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Facilitated by the National Materials and Manufacturing Board, Division on Engineering and Physical Sciences

A Quadrennial Review of the National Nanotechnology Initiative

The report can be found at: NAP.EDU/25729

Nanoscience, Applications, and Commercialization

Tuesday, June 9, 2020 from 1-2:30pm ET 2020

Origins of the NNI

In a January 2000 speech president Bill Clinton advocated the development of nanotechnology, at the California Institute of Technology

'Some of our research goals may take twenty or more years to achieve, but that is precisely why there is an important role for the federal government.'

Image credit: AP

Origins of the NNI

President George W. Bush further increased funding for nanotechnology.

On 3rd of December 2003 Bush signed into law the

21st Century Nanotechnology Research and Development Act.

Public Law 108-153

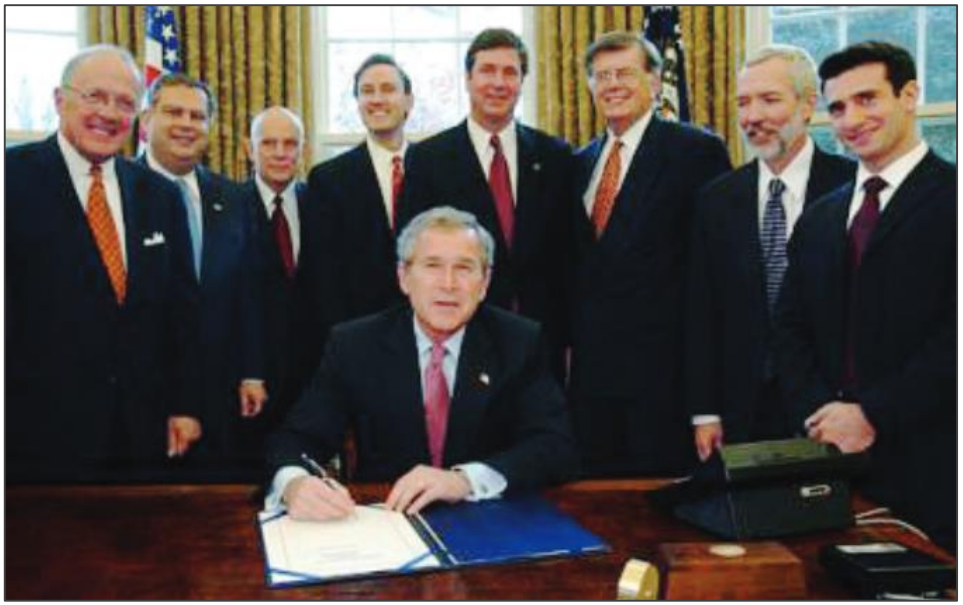

Image credit: Brandi L. Schottel and Barbara Karn

The NNI Today

Today the NNI is a United States Government research and development initiative involving 20 agencies and departments working together toward the shared vision of developing -

A future in which the ability to understand and control matter at the nanoscale leads to a revolution in technology and industry that benefits society.

https://www.nano.gov/about-nni

The NNI Structure and Coordination

The NNI brings together the expertise needed to advance this very broad and complex field — **creating a framework for shared goals, priorities, and strategies** that helps each participating **Federal agency leverage the resources of all participating agencies.**

With the support of the NNI, nanotechnology R&D is taking place in **academic, government, and industry laboratories** across the United States.

The NNI is coordinated by the Nanoscale Science, Engineering, and Technology (NSET)* - a subcommittee of the National Science and Technology Council's (NSTC) Committee on Technology, under the White House Office of Science and Technology Policy.

*Composed of representatives from the 20 Federal agencies and departments

2020 Review of the NNI

Pursuant to the 2003 21st Century
Nanotechnology Research and Development Act
The National Nanotechnology Coordination Office
asked the
National Academies of Sciences, Engineering, and Medicine
to form an ad hoc review committee to conduct this quadrennial review of the National Nanotechnology Initiative (NNI)

Statement of Task

This quadrennial NNI review addressed the following tasks:

A. **Analyze the relative position of the United States** compared to other nations with respect to nanotechnology R&D, including trends and developments in nanotechnology science and engineering and the identification of any critical research areas where the United States should be the world leader to best achieve the goals of the Program

B. **Assess the current state** of nanoscience and nanotechnology resulting from the NNI as authorized in 2003, including the current impact of nanotechnology on U.S. economic prosperity and national security. Based on this assessment, **consider if and how the NNI should continue.** If continuation is suggested, **make recommendations regarding new or revised Program goals, new research areas and technical priorities, partnerships, coordination and management mechanisms, or programs to be established to achieve these goals.**

NNI Quadrennial Review Committee

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The committee is gratefully to the reviewers of the report

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And also Martin A. Philbert, NAM (University of Michigan) for his oversight of the review.

Preface

- Nanotechnology is highly-interdisciplinary and has made **transformative societal impacts**.
- Nanotechnology significantly contributes to the US high-technology economy, the nation's security, to the health and to the prosperity of its citizens.
- The US maintains a strong nanoscience and technology R&D program, but the **global arena is increasingly competitive**.
- **Program coordination** is now critical in the current hyper-competitive global era.
- In **China**, particularly, we see a **robust national R&D strategy** that seeks to harvest the economic, medical, and national security benefits of the international nanotechnology R&D effort as quickly as possible.
    - Very large investments in state-of-the-art facilities and the allocation of substantial resources for the training and attraction of top international talent, is clearly intended to result in **China's leadership in nanotechnology**.

Summary

The highest priority of this report is to provide recommendations that will restore the US to the global forefront of nanotechnology-enabled advances in electronics, health care, clean energy, food production, and clean water and air, and to contribute to the robust defense of U.S. national security interests.

- A **redesign of the NNI** with the goal of achieving a U.S. **resurgence in nanotechnology** is recommended.
- The NNI should be restructured around these **priorities**:
  1. Improve NNI alignment with the **stated national priorities** for R&D.
  2. Broaden NNI work to **accelerate technology transfer** to relevant markets.
  3. Strengthen state-of-the-art enabling **R&D infrastructure** and expand domestic **workforce** education and training.
- **Engaging and partnering** with the nanoscience and technology community broadly will be vitally important if the US is to fully reap the societal benefits of nanotechnology.

Introduction

Impacts of the NNI to date

The goals of the NNI are:

1. Advance a world-class nanotechnology R&D program.
2. Foster the transfer of new technologies into products for commercial and public benefit.
3. Develop and sustain educational resources, a skilled workforce, and a dynamic infrastructure and toolset to advance nanotechnology, and
4. Support responsible development of nanotechnology

- The NNI is widely viewed nationally and globally as a highly successful cross-disciplinary and interagency coordination effort — arguably the best modern example of such an effort in the US.

- Impressive, tangible outcomes that have emerged from these coordination efforts, including the recent formation of the NQI.

Organization of NNI effort via PCAs and NSIs

- NNI is organized into Program Component Areas and Nanotechnology Signature Initiatives to promote interagency coordination in areas of national relevance.
- This "light coordination" approach has resulted in uneven investments.
  - Poorly funded: technology transfer and workforce development
  - Well funded: fundamental research, infrastructure, health, and public safety.
- A lack of data collection / availability makes it difficult to determine impacts.
- We observe significant inertia to change in priorities hampering timely alignment with national priorities.
- *In the past, when the global arena was paced by the work of the United States, this approach to NNI coordination was more appropriate than it is today.*

Given intense competition and increasing risk of technological surprise, the review committee is concerned that the organizing principles and budgetary arrangements to execute an agile program are no longer adequate.

The U.S. Nanotechnology R&D Ecosystem

- There are many notable **NNI successes**, in electronics, healthcare, environmental nanosensors, the development of **world-class facilities**, and establishment of the US as a **global leader in EHS** efforts.
- Comparison of U.S. and international efforts reveals key **competitive weaknesses** for the U.S. efforts.
- While support of basic nanoscience research must continue, the opportunity now exists for the United States to **fully realize the societal benefits of nanoscience** via commercialization of responsible nanoproducts.

There exists an urgent need to better integrate nanoscience, infrastructure development, and workforce development into an ecosystem that supports the goal of responsible commercialization of nanotechnology for the benefit of the US.

Current Perspective

- The SARS-COV2 pandemic has shown the value and critical importance of advanced science and technology research and infrastructure to society.
- The rapid response in sensors, testing and potential vaccines has been facilitated by nanotechnologies.
- 20 years of the NNI has built significant resources and learning, in particular about interdisciplinary research and technology development.
- It is time to pivot the NNI to align with current US Strategic R&D Priorities.

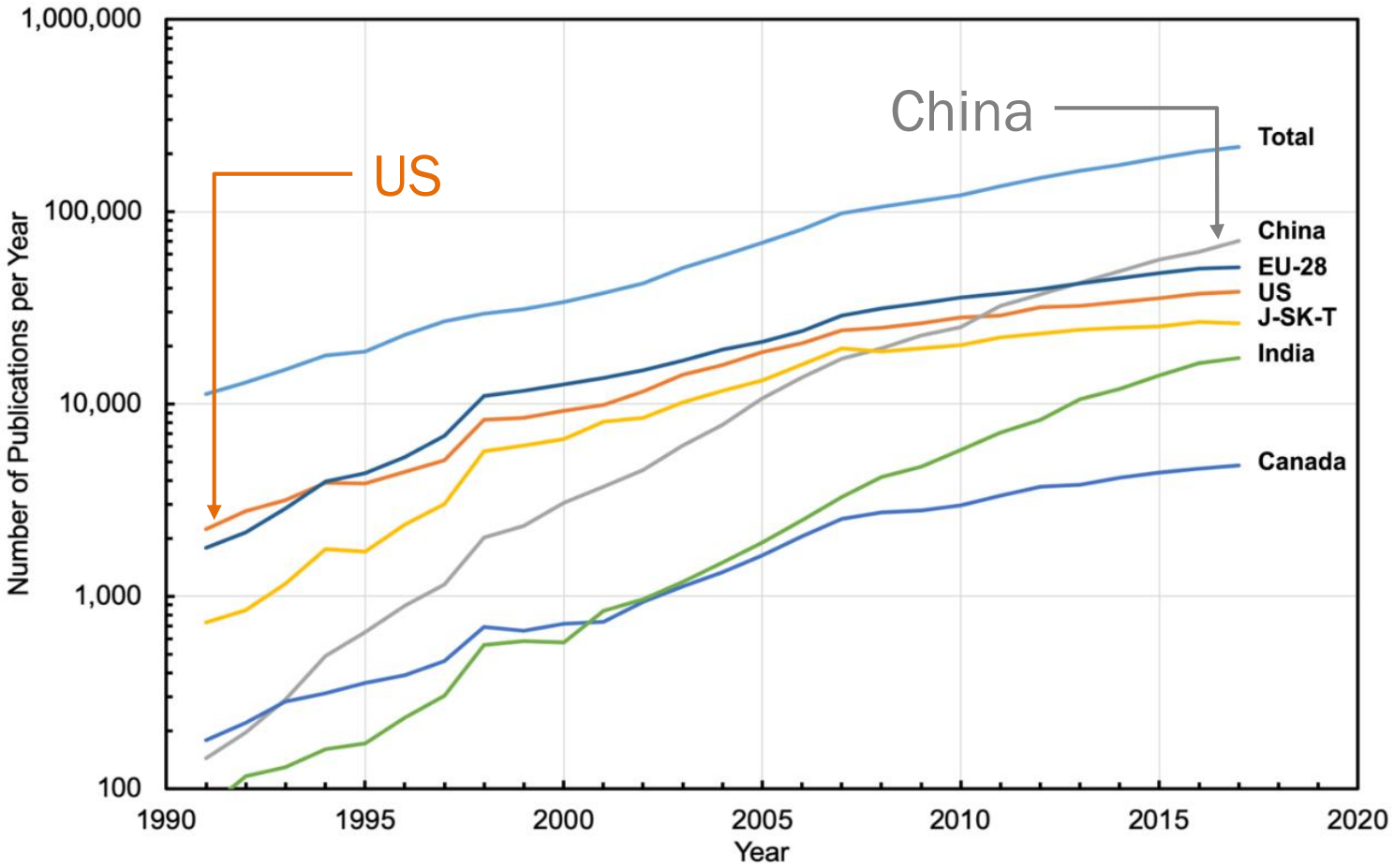
The Changing Global Environment

A Global Perspective

- At the launch of the NNI, 20 years ago, **government investment** into nanotech and R&D was on par between the United States, Western Europe, and Japan, and the United States had a **strong lead in the number of patents** in nanotechnology.
- **Sustained investments** have been made by other developed nations and the EU, and **accelerated investment** is seen in developing nations, especially China.
- Today, the US is **but one of several nations** where nanoscience discoveries and technology applications are making important contributions to the economy and to the health of their citizens.
- It is unrealistic to expect or to advocate that the United States should lead in every area of nanoscience and technology.
- There is a need to **identify the most critical topics in which the United States should aim to lead the world**.

So how has the NNI evolved compared to the nano-programs of other nations?

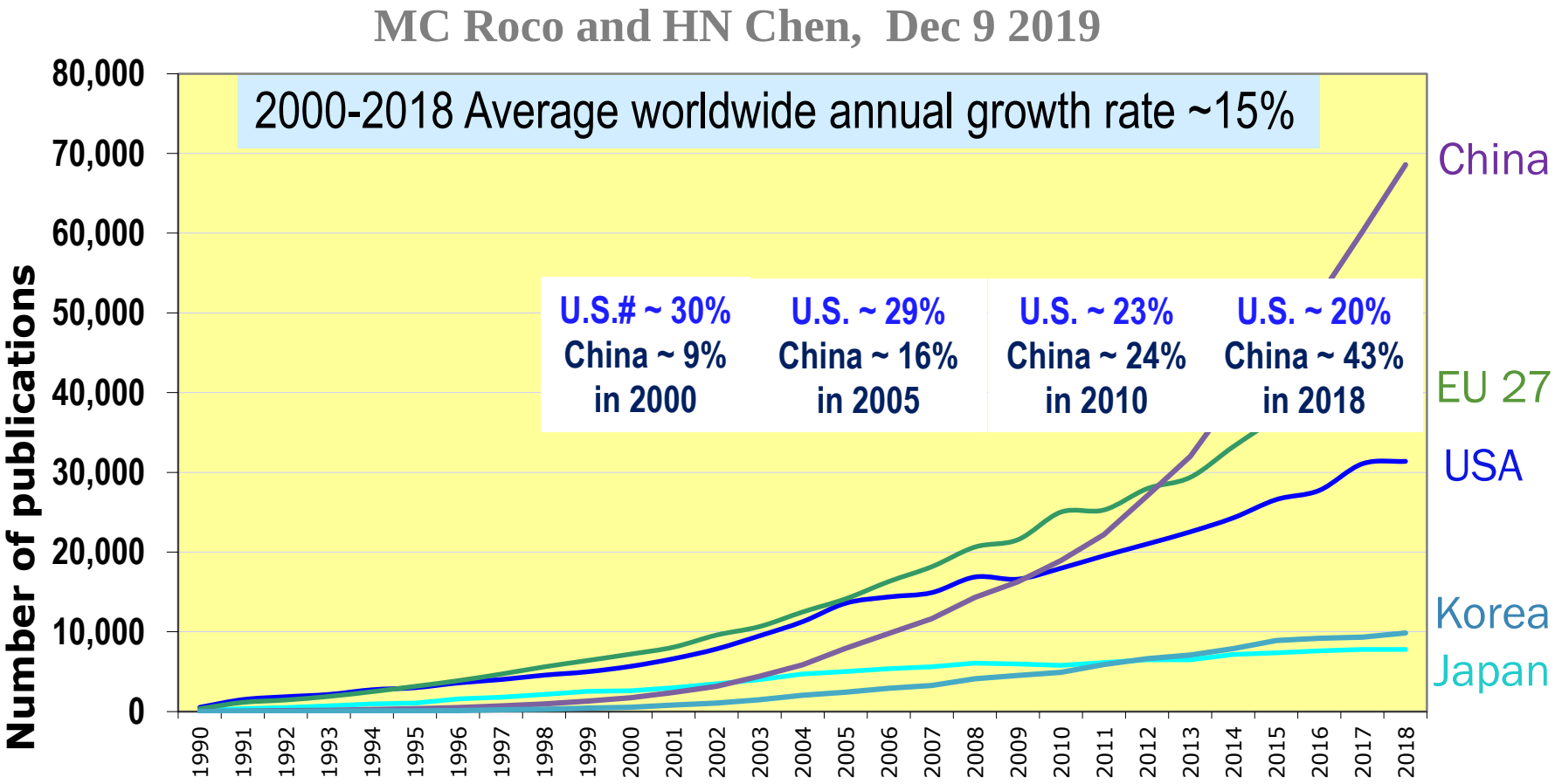
Rapid Global Shifts in Origins of "Nano-related" Publications



Source: Extracted from the nanotechnology database recently published in Z. Wang, A.L. Porter, S. Kwon, J. Youtie, P. Shapira, S.F. Carley, and X. Liu, 2019, "Updating a search strategy to track emerging nanotechnologies", Journal of Nanoparticle Research 21(9):199. The committee thanks the authors for permitting a customized search of their database.

Nanotechnology publications in the WoS: 1990 - 2018

"Title-abstract" search for nanotechnology by keywords for five regions



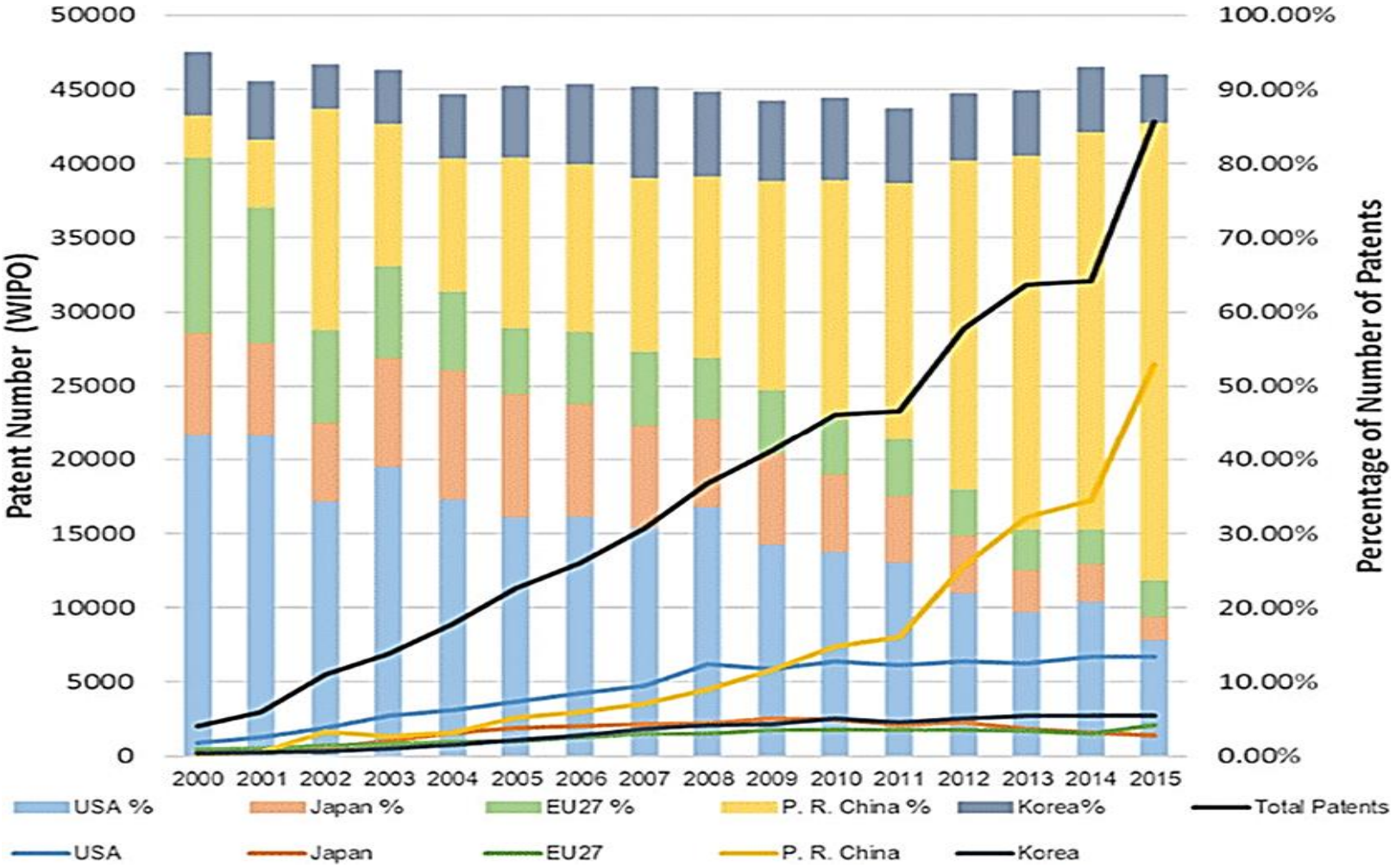
U.S. contribution fell from ~30% in 2005 to ~20% in 2018 (about -0.7% per year)

Nanotechnology Publications by Application Field and Region (2000-16)

	Total	Asia		EU-28 and EFTA		North America	
		Number	%	Number	%	Number	%
ICT	809,820	419,031	51.7	255,411	31.5	166,130	20.5
Manufacturing	286,447	158,468	55.3	84,476	29.5	51,245	17.9
Health	266,741	112,740	42.3	87,452	32.8	71,418	26.8
Energy	197,539	116,294	58.9	51,263	26.0	41,353	20.9
Photonics	112,378	56,012	49.8	36,215	32.2	29,711	26.4
Environment	66,100	28,683	43.4	21,595	32.7	14,915	22.6
Transport	22,803	8,767	38.4	9,090	39.9	6,353	27.9
Construction	21,648	7,124	32.9	8,651	40.0	4,042	18.7
	1,783,476	907,119	50.9	554,153	31.1	385,167	21.6

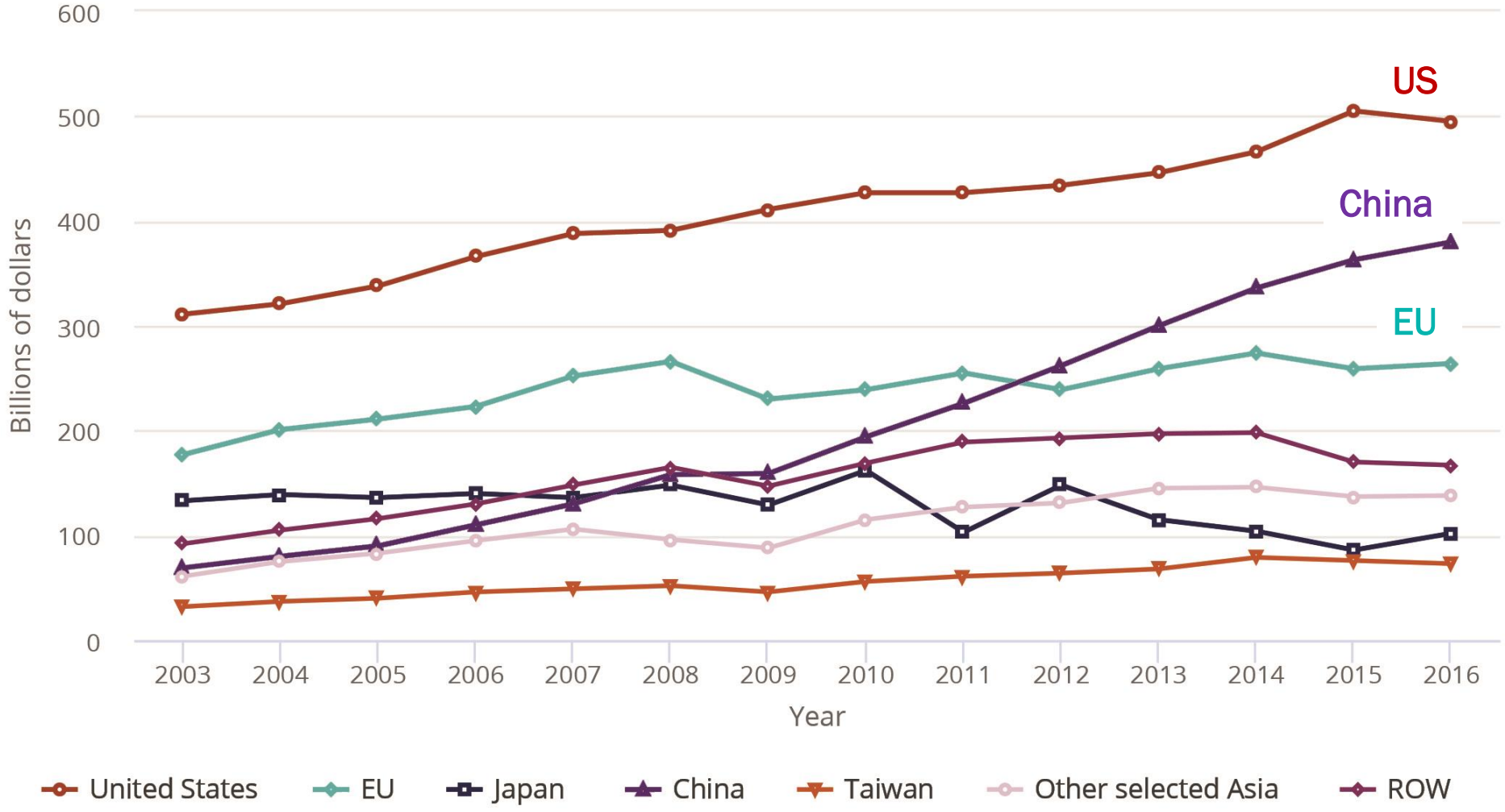
SOURCE: Data from European Commission, 2018, NanoData Landscape Compilation Update Report 2017, doi: 10.2777/031727, at https://op.europa.eu/en/publication-detail/-/publication/69470216-f1f6-11e8-9982-01aa75ed71a1/language-en/format-PDF/source-81483247, accessed 11/04/2019.

Rapid Global Shifts in Origin of Patents



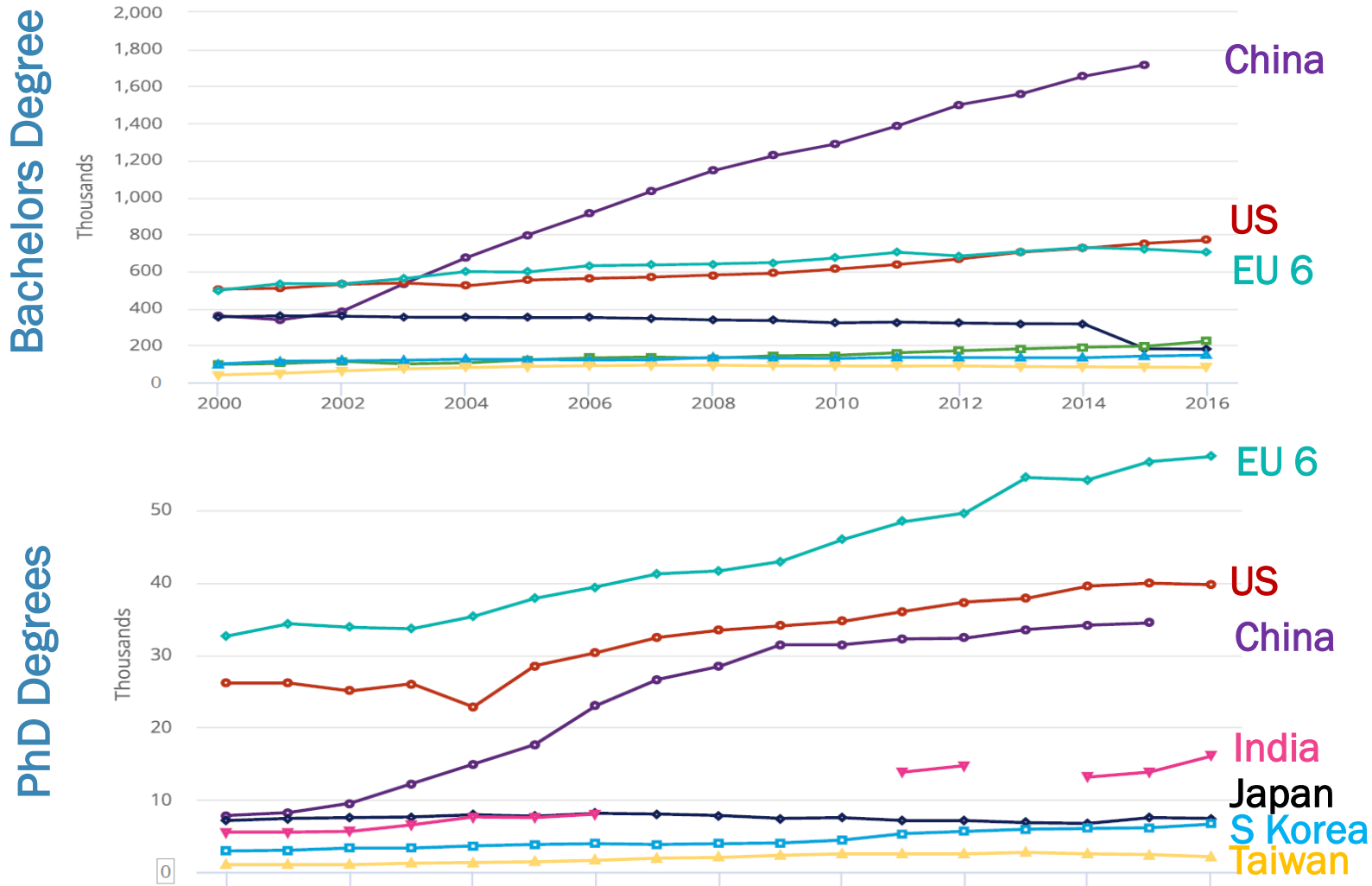
Global nanotechnology patents recorded in the WIPO data base, by lead author location. SOURCE: Reprinted by permission from Springer Nature: H. Zhu, S. Jiang, H. Chen, and M.C. Roco, 2017.

Output of high-technology manufacturing industries for selected regions, countries, or economies (2003 – 2016)



SOURCE: IHS Global Insight, World Industry Service database (2017) &National Science Board, 2018, *Science and Engineering Indicators.*

Degree awards in S and E fields by country or economy



SOURCE: National Science Board, Science & Engineering Indicators 2020, https://ncses.nsf.gov/indicators, Figs 3 and 4.

Concluding Remarks on the Global Nanotechnology R&D Ecosystem

The **US remains a competitor** in nanotechnology, but **no longer the unambiguous leader**.

Developed and emerging economies have implemented mechanisms that raise the scale and productivity of their programs:

- **Prolonged and focused support** of the most innovative **basic science research and technology development.**
- **Agile, and highly effective, coordination** among national and regional agencies to maximize the impacts on societal problems in recognized areas of strategic importance.
- **Integrated R&D efforts addressing societal challenges** that are highly interdisciplinary.
- Novel, highly effective, **coordination of research in disparate fields** has contributed significantly to the rapid rise of **new centers of leadership** outside the United States.
- **Promotion of government-industry partnerships**, to create and nurture national nanotechnology ecosystems, and to **speed the commercialization** of promising R&D.
- **Creation and maintenance of shared state-of-the-art nanotechnology infrastructure** that supports fundamental and applied science, commercialization of nanotechnology products, and development of nanotechnology-enabled systems and applications.
- **National educational and training policies** to promote the rapid growth of a highly trained and nanotechnology-skilled workforce.

Key findings and recommendations

1 – STRATEGIC ALIGNMENT WITH NATIONAL PRIORITIES

Finding 1.1:

The activities of the National Nanotechnology Initiative (NNI) and its current signature initiatives, while addressing relevant societal challenges, are not explicitly aligned with the current research and development (R&D) priorities established by the federal government.

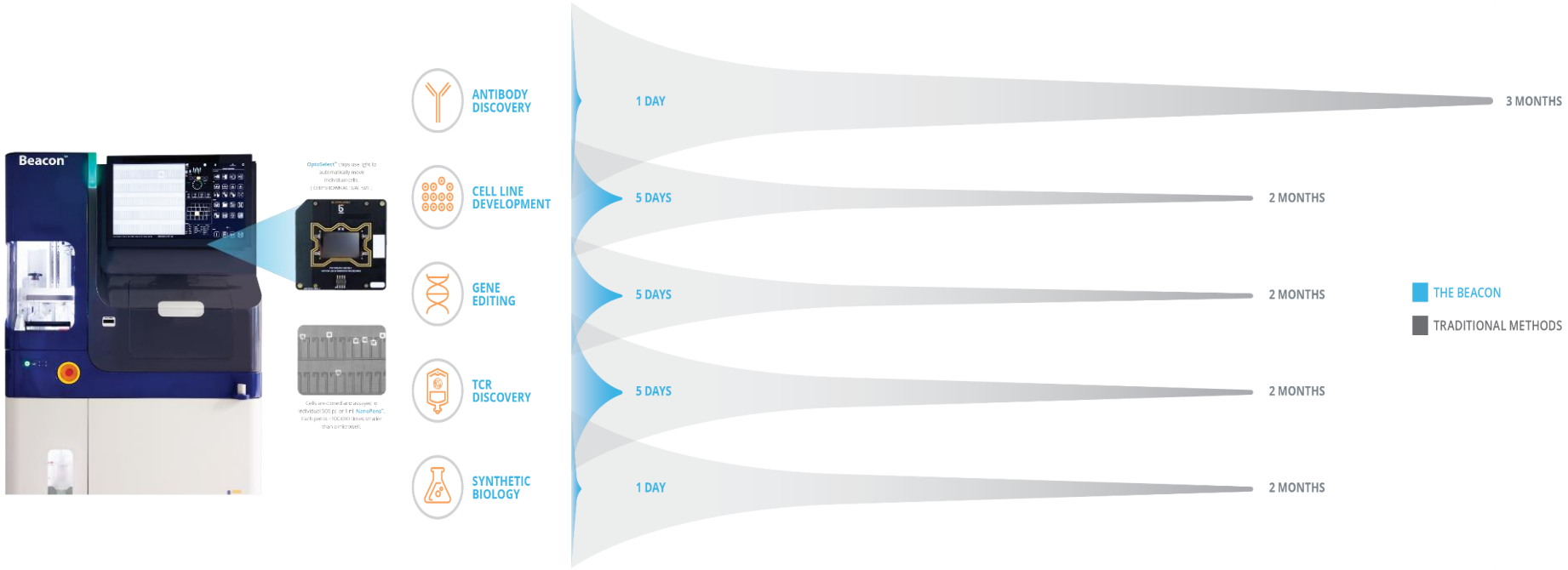
Finding 1.2:

The National Quantum Initiative (NQI) is, in large part, an important outgrowth of the National Nanotechnology Initiative (NNI), but the degree of coordination and collaboration between these national high-priority efforts is not yet clear.

Finding 1.3:

The goals of the Bioeconomy Initiative overlap with those of the National Nanotechnology Initiative (NNI) toward advanced manufacturing, creating an opportunity to leverage nanomanufacturing infrastructure and the coordinating relationships of the NNI in service of advancing the Bioeconomy Initiative.

An example of how nanotechnology contributes to national strategic R&D priorities – the Bioeconomy and COVID-19 Response



Images Courtesy of Berkeley Lights

Finding 1.4:

U.S. competitiveness in nanotechnology is slipping in some areas, putting U.S. economic prosperity and national security at risk.

Finding 1.5:

The United States is not investing significant resources in nanotechnology in ways that are as focused and strategic as in other nations.

Finding 1.6:

U.S. nanotechnology stakeholders report considerable challenges along the lab-to-market path for nanotechnology-based products.

Key Recommendation 1:

The Nanoscale Science, Engineering, and Technology (NSET) Subcommittee and the National Nanotechnology Initiative (NNI) agencies should **align the efforts of the NNI to** deliver responsible and sustainable nanotechnology-based solutions that address **the federal research and development (R&D) priorities**, which currently include security, artificial intelligence, quantum information sciences, manufacturing, bio-based materials, water, climate change, space travel, exploration, inhabitation, energy, medical innovations, and food and agriculture.

Implementation Recommendation 1a:

Convene multiagency coordination efforts to **align the National Nanotechnology Initiative (NNI) priorities with federal research and development (R&D) priorities**.

Implementation Recommendation 1b:

Facilitate ongoing close partnership and collaboration between the National Nanotechnology Initiative (NNI) and National Quantum Initiative (NQI) to minimize duplication of effort, maximize the utilization of existing infrastructure, and allow for cross-pollination of ideas across both initiatives.

Implementation Recommendation 1c:

Through the National Nanotechnology Coordination Office (NNCO) and interagency efforts, **align the National Nanotechnology Initiative (NNI) and the Bioeconomy Initiative** to leverage research and development (R&D) and coordination efforts on nanotechnology to strengthen the bioeconomy, including biotechnology, bio-based products, and sustainable bioproduction, including molecular assembly.

Implementation Recommendation 1d:

To address the need for closer coordination and agile refocus on strategic opportunities, the **NNCO should be adequately resourced to fully interact with NNI agencies** and hold those agencies accountable to the new plan.

2 – COMMERCIALIZATION OF NANOTECHNOLOGY

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A FEW KEY FINDINGS

- Other countries and regions have evolved their central nanotechnology research and development (R&D) efforts to incorporate a **strong emphasis on commercial translation**, yielding lab-to-market pathways that are accelerated relative to those in the United States. (Examples: EU Horizon 2020, Japan, China)

- Supporting knowledge **translation and technology transfer** has not been a sufficiently major focus of the National Nanotechnology Initiative (NNI) to date.

- **Data on the competitive status** of the United States with regard to nanotechnology implementation and commercialization is unavailable through the National Nanotechnology Initiative (NNI) public-facing digital portals.

- **Pilot and test-bed facilities** are a key part of lab-to-market and return-on-investment activities. The United States has not maintained a competitive position with this type of facility.

Key Recommendation 2:

The Nanoscale Science, Engineering, and Technology (NSET) Subcommittee and the National Nanotechnology Coordination Office (NNCO) should **strengthen and expand the lab-to-market innovation ecosystem** in support of the transfer of nanotechnologies from bench research to products, to ensure U.S. competitiveness.

2 – COMMERCIALIZATION OF NANOTECHNOLOGY

KEY IMPLEMENTATION RECOMMENDATIONS

- Implement effective coordination among the various national or regionally supported funding agencies to maximize the impacts of fundamental research to advance applications and solutions to societal problems in recognized areas of strategic importance.

- Develop a service model strategy to support commercialization activities so as to ensure that (1) nanoproducts are made in the United States whenever possible, (2) relevant skills and expertise are developed locally, (3) barriers to commercialization are identified quickly, and (4) the national return on investment (ROI) is maximized.

- Create appropriate data collection methods and a data repository to allow routine assessment of (1) the global status of nanotechnology, (2) new and emerging trends, and (3) the status and return on investment (ROI) of the National Nanotechnology Initiative (NNI) to be readily assessed. Ideally the data collection process should not become a significant burden on the researchers.

- Expand efforts to build a national community of National Nanotechnology Initiative (NNI) participants, and then leverage this community to improve access to national facilities, increase opportunities for collaboration, create public-private partnerships, and generate pathways for commercialization of products to global markets.

2 – COMMERCIALIZATION OF NANOTECHNOLOGY

KEY IMPLEMENTATION RECOMMENDATIONS (continued)

- Create a not-for-profit organization whose mandate is to connect National Nanotechnology Initiative (NNI) participants, industry, and academia through membership and provision of services such as ecosystem studies, national and international conferences, regional workshops, and turnkey missions for stakeholders to international trade shows abroad.

- Assess the value of establishing a Nano-Manufacturing Institute that would offer tools to and share expertise with small and medium-size enterprises (SMEs) to accelerate product development.

- Expand international collaborations on responsible development and manufacturing, with the European Union in particular, and other countries as appropriate, to ensure transparent global standards emerge to the benefit of consumers and U.S. industry.

- Leverage the recent Lab-to-Market Return-on-Investment (ROI) Initiative to accelerate nanotechnology commercialization.

- Enhance the training of competent nanotechnology professionals in entrepreneurship, technology transfer, and commercialization are essential to lab-to-market return on investment.

3 – NANOTECHNOLOGY INFRASTRUCTURE

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Finding 3.1: Other countries have followed U.S. lead and are investing heavily in nanotechnology infrastructure.

Finding 3.2: U.S. nanotechnology infrastructure is aging.

Finding 3.3: Easy-to-access infrastructure is key enabler for researchers and start-ups.

Finding 3.4: State-of-the-art infrastructure helps attract talent.

National Nanotechnology Coordinated Infrastructure

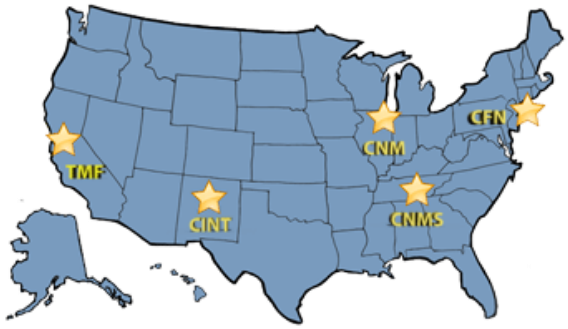
www.nnci.net

NCL Nanotechnology Characterization Laboratory

ncl.cancer.gov

U.S. DEPARTMENT OF ENERGY

Nanoscale Science Research Centers



nsrcportal.sandia.gov

NIST

CNST Center for Nanoscale Science & Technology

www.nist.gov/cnst

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China Nano Valley

www.nanopolis.cn/en/

NanotechJapan
Nanotechnology Platform

https://www.nanonet.go.jp/ntj

3 – NANOTECHNOLOGY INFRASTRUCTURE

Finding 3.5: U.S. nanotechnology infrastructure is lacking scale-up capabilities.

Finding 3.6: Non-U.S. micro/nanotechnology centers attract U.S. companies because of technology transfer capabilities.

Finding 3.7: Need to redesign and streamline resources for inventors to facilitate commercialization of Nanotechnology.

imec Belgium

www.imec-int.com

MINATEC® France

https://www.minatec.org/

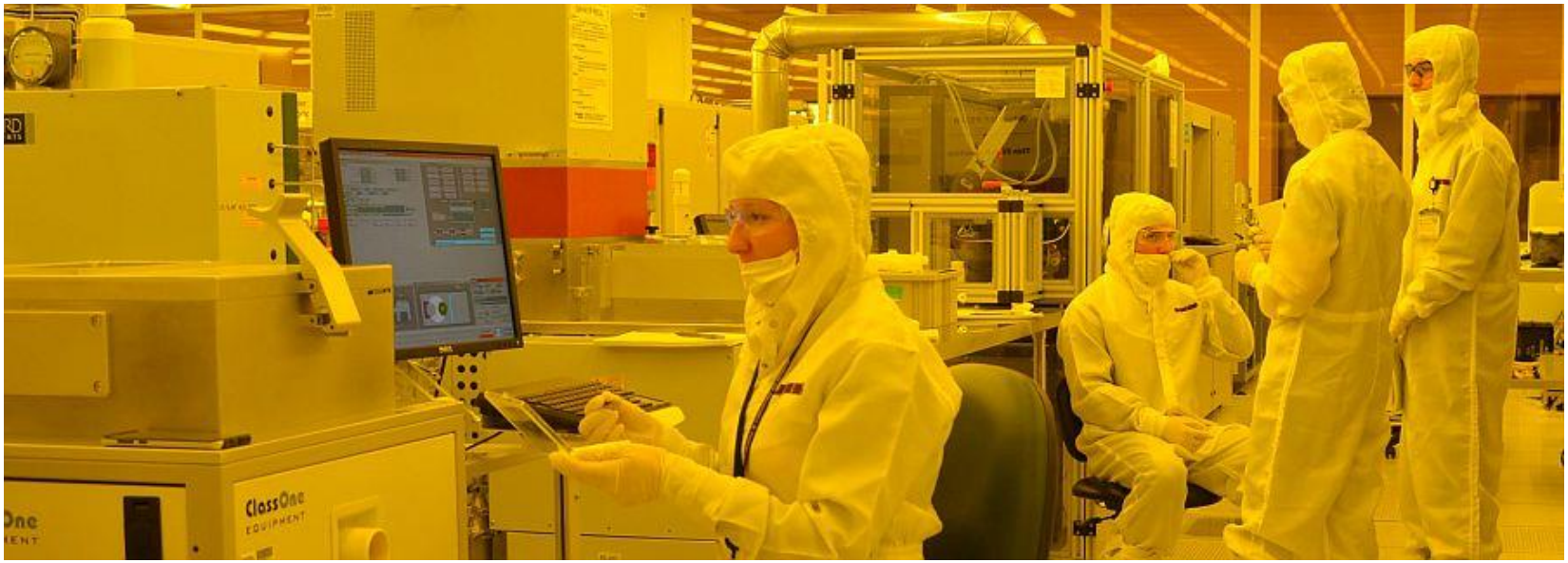
Key Recommendation 3:

New investments by the National Nanotechnology Initiative (NNI) agencies are required to **strengthen and renew the U.S. network of fabrication and characterization facilities** to retain international leadership. These investments should make readily available new tools, expertise, techniques, and processes to support fundamental research in existing and emerging areas, as well as prototyping and pilot/scale-up capabilities.

3 – NANOTECHNOLOGY INFRASTRUCTURE

Implementation Recommendation 3a:

The National Nanotechnology Initiative (NNI) agencies should **solicit and promote innovative approaches to transform models of access to, and modernization of, the nanotechnology infrastructure** to ensure U.S. leadership in lab-to-market outcomes. A whole-of-government approach is required to **develop more thoughtful, strategic, and effective approaches to accelerate technology transfer**. Effective collection of performance metrics is also needed. A mechanism for moving this activity forward is to appoint a responsible person from, for example, the Department of Commerce.



3 – NANOTECHNOLOGY INFRASTRUCTURE

Implementation Recommendation 3b:
National Nanotechnology Initiative (NNI) agencies/organizations should **develop programs that fund replacement of aging infrastructure (tools)** in addition to programs for new, state-of-the-art infrastructure.

4 – WORKFORCE DEVELOPMENT: GLOBAL VIEW ON COMPETITIVENESS

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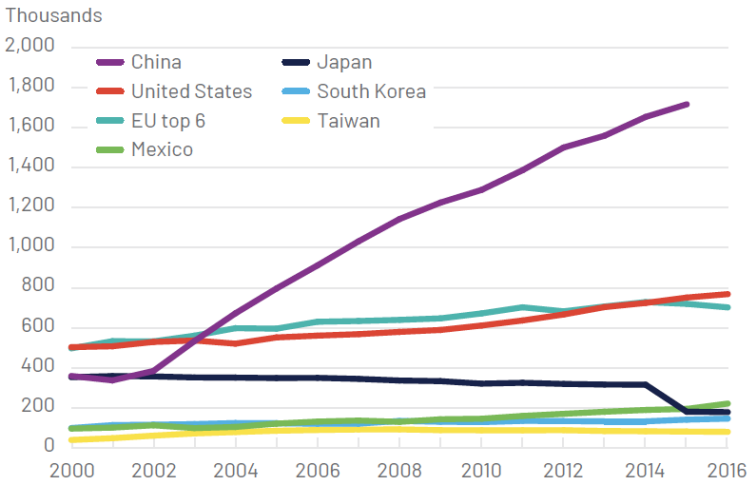
Finding 4.1: The United States is losing **global competitiveness** in recruiting international graduate students and in training science, technology, engineering, and mathematics (STEM) students at all levels.

Finding 4.2: The United States lacks an overarching strategy for **graduate student** recruitment and development to support nanotechnology advancement.

Figure 3. First university degrees in S&E, by selected region, country, or economy: 2000–16

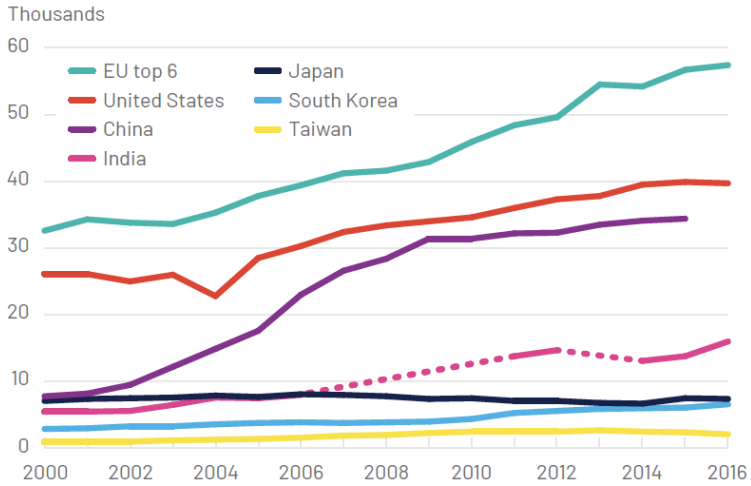


NOTES: EU top 6 is France, Germany, Italy, Poland, Spain, and the United Kingdom. Data are not available for all regions, countries, or economies for all years. See p. 22.

SOURCES: Educational statistics of OECD, Eurostat, MEXT (Japan), NBS (China), and MOE (Taiwan).

Indicators 2020: Higher Education

Figure 4. Doctoral degrees in S&E, by selected region, country, or economy: 2000–16



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Indicators 2020: Higher Education

2020 National Science Board

Key Recommendation 4:

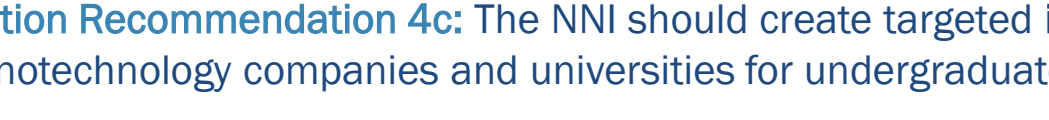
Nanoscience-supporting agencies should significantly **increase efforts to attract and train the best students** to studies in relevant nanoscience / nanotechnology science, technology, engineering, and mathematics (STEM) disciplines to ensure a diverse, **world-class** workforce to support our national interests and security, including via **public-private partnerships** that support student fellowships.

4 – WORKFORCE DEVELOPMENT: GLOBAL VIEW ON COMPETITIVENESS

Implementation Recommendation 4a: NNI agencies, such as the National Science Foundation, should seed the creation of undergraduate certificate programs in **entrepreneurship** in partnership with universities.

Implementation Recommendation 4b: The NNI agencies should increase and sustain the number of Research Experiences for Undergraduates (REU) programs focused on **nanoscience and nanotechnology**.

Implementation Recommendation 4c: The NNI should create targeted **internship** programs between nanotechnology companies and universities for undergraduate and graduate students.

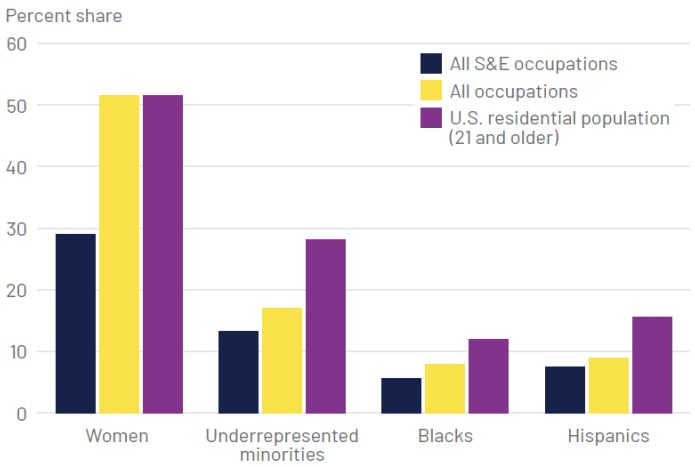


4 – WORKFORCE DEVELOPMENT: GLOBAL VIEW ON COMPETITIVENESS

Implementation Recommendation 4d: NNI agencies should foster models that create **teams** of nanotechnology graduate students, **business school students**, and private sector stakeholders to advance **interdisciplinary** training in support of accelerated U.S. **lab-to-market** outcomes.

Implementation Recommendation 4e: The NNI should expand the diversity of STEM students by gender, age, and ethnicity to greatly increase the nanotechnology workforce.

Figure 6. Women, underrepresented minorities, blacks, and Hispanics in S&E and all occupations: 2017

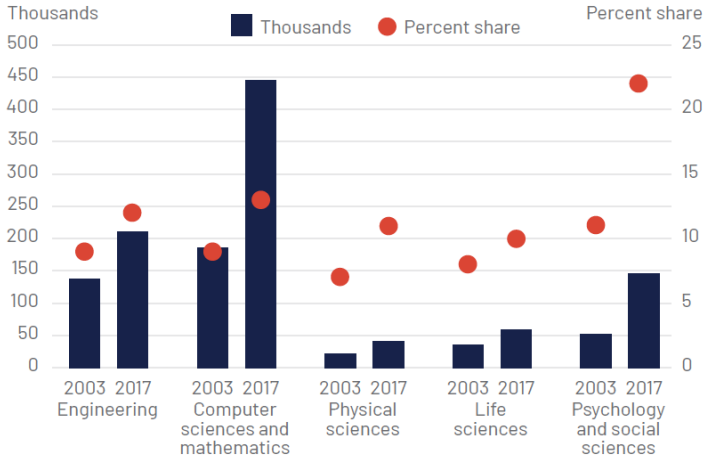


NOTES: Underrepresented minorities includes individuals who are black, Hispanic, or American Indian or Alaska Native. The S&E and all occupations data are for those with a bachelor's degree and above. The U.S. residential population data are for those at all education levels.

SOURCES: NCSES, 2017 NSCG; Census Bureau, 2017 ACS.

Indicators 2020: Labor Force

Figure 8. Underrepresented minorities in S&E occupations, by broad occupational category: 2003 and 2017



NOTE: Underrepresented minorities includes individuals who are black, Hispanic, or American Indian or Alaska Native.

SOURCES: NCSES, 2003 SESTAT and 2017 NSCG.

Indicators 2020: Labor Force

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5 – STRUCTURE AND MANAGEMENT

Key Recommendation 5:

The **National Nanotechnology Initiative (NNI)**, through the Nanoscale Science, Engineering, and Technology (NSET) Subcommittee and the National Nanotechnology Coordination Office (NNCO), **should continue to perform its important coordinating role.** The NNCO should be **adequately resourced and appropriately staffed** to deliver an agile and globally competitive nanotechnology program. The work of the NNCO should also be augmented through **expanded collaborations** with not-for-profit organizations and by establishing new **public-private partnerships.**

5 – STRUCTURE AND MANAGEMENT

Implementation Recommendation 5a: The National Nanotechnology Initiative (NNI) should signal to all stakeholders that it is refocusing its efforts through a renaming or rebranding that captures the revised priorities recommended in this report.

Implementation Recommendation 5b: The Office of Science and Technology Policy (OSTP) should evaluate the current budget level and funding mechanism with consideration to the expanded role of the National Nanotechnology Coordination Office (NNCO) and provide specific guidance through the Office of Management and Budget (OMB) to modify the level of flow through funding from participating agencies to ensure that the NNCO has the resources necessary to execute its responsibilities on behalf of the Nanoscale Science and Technology (NSET) Subcommittee.

Implementation Recommendation 5c: Nanoscale Science and Technology (NSET) and the National Nanotechnology Coordination Office (NNCO) should actively leverage the Nanotechnology Signature Initiative (NSI) mechanism to focus and coordinate agency work and funding on activities such as technology transfer or training.

Implementation Recommendation 5d: Nanoscale Science and Technology (NSET) should coordinate with grants.gov (or other federal research and development reporting avenues) to develop mechanisms to collect and present accurate, current performance data on the outcome of the National Nanotechnology Initiative (NNI) research and make clear to all, including to the researchers involved, what research is part of the NNI.

Conclusions

A VISION FOR THE FUTURE OF THE NNI

The report Recommendations identifies these three priorities for shaping the future of the NNI:

Priority 1. The NNI should improve ***alignment with the stated national priorities for R&D*** and ***focus on strategically selected*** environmental and other societal challenges.

Priority 2. The NNI should ***partner broadly*** to improve the ***efficiency of translation*** of nanoscience/nanotechnology research and development into economic, environmental, security, health, etc., (i.e. societal) benefits.

Priority 3. The NNI should expand the nation's nanotechnology ecosystem via increased ***recruitment*** and ***training*** of future scientists and engineers, with an intentional focus on accelerated technology translation, and with robust investments in ***next-generation infrastructure*** to support both basic science and commercialization.

Thanks for listening!

This report has also been briefed to
NNCO, OSTP, the NNI agencies, and the Hill

We now move to Q&A
please type in any questions

The report can be found at:
NAP.EDU/25729