
| 2019 | Non-EPSCoR | 140 |
| 2020 | EPSCoR | 27 |
| 2020 | Non-EPSCoR | 165 |
| 2021 | EPSCoR | 30 |
| 2021 | Non-EPSCoR | 152 |
| 2022 | EPSCoR | 36 |
| 2022 | Non-EPSCoR | 136 |
| 2023 | EPSCoR | 64 |
| 2023 | Non-EPSCoR | 192 |
| 2024 | EPSCoR | 55 |
| 2024 | Non-EPSCoR | 214 |

***Figure B.5. Distribution of STW-Related Awards by Institution Type, FY 2018-FY 2024 (Figure 6)***

| FY | Institution Type | Percentage of STW-Related Awards |
|---|---|---|
| 2018 | Doctoral Universities | 40% |
| 2018 | Associate's Colleges | 42% |
| 2018 | Other | 18% |
| 2019 | Doctoral Universities | 44% |
| 2019 | Associate's Colleges | 38% |
| 2019 | Other | 18% |
| 2020 | Doctoral Universities | 53% |
| 2020 | Associate's Colleges | 32% |
| 2020 | Other | 14% |
| 2021 | Doctoral Universities | 50% |
| 2021 | Associate's Colleges | 33% |
| 2021 | Other | 17% |
| 2022 | Doctoral Universities | 45% |
| 2022 | Associate's Colleges | 34% |
| 2022 | Other | 21% |
| 2023 | Doctoral Universities | 59% |
| 2023 | Associate's Colleges | 25% |
| 2023 | Other | 16% |

| FY | Institution Type | Percentage of STW-Related Awards |
|---|---|---|
| 2024 | Doctoral Universities | 51% |
| 2024 | Associate's Colleges | 28% |
| 2024 | Other | 21% |

***Figure B.6. STW-Related Awards to Associate's Colleges, FY 2018-FY 2024 (Figure 7)***

| FY | Number of STW-Related Awards |
|---|---|
| 2018 | 65 |
| 2019 | 53 |
| 2020 | 52 |
| 2021 | 51 |
| 2022 | 52 |
| 2023 | 56 |
| 2024 | 66 |

***Figure B.7. STW-Related Awards to Doctoral Institutions, FY 2018-FY 2024 (Figure 8)***

| FY | Number of STW-Related Awards |
|---|---|
| 2018 | 62 |
| 2019 | 62 |
| 2020 | 86 |
| 2021 | 78 |
| 2022 | 70 |
| 2023 | 130 |
| 2024 | 119 |

***Figure B.8. STW-Related Awards by Institution ERI Status, FY 2018-FY 2024 (Figure 9)***

| FY | ERI Status | Number of STW-Related Awards |
|---|---|---|
| 2018 | ERI | 109 |
| 2018 | Missing | 19 |
| 2018 | Non-ERI | 51 |
| 2019 | ERI | 91 |
| 2019 | Missing | 15 |
| 2019 | Non-ERI | 52 |
| 2020 | ERI | 95 |
| 2020 | Missing | 27 |
| 2020 | Non-ERI | 70 |
| 2021 | ERI | 99 |

| FY | ERI Status | Number of STW-Related Awards |
|---|---|---|
| 2021 | Missing | 19 |
| 2021 | Non-ERI | 64 |
| 2022 | ERI | 103 |
| 2022 | Missing | 11 |
| 2022 | Non-ERI | 58 |
| 2023 | ERI | 123 |
| 2023 | Missing | 31 |
| 2023 | Non-ERI | 102 |
| 2024 | ERI | 153 |
| 2024 | Missing | 31 |
| 2024 | Non-ERI | 85 |

## Appendix C. Quality Assurance

### A. Data Collection and Analysis

After collecting data from NSF's Data Lake, a research associate from Westat drafted code for data diagnostics intended to identify potential problems. The diagnostic checks included assessing the degree of missingness for each variable, ensuring values for each variable fell within an expected range, checking continuous variables for outliers, and asserting that unique identifiers were apparent within the data. After completing the code, a second research associate conducted a code review that included a review of syntax and a check of the output against the code.

Following the data diagnostics, a senior research associate developed coding specifications for guiding the development of the analysis code. The senior research associate met with the research associate responsible for drafting the code to discuss the coding specifications and answer any questions. After the meeting, the research associate drafted code based on the specifications, annotating each step in the code to align with instructions given in the coding specifications. After drafting the code, a second research associate conducted a code review. The code review included a line-by-line audit of the code and its alignment with the coding specifications. The research associate made any required changes to the code that were identified during the code review before outputting summary data for use in the final report.

### B. Evaluation Report

Westat used a multi-step process for developing the final report that included numerous quality control checks. Before drafting the report, Westat presented a detailed report outline to NSF project leadership. Westat incorporated NSF feedback on the outline into an initial draft report that went through two rounds of internal quality assurance review—one by a quality assurance reviewer with experience in STW research and another by the Project Director—and an editing and formatting review by a professional production team. NSF then reviewed and provided feedback on the initial draft report, which Westat addressed in a revised draft report. The revised draft also went through two rounds of quality assurance review and an editorial and formatting review before being submitted to NSF. Westat then presented findings from the revised draft to project leadership and NSF staff in a final briefing. Westat incorporated feedback on the revised draft and from the final briefing into a final report, which again went through two rounds of quality assurance review and editorial and formatting reviews before submission to NSF.

## Appendix D. Abbreviations and Acronyms

ATE = Advanced Technological Education

BIO = Directorate for Biological Sciences

CISE = Directorate for Computer and Information Science and Engineering

EAC = Evaluation and Assessment Capability

EDU = Directorate for STEM Education

ENG = Directorate for Engineering

EPSCoR = Established Program to Stimulate Competitive Research

ERI = Emerging Research Institution

ExLENT = Experiential Learning for Emerging and Novel Technologies

FY = fiscal year

GEO = Directorate for Geosciences

MPS = Directorate for Mathematical and Physical Sciences

NCSES = National Center for Science and Engineering Statistics

NSB = National Science Board

NSF = National Science Foundation

NTEWS = National Training, Education, and Workforce Survey

OD = Office of the Director

PI = principal investigator

S&E = science and engineering

SBE = Directorate for Social, Behavioral and Economic Sciences

STEM = science, technology, engineering, and mathematics

STW = skilled technical workforce

TIP = Directorate for Technology, Innovation and Partnerships

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