Compete.
Council on Competitiveness

# The 2025 State of Competitiveness: A New Age of Disruption and Discontinuity

In the release of *Competing in the Next Economy: Innovating in the Age of Disruption and Discontinuity*, the Council on Competitiveness' flagship initiative, the National Commission on Innovation and Competitiveness Frontiers, argued "the convergence of technologies—from artificial intelligence to quantum science and computing, advanced nuclear, robotics, and advanced biology—is accelerating innovation, reshaping traditional business models, spawning new industries, and fundamentally redefining the world order." Building from this foundational argument, the Commission's report includes 55 recommendation, organized under seven pillars of innovation—all aimed at dramatically enhancing U.S. productivity, living standards, and national security.

This white paper offers a snapshot of the state of U.S. competitiveness and the increasingly global competitive landscape. This white paper also serves as an annex to the *Competing in the Next Economy: Innovating in the Age of Disruption and Discontinuity* report.

While the recommendations in the *Competing in the Next Economy* report were developed through extensive discussions, debates, and collaborative efforts conducted between 2022 and 2024—encompassing two Commission summits, numerous Working Group meetings, and the contributions of more than 50 National Commissioners and hundreds of leaders from across geographies and domains—the Council undertook significant additional research and analysis to provide data and insights that shaped the report's recommendations. Through this research, which have been distilled into this white paper, the Council and its National Commission confidently posit the world has entered a new age of innovation; one driven by disruption and discontinuity.

## Mega Trends and Drivers Shaping the U.S. Future

Since the National Commission on Innovation and Competitiveness Frontiers released *Competing in the Next Economy* and its call to action in 2020:

- The technology and competitive landscape has shifted radically along numerous dimensions
- Change is accelerating at an unprecedented pace
- The United States faces its strongest challenger ever in the competitiveness arena, and
- The nation–in fact, the world–has entered unknown territory brought about by a major technological discontinuity, creating great uncertainty about the future with implications difficult to understand.

The convergence of these disruptive changes has brought about a powerful duality—the promise of heretofore unimaginable opportunity, balanced against an unprecedented shake-up in the world order.

Rapid technological advancement is defining and reshaping this new age and world order. Amid multiple technology revolutions and their convergence, the United States is challenged across the technology landscape like never before. A geostrategic competitor seeks to unseat us and undermine the current world order with overmatch in the key technologies of the future, eroding our economic competitiveness, military superiority, and geopolitical leadership. More than anything else, winning the competitive challenge for the future, defending the current world order, and our global leadership rest with the strength of our ability to innovate with speed and at scale.[1]

# SECTION A

## Technology Takes Center Stage in the Economy, National Security, Geopolitics, and Society

**Ensuring U.S. leadership in critical technologies has risen to the top of the nation's connected economic, national security, and geopolitical agendas. These revolutionary technologies include advanced digital and telecommunications technologies, bio and agrotechnology, the ever-mounting data tsunami, hypersonics, autonomous systems, quantum, and artificial intelligence. These technologies are reshaping and driving the global economy and competitiveness landscape. They are also the platforms from which the industries of the future are now arising. The dual-use nature of these emerging technologies makes it more difficult than ever to separate commercial and security interests in trade and investment.**

**The Age of AI has suddenly arrived, with the hallmarks of a discontinuity.** It is poised dramatically to transform the relationship between humans and machines, rewrite the scientific process, shatter the time and cost calculus for an array of human endeavors, drive innovation, super-charge the forces of creative destruction, propel a leap in productivity, and drastically alter military capabilities and the character of war.

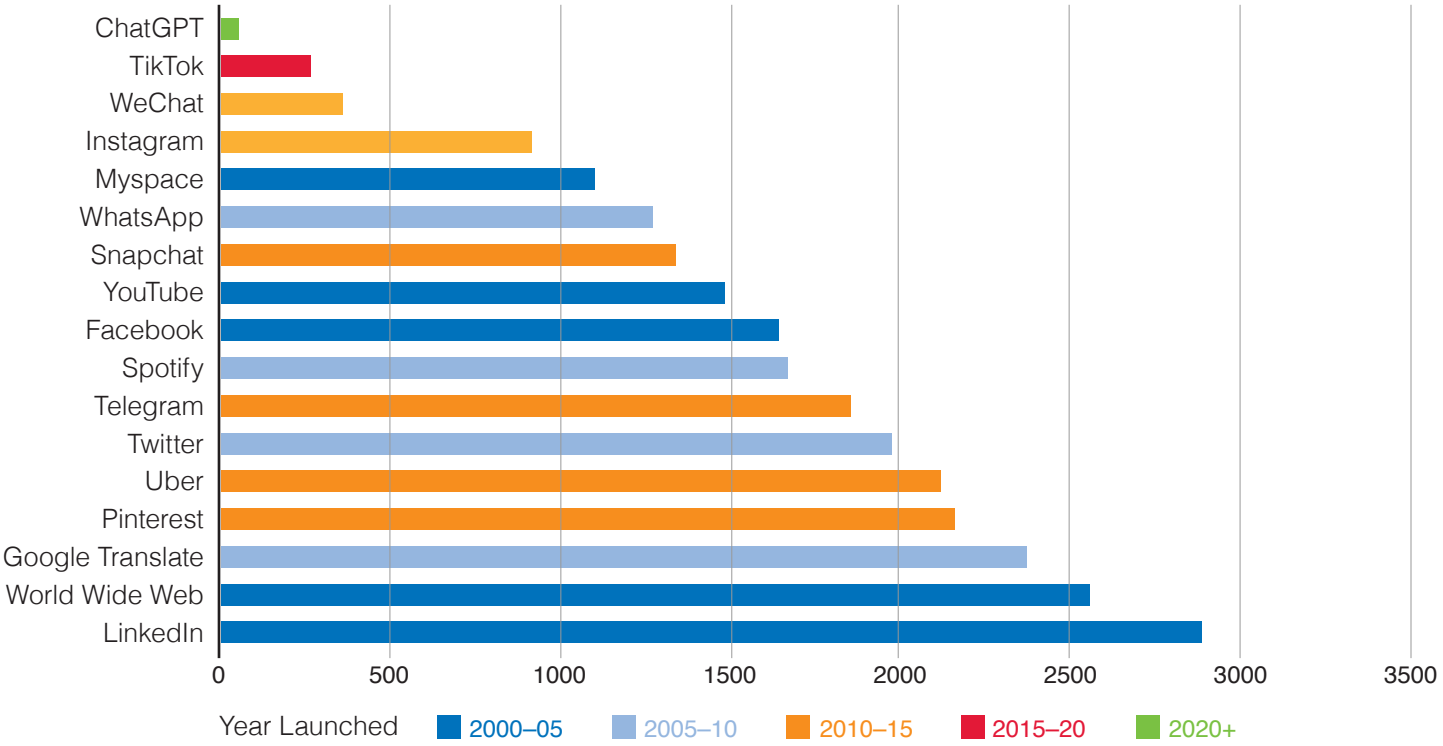
In 2023, a powerful generative AI model—ChatGPT—was released to the public, scaling faster than any technology in history. It reached 1 million users in 5 days, and 100 million users in two months.[2]

1 Quotes in this report are drawn from leaders who participated in Council on Competitiveness and National Commission fora including: the 2022 and 2023 National Competitiveness Forum, 2023 Summer Meeting of the National Commission on Competitiveness Frontiers, 2023 National Commission Phase 2 Launch Summit, and 2024 Competitiveness Conversations Across America.

2 ChatGPT Sets Record for Fastest-Growing User-base—analyst note, Reuters, February 2, 2023.

## Digital Platform Years to Reach 100MM Users

Source: Company Filings, Press, Netflix represents streaming business.




Since then, more generative AI models have been released, they are improving at a rapid pace, new text-to-image and text-to-video models are spreading. Search engines are integrating generative AI into smart phones, laptops and desktops used by billions of people worldwide, and these AI models are rapidly integrating into the economy.

AI is different than previous general purpose enabling technologies such as the steam engine, computer, and even the Internet. AI will apply to a broad range of cognitive tasks, has the potential to operate independently from humans, has the capacity for self-improvement, and, since it can generate and test ideas, it could increase productivity in research and innovation.[3]

In addition, the convergence of AI with other enabling technologies—such as biotechnology, advanced manufacturing, autonomous systems, and advanced computing—holds significant potential for opening a new age of discovery and innovation frontiers, new models of production, a flow of new products, personalized medicine, and novel solutions to global problems, creating significant economic benefits, strengthening national security, and driving productivity gains.

For example (see Appendix 2., **AI's Transformational Potential,** for a deeper exploration of the effects of AI on everyday life and work):

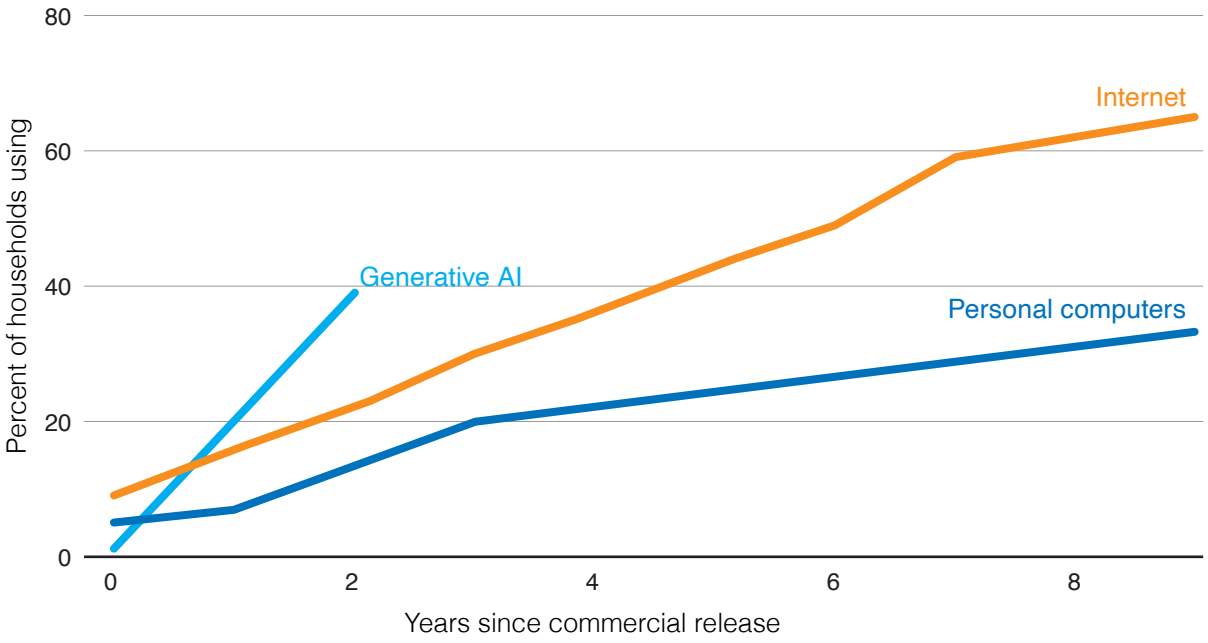
- **AI is set to fundamentally transform the healthcare industry by significantly accelerating drug development and enhancing diagnostic accuracy.** The Food and Drug Administration has already approved more than 800 AI/ML devices,[4] and the number of AI-discovered drugs in clinical trials

3 The Impact of Artificial Intelligence on Productivity, Distribution, and Growth, OECD 2024.

4 Testimony of Patrizia Cavazzoni, M.D., et.al, Food and Drug Administration before the Subcommittee on Health, Committee on Energy and Commerce, U.S. House of Representatives, May 22, 2024.

## Household Adoption Rates of Digital Technologies in the United States

Source: International Energy Agency.




has surged from 17 in 2020 to 67 in 2023,[5] exemplifying its rapid integration and impact within the sector. For example, using AI, a firm took just 18 months and $3 million to identify a drug candidate for treating pulmonary fibrosis, a process that normally would have taken $430 million out of pocket expenses and 3-6 years.[6]

- **AI is revolutionizing materials development by rapidly identifying and simulating millions of materials for specific applications, drastically reducing the time required for discovery.** For example, a collaboration between the Pacific Northwest National Laboratory and a leading software company analyzed over 32 million inorganic materials and identified 18 promising candidates for batteries in under 80 hours, a task that traditionally might have taken years.[7]
- **AI text-to-image and text-to-video technologies are transforming the creative industries** by providing powerful, accessible tools that allow creators to generate content rapidly and cost-effectively. In just 20 seconds, developers can create first drafts of music and lyrics using simple text prompts,[8] while the rapid proliferation of AI-generated images—tens of billions posted online[9]—highlights the scale of this shift. However, this democratization of creativity also raises important ethical concerns, including issues related to deepfakes and intellectual property rights.

5 How Successful are AI-discovered Drugs in Clinical Trials? A First Analysis and Emerging Lessons, Madura KP Jayatungo, et.al, Drug Discovery Today, Vol. 29, Issue 6, June 2024.

6 From Start to Phase 1 in 30 Months: AI-discovered and AI-designed Anti-fibrotic Drug Enters Phase 1 Clinical Trial, Insilico Medicine, press release, February 24, 2022.

7 Accelerating Computational Materials Discovery with Artificial Intelligence and Cloud High-Performance Computing: From Large-scale Screening to Experimental Validation, Chi Chen, et.al., Azure Quantum, Microsoft, Pacific Northwest National Laboratory, January 8, 2024.

8 Why Musicians are Smart to Embrace AI, Washington Post, August 27, 2024.

9 AI is Outrageous-and Wonderful. It's Also Prompting a New Art Form, Washington Post, January 7, 2024.

- **AI has the potential to significantly boost productivity.** For example, researchers at MIT found that AI technology reduced the time needed to complete mid-level writing tasks—common in marketing, consulting, and management—by 37 percent, compared to a control group.[10] Software developers using AI tools completed tasks 56 percent faster. Looking over several recent estimates, generative AI has positive effects on worker performance from 15 percent to 56 percent across different tasks.[11] Top economists estimated that output could nearly double after 20 years from an AI-enabled productivity growth rate 44 percent higher than baseline projections of the U.S. Congressional Budget Office.[12]
- **AI is increasingly integrated into the education system,** with about half of K-12 and undergraduate students now using AI tools. The increased productivity from AI could lead to lower education costs and improved outcomes, making it a key consideration for state and local leaders aiming to educate more students within existing budgets.

**AI is poised to disrupt the job market significantly,** potentially affecting nearly 40 percent of jobs globally, with advanced economies potentially seeing up to 60 percent impacted due to their cognitively intensive workforce.[13] Large numbers of workers are likely to be exposed to AI, including those who perform non-routine tasks in high skilled occupations that previously have never been threatened by automation.[14]

"Think about being able to type something into a phone or laptop. (AI) will create a video from scratch, out of thin air…So, the cost for someone (working on) a video game or piece of music… goes down low enough that you can do it with an iPhone, instead of (investing) millions and millions of (development) dollars."

**Tom Mildenhall**
Global Head of Technology Partnership Development
Bank of America

**The United States is positioned as the global AI leader,** developing 73 percent of foundational AI models since 2017 and releasing 61 notable machine learning models in 2023 compared to just 15 from China.[15] U.S. investment in AI far exceeds that of other countries, with an estimated $67.2 billion in private funding in 2023, significantly higher than the EU/UK's $11 billion and China's $7.8 billion.[16] Additionally, 61 percent of venture capital funding among the top 1,000 AI startups globally is allocated to U.S. companies.[17]

**The lines between commercial technology, and national security and defense technology have all but disappeared.** Game-changing, dual-use technologies and tech-enabled concepts like AI, ML, autonomy, next-generation communications, biotech, etc. are reshaping the

10 Experimental Evidence on the Productivity Effects of Generative Artificial Intelligence, Shakked Noy and Whitney Zhang, Working Paper, Massachusetts Institute of Technology, March 2, 2023.

11 The Impact of Artificial Intelligence on Productivity, Distribution, and Growth, OECD 2024.

12 Machines of the Mind, The Case for a n AI-powered Productivity Boom, Martin Neal Baily, Erik Brynjolfsson, and Anton Korinek, Brookings, May 10, 2023.

13 Gen-AI: Artificial Intelligence and the Future of Work, International Monetary Fund, January 2024.

14 ibid.

15 ibid.

16 Artificial Intelligence Index Report 2024, Stanford University Institute for Human-Centered Artificial Intelligence, 2024.

17 Forge Ahead or Fall Behind, Why We Need a United Europe of Artificial Intelligence, CEPS Explainer, CEPS, 2023.

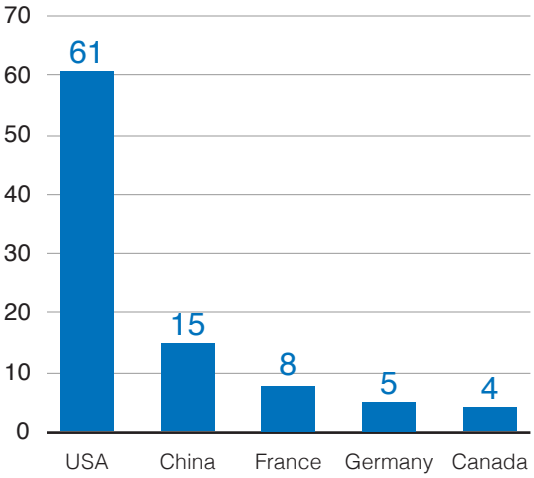
U.S. industrial base writ large—as well as, more narrowly, U.S. defense capabilities. Leadership in many of these dual-use technologies is in commercial firms, high-tech start-ups, universities, and national laboratories. The Department of Defense and defense primes must reach into innovating commercial firms, small businesses, and start-ups to bring advanced technologies to military systems. But the commercial sector is moving so fast, and the investments are so big, the defense industry cannot keep up.

While amazing technology is being developed across the whole U.S. innovation ecosystem, it can take years for it to have its intended impact for national security. Recently, the U.S. Government Accountability Office found that the Department of Defense continues to struggle with delivering innovative technologies quickly. Recent reforms were intended to lead to faster results, but slow, linear development approaches persist. GAO found that leading commercial companies deliver complex, innovative products with speed through iterative cycles of design, development, and production. But the average major defense acquisition program (MDAP) yet to deliver initial capability plans to take over 10 years to do so. Cycle time is increasing. GAO found that, for MDAPs that have delivered capability, the average amount of time it took to do so increased from 8 years to 11 years—an average increase of 3 years from their original planned date.[18]

**The federal government's role in research, technology, and innovation is changing, moving downstream in the innovation process, but diminishing in the nation's R&D portfolio as private sector R&D investment increases.**

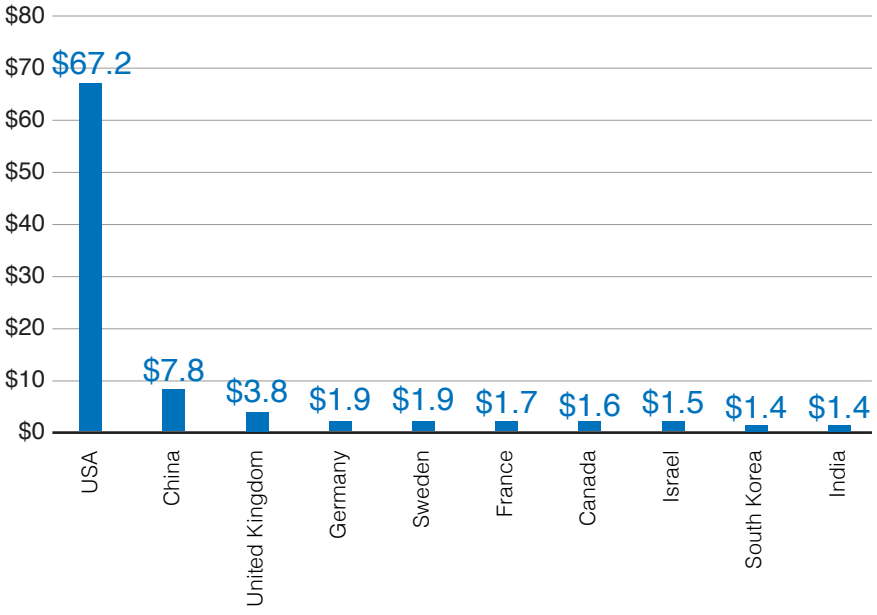
## Notable Machine Learning Models (2023) by Country

Source: 2024 Stanford AI Index Report, Epoch, 2023




## AI Private Investment (2023) by Goegraphic Area ($B)

Source: 2024 Stanford AI Index Report, Quid, 2023




18 Weapon Systems Annual Assessment, DOD Is Not Yet Well-Positioned to Field Systems with Speed, Government Accounting Office, June 2024.

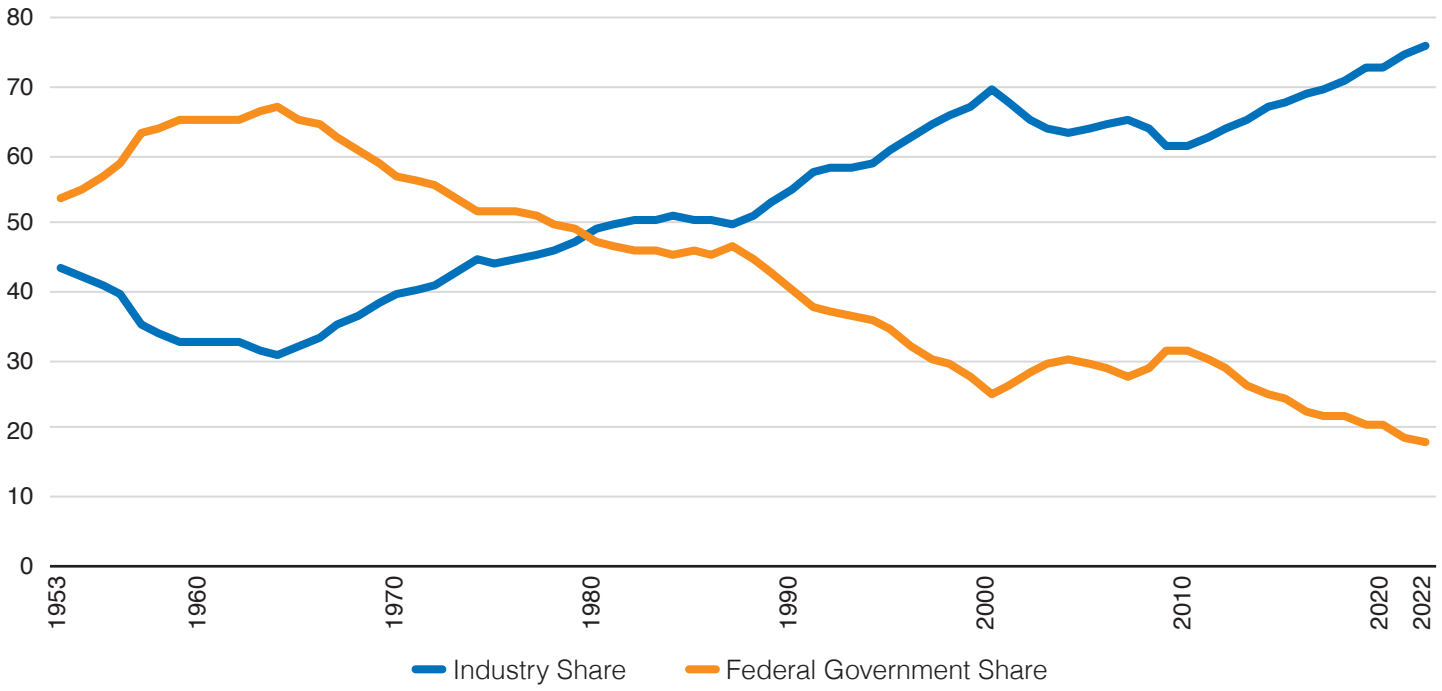
The federal government continues to target research and innovation in critical and emerging technologies and industries of the future. These include: trustworthy artificial intelligence, quantum information science, advanced communications, microelectronics, nanotechnology, high-performance computing, biotechnology and biomanufacturing, robotics, advanced manufacturing, financial technologies, undersea technologies, and space technologies. Research and technology to address the climate crisis is a high priority. And government has increased the focus of research and innovation on addressing social challenges such as health and inequity, and expanding participation in the science, engineering, and innovation enterprise, with an emphasis on emerging research institutions and historically underserved communities. It has also made investments aiming to bridge the so-called Valley of Death, for example, funding an extension of Phase II Small Business Innovation Research program grants, and providing funding for prototype development and pilot demonstrations.

In addition, the National Science Foundation's mission was expanded. The CHIPS and Science Act established a new NSF Directorate on Technology, Innovation and Partnerships. In this historic expansion of its mission, NSF is charged with driving technology development, innovation, and growth of regional innovation ecosystems.

The federal government has also taken a large role in funding the establishment and growth of hubs in clean energy, a range of critical technologies, and microelectronics.

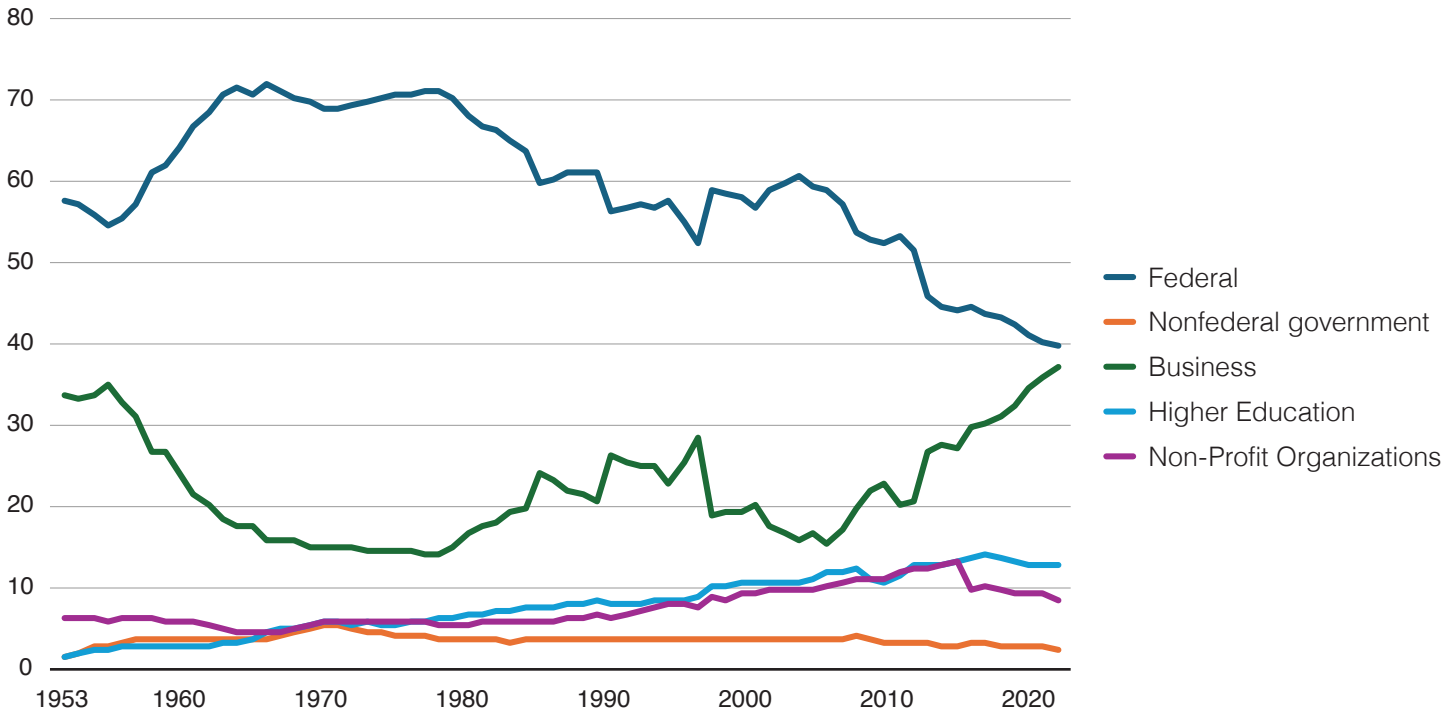
## Federal Government and Business Share of U.S. R&D Investment

Source: National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2021–22 edition). Science and Engineering Indicators



## U.S. Basic Research Expenditures, by Source of Funds: 1953–2022

Source: National Center for Science and Engineering Statistics, National Patterns of R&D Resources (annual series).




However, the private sector's dominant share of U.S. R&D investment continues to grow and diminish the federal government's place in the nation's overall R&D portfolio. In 2009, the private sector accounted for 61.2 percent of U.S. R&D investment and the federal government's share was 31.2 percent. By 2022, the private sector's share had grown to 76 percent, and the federal share had dropped to 18 percent. The National Science Foundation estimates 2022 total U.S. investment in R&D at $886 billion of which the private sector accounts for $673 billion, and the federal government for $160 billion.

Businesses now play a significant role in U.S. basic research, funding 37 percent ($48 billion) and performing 36 percent ($46 billion) of it, while universities perform 45 percent ($58 billion) and the federal government funds 40 percent ($51 billion).[19] Drilling down, a significant portion of private sector basic research investment is accounted for by the U.S. pharmaceutical and medicines industry. In the latest available data, that industry spent $17.3 billion on basic research in 2021, approaching the basic research investment made by the U.S. Department of Health and Human Services of $21 billion.[20]

Critically, the United States must not lose its historically significant role in funding basic research. This has been the seed corn for all major innovation. Concern is mounting that without a rebalancing of effort, the nation may not be as poised in the coming decades to lever significant basic research contributions.

19 National Patterns of R&D Resources, National Science Foundation, January 2024; Analysis of Federal Funding for Research and Development in 2022: Basic Research, National Center for Science and Engineering Statistics, National Science Foundation, August 15, 2024.

20 Table 12. Domestic R&D Paid for by the Company and Others and Performed by the Company, by Type of R&D, Industry, and Company Size: 2021, Business Enterprise Research and Development Survey, National Center for Science and Engineering Statistics, National Science Foundation; Table 18-1. Federal Research and Development Spending, Analytical Perspectives, Budget of the U.S. Government, Fiscal Year 2023, Office of Management and Budget.

## SECTION B

### New Opportunities and Rising Risks in Industry

**The U.S. industrial landscape and manufacturing are undergoing significant shifts driven by rising geopolitical risks and the need for self-sufficiency in critical materials and goods, for example, in microelectronics and clean energy. The CHIPS and Science Act of 2022 allocated $50 billion to enhance domestic semiconductor manufacturing, while increasing attention is being paid to re-shoring key mineral sources due to rising threats around supply chains for critical goods, materials, and minerals—a threat to the U.S. economy, society, and ability to develop and deploy technologies.**

**The threat to U.S. supply chains is multidimensional ranging from geopolitical risks and extreme weather to local disease outbreaks and disruption in goods transport. In addition, the Chinese leadership has expressed "intentions to increase global supply chain dependencies on China to control key supply chains and be able to use those supply chain dependencies to threaten and cut off foreign countries during a crisis."[21]**

**In addition to semiconductors, other high-tech sectors are evolving, growing, and reshoring within U.S. borders. For instance, the United States is poised for significant expansion of the bioeconomy, driven by technological advancements that will have far-reaching effects on domestic commodities, manufacturing processes, and consumer products and behavior, while also helping secure supply chains and improve sustainability. Similarly, the space industry is undergoing rapid transformation in the United States, fueled by innovations from private companies, which are redefining satellite launches and enhancing space exploration capabilities, space tourism, material science, and space-based communications.**

**Rising geopolitical risks have given strong momentum to repatriating the manufacturing of critical technologies back to the United States, particularly microelectronics.** The CHIPS and Science Act, passed in 2022, appropriated $50 billion for: financial assistance to establish semiconductor fabrication, assembly, testing, advanced packaging, or R&D in the United States; a new National Semiconductor Technology Center; a National Advanced Packaging Program; microelectronics metrology research; and ManufacturingUSA institutes on semiconductor manufacturing. Two-hundred million was provided for workforce education and training, $2 billion for a Department of Defense National Network for Microelectronics Research and Development, and $500 million for international technology and supply chain security and innovation activities.

**The United States is significantly or entirely dependent on non-domestic sources of several key minerals critical for high-tech applications and clean energy technologies.** In some cases, the United States is dependent on China, including for more than 95 percent of rare earths it consumes. This dependency has increased attention to ways to re-shore, forge partnerships with allies, develop alternatives, and resume sustainable mining to ensure access to critical minerals.

The transition to clean energy and vehicle electrification has driven significant increases in the demand for critical minerals. The market for key energy transition minerals doubled over the past five years, reaching $320 billion in 2022, broadly similar to the market size for iron ore mining. From

21 Annual Threat Assessment of the U.S. Intelligence Community, Office of the Director of National Intelligence, February 6, 2023.

## Select Critical Minerals With High Tech Applications 2023

Source: Minerals Commodity Summaries 2024, U.S. Geological Survey

| Critical Mineral | Applications | U.S. Net Import Reliance as a Percentage of Apparent Consumption | Primary Import Source (2019-2022) | Leading Producing Country |
|---|---|---|---|---|
| Arsenic | Pesticides, semiconductors | 100 | China | Peru |
| Cobalt | Batteries, metallurgy | 67 | Norway | Congo (Kinshasa) |
| Fluorspar | Cement, industrial chemicals, metallurgy | 100 | Mexico | China |
| Gallium | Integrated circuits, optical devices | 100 | Japan | China |
| Germanium | Defense, fiber optics | >50 | Belgium | China |
| Graphite | Batteries, fuel cells, lubricants | 100 | China | China |
| Indium | Liquid crystal displays | 100 | Republic of Korea | China |
| Nickel | Batteries, metallurgy | 57 | Canada | Indonesia |
| Rare Earths | Fiber optics, lasers, optical amplifiers, batteries, nuclear control rods, medical imaging, metallurgy, permanent magnets, catalysts, electronics, aerospace alloys, solid state devices, data storage devices | >95 | China | China |
| Scandium | Ceramics, fuel cells, metallurgy | 100 | Japan | China |
| Tantalum | Capacitors, metallurgy | 100 | China | Congo (Kinshasa) |
| Yttrium | Catalysts, ceramics, lasers | 100 | China | China |

2017 to 2022, demand from the energy sector drove a tripling in overall demand for lithium, a 70 percent jump in demand for cobalt, and a 40 percent rise in demand for nickel. In 2022, the share of clean energy applications in total demand reached 56 percent for lithium, 40 percent for cobalt and 16 percent for nickel, up from 30 percent, 17 percent, and 6 percent, respectively, five years ago. Demand is expected to increase significantly, potentially doubling by 2030 and more than tripling by 2050. That growth could occur much faster if the energy transition accelerates.[22]

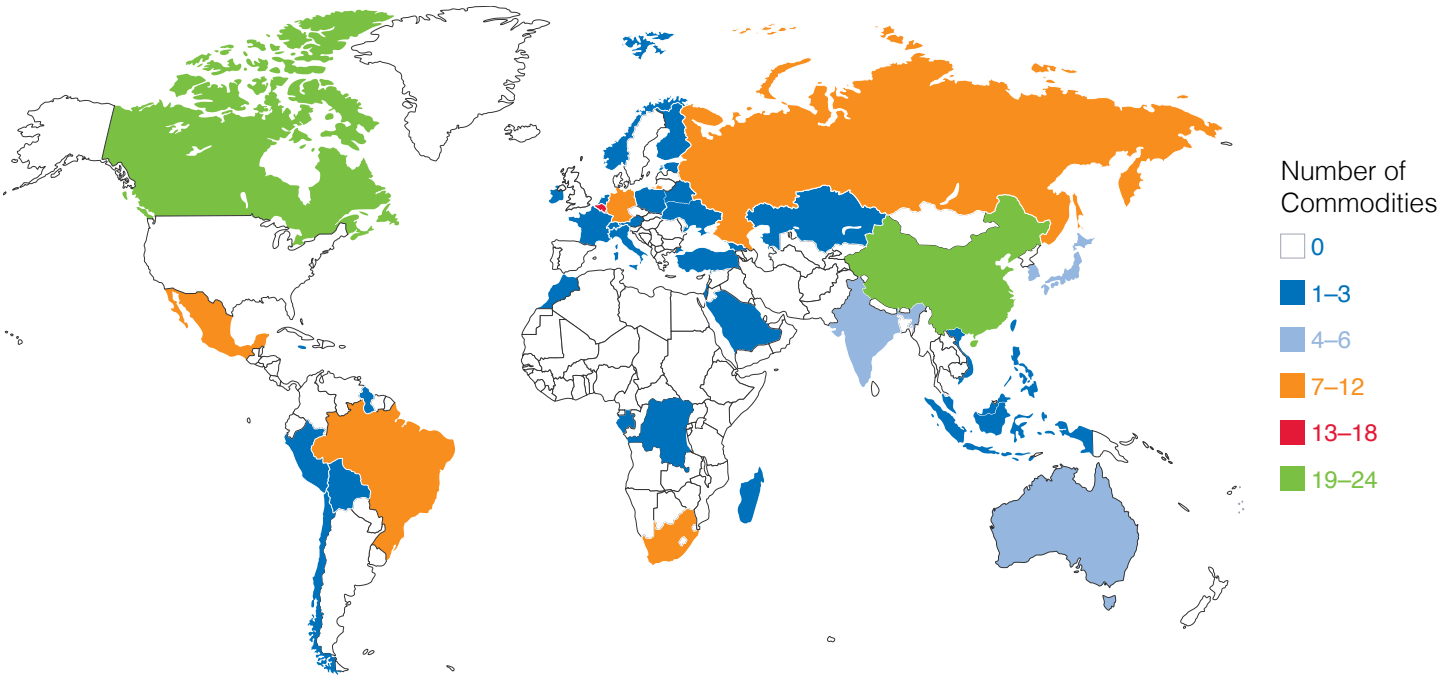
China is reaching out around the world to secure sources of critical minerals for batteries and other high-tech applications. As of year end 2020, the mining sector accounted for a total accumulated value of $175 billion in Chinese outward foreign direct investment. China invested in metal projects—for example, for cobalt, copper, lithium, nickel, and rare earths—in other countries, including Argentina, Australia, Chile, the Democratic Republic of the Congo (Kinshasa), Indonesia, and Papua New Guinea.[23]

22 Critical Minerals Market Review 2023, International Energy Agency, December 2023.

23 2020-2021Minerals Yearbook: China, U.S. Geological Survey, May 2024.

## Leading Import Sources (2019–22) of Non-fuel Mineral Commodities for Which the United States was Greater Than 50 Percent Net Import Reliant

Source: U.S. Geological Survey




Seabed mining is shaping up as a critical resource for rare metals crucial for producing electronics, clean energy products, and microchips. China is taking aim at rule-making at the International Seabed Authority, setting-up a permanent mission to ISA, sending large delegations, and providing significant financial support. The United States is an observer rather than an ISA. To gain leadership in seabed mining, China is setting up institutes in deep sea research, and dozens of colleges on marine sciences, while President Xi has directed that China "master key technologies for entering the deep sea."[24]

**The bioeconomy presents substantial opportunities for U.S. competitiveness through advancements in biotechnology and biomanufacturing.** The rapidly growing bioeconomy involves using renewable biological resources sustainably to produce food, energy, materials, and industrial goods. It also exploits the untapped potential stored within millions of tons of biological waste and residual materials. This incredible opportunity for economic growth, new business formation, and greater sustainability is made possible by the convergence of affordable gene sequencing with powerful computing, automation, and artificial intelligence technologies.

The bioeconomy harnesses the power of biology to replace traditional chemicals and chemical processes, which is more sustainable and helps shore up domestic supply chains. The transition from chemistry to biology has broad applications—biopharmaceuticals, fuels, chemicals and polymer monomers, electronics, optics and photonics, materials, food and fiber, personal care, and even national security. Research has found that up to 60 percent of physical inputs

24 China Set to Dominate the Deep Sea and Its Wealth of Rare Metals, Washington Post, October 19, 2023.

in the global economy could be produced biologically, with one-third of materials derived from biological sources and two-thirds manufactured using biological processes. These developments could yield a direct economic impact of $4 trillion annually over the next 10 years.[25] Advances in biotechnology also have profound implications for human health, with an estimated 45 percent of the current global disease burden addressable using technologies now conceivable through advanced biotechnology today.[26]

However, despite its historical leadership in biotechnology, the United States faces increasing competition for leadership in the bio-transition, particularly from China, which also recognizes the bioeconomy's significant potential to drive economic growth, improve public health, and tackle societal challenges. China has made the bioeconomy a key element in several of its national plans for science and technology, precision medicine, military-civilian fusion, and strategic emerging industries.[27] Through these national initiatives, the Chinese government emphasizes biotechnology research and development, significantly increasing funding and support for domestic biotech companies and clusters. This focus includes enhancing food security and healthcare solutions. China's ambition to lead in biotechnology is underscored by its substantial share in global gene sequencing capacity, as well as its efforts in international collaboration, all aimed at strengthening its global competitiveness in this critical sector.[28]

To address this challenge and maintain global leadership in biotechnology and biomanufacturing, the U.S. Department of Defense funds Bio-MADE (Bioindustrial Manufacturing and Design Ecosystem), a $500 million ManufacturingUSA Institute unites more than 275 organizations to rapidly develop and deploy biomanufacturing innovations at scale.

In addition, in 2022, President Biden issued an Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy. This EO establishes a comprehensive policy framework to harness biotechnology and biomanufacturing as essential tools for addressing significant challenges in health, climate, energy, food security, and national security. Key components include advocating for increased investments in foundational scientific research and scalable biomanufacturing, promoting biosafety and biosecurity to mitigate biological risks, ensuring the ethical and responsible use of biotechnology, and protecting the U.S. bioeconomy from foreign threats.

**A new age of commercial space has opened with routine launches.** The space industry is being radically transformed with deep structural change. The emergence of reusable launchers has been a game changer, along with private financing, higher risk tolerance, faster delivery, and lower cost.

Operating at an unprecedented pace, SpaceX is leading the disruption of a market dominated by government for a half century—disrupting satellite

25 The Bio Revolution: Innovations Transforming Economies, Societies, and Our Lives, McKinsey Global Institute, May 2020.

26 ibid.

27 China's Hybrid Economy: What to Do about BGI? Anna Puglisi, Center for Security and Emerging Technologies, February 2024.

28 China's Hybrid Economy: What to Do about BGI? Anna Puglisi, Center for Security and Emerging Technologies, February 2024.

launch, space exploration, and the industry's ecosystem. It launched its Falcon 9 rocket 98 times in 2023, and more than 100 times by fall of 2024.[29] In the fourth quarter of 2023 alone, SpaceX lifted 420 tons into space, nearly ten times more than second-place China's 45 tons. SpaceX recently made history with the first commercial spacewalk during its Polaris Dawn mission, testing a spacesuit design for extra-vehicle activities, while also carrying out scientific research on human health and space radiation effects on human biological systems. With its heavy lift rocket in test flight, SpaceX aims to send 100-ton payloads to the moon and Mars at a cost of $10 million a trip.[30] A dramatically higher launch tempo with dramatically lower launch costs means a revolution in what humans can do in space and new space-based industries.[31]

Blue Origin is also making significant advancements in commercial space, opening a market for space tourism, and developing its New Glenn rocket for orbital launches. Lockheed Martin, another major player, is constructing lunar and deep-space exploration spacecraft such as NASA's Orion and early-warning weather and climate observation satellites. And companies like United Launch Alliance and Rocket Lab are providing commercial launch services, and Axiom Space is developing a private space station.

The innovations in space have major terrestrial benefits as well. Recently, the importance of space-based communications during crisis came to the forefront. When catastrophic Category 4 Hurricane Helene devastated and flooded communities in Western North Carolina, knocking out power and ground-based communications, Starlink satellite-based broadband systems were deployed to help with responder communications and assist with communications infrastructure restoration. In a few communities, Starlink systems were set up in a day or two after the storm passed—in a shelter, a hotel, a college, several fire departments, and a retirement community—and residents who already had these systems enabled people in the affected communities to communicate with distant families.[32]

The space economy could grow to $1.8 trillion by 2035.[33] About 6,500 institutional satellites, both civil and defense, are expected to be launched worldwide from 2023 to 2032.[34] However, space-based capabilities are enabling for broader segments of the economy, driving new markets, generating value-added, and enabling other industries. When taking that into account, that value of the space economy rises to a forecasted $7.9 trillion.[35]

While the United States has an uncontested lead in defense and commercial space and space exploration, China is taking aim. Its Long March 8 is expected to reach ten-time reusability by 2025. In 2022, U.S. defense applications accounted for about 60 percent of its $37 billion space-related expenditure, while China's total space expenditure in 2023 is estimated to have been nearly $14 billion, but with 62 percent devoted to civil space and 38 percent to defense. China's space program is large and comprehensive, with technological know-how across all main areas of satellite application.[36]

29 Space X lifted more than 842,000 pounds into space in 27 launches, compared to China's second place at 90,000 in 15 launches; SpaceX Could Finally Face Competition. It May be too Late, Washington Post, April 15, 2024; Elon Musk All But Owns the Market for U.S. Government Launches, Washington Post, November 16, 2024.

30 What is SpaceX's Starship? It's Really a Mars Ship. New York Times, March 14, 2024.

31 Elon Musk All But Owns the Market for U.S. Government Launches, Washington Post, November 16, 2024.

32 Starlink, Compact Cell Towers Deployed in NC Mountains with "Backout Zones" Common After Helene Devastation, CBS15.com, September 30, 2024; Death Toll Rises to 30 in NC from Hurricane Helene, The Carolina Journal, September 29, 2024.

33 Space: The $1.8 Trillion Opportunity for Global Economic Growth, World Economic Forum, April 2024.

34 The Future of European Competitiveness, European Commission, September 2024.

35 More than a Space Programme, The Value of Space Exploration to Empower the Future of Europe, Boston Consulting Group and European Space Policy Institute, November 2023.

36 The Future of European Competitiveness, European Commission, September 2024.

**Space is becoming ever more vital to the function of the economy, national security, industries, and society:**

- Positioning, navigation and timing for transportation industries
- Infrastructure monitoring
- Satellite communications, broadband, television transmission, and broadcasting
- Earth observation, including mapping weather and climate change
- Monitoring of land and sea resources, natural formations such as sea ice and coral reefs, air quality, pollution, and natural disasters
- Data collection to map, locate, and operate infrastructure for offshore renewable energy generation
- Timing from GPS used on world financial markets
- Security and defense to identify and monitor threats on the ground, at sea, and in the air, secure communication between all platforms in hostile territory, and to intercept and disrupt communications

Source: U.S. National Oceanic and Atmospheric Administration; The Future of European Competitiveness, European Commission, 2024.

## SECTION C

## The Transition to Cleaner Energy and a Low Carbon Economy: New Hurdles and New Hope

**The world is in the midst of a once-in-a century energy transition, but the global energy landscape has been turbulent. There are new goals, investments, and incentives to drive the transition, but also headwinds in achieving progress, rising energy costs, unexpected new energy demand, and new threats to energy security.**

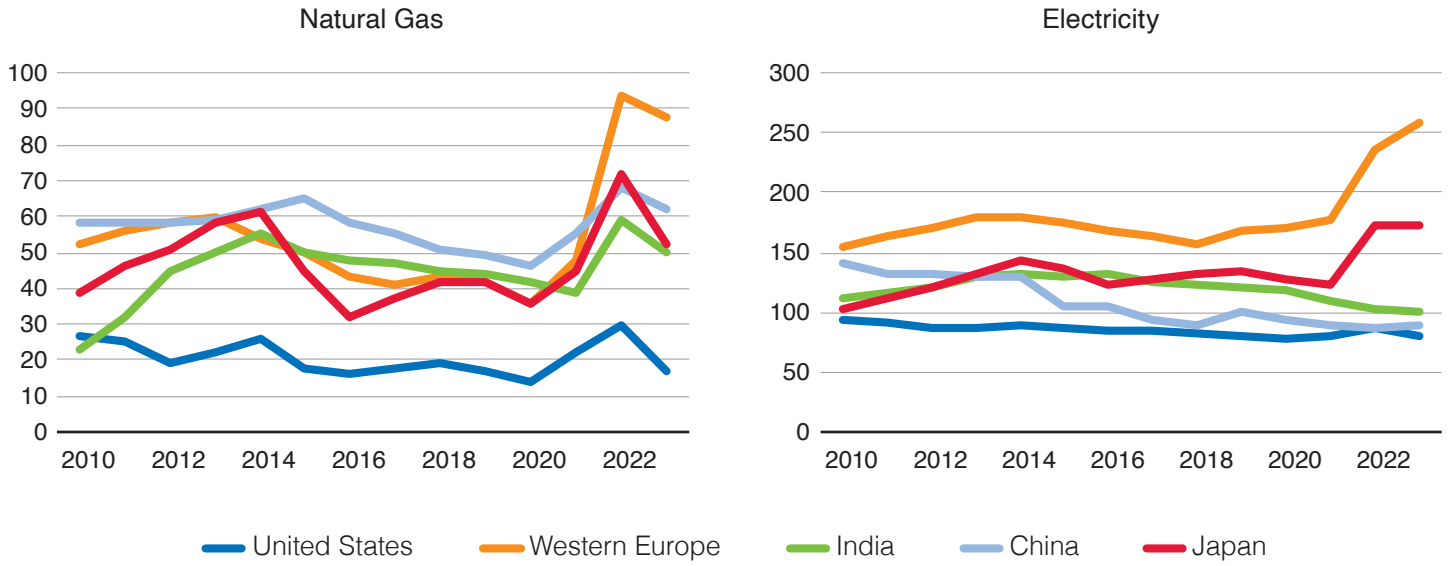
**The critical link between energy security and competitiveness has come to the forefront.** The Russian invasion of Ukraine caused energy price spikes and threatened the energy security of Europe. Instability in the Middle East could lead to further disruption of energy markets and prices. And concerns about assuring the supply of critical minerals needed for clean energy technologies are on the rise.

Energy costs are a key competitiveness factor and an often decisive factor for business investment location decisions, particularly for energy-intensive industries. Lower costs of energy in the United States gives U.S. industry a substantial competitive advantage over some of its global competitors, particular in energy-intensive industries. For example, the International Energy Agency reported that electricity prices for energy-intensive industries in the EU in 2023 were almost double those in the United States—despite an estimated 50 percent price decline in the EU in 2023 versus 2022.[37]

37 Electricity 2024, Executive Summary, International Energy Agency, May 2024.

## Industry End-User Prices for Natural Gas and Electricity in Selected Regions, USD/MWh

Source: Advancing Clean Technology Manufacturing: An Energy Technology perspectives Special Report, International Energy Agency, May 2024.




**The U.S. power supply is under pressure.** Decarbonizing the power sector is a fundamental step as the nation rushes to reduce emissions via electrification—from industrial production and heating, to vehicles and household appliances, to powering the AI revolution and unprecedented proliferation of data centers. The United States will need electricity for increased automation and scaling of energy-intensive artificial intelligence applications. Power consumption from data centers is expected to nearly double by 2030.[38] To electrify vehicle transportation, the United States will need a half million EV battery chargers linked to the grid. And, adding to the challenge is the quest to re-shore critical manufacturing such as semiconductor production in which large microchip fabs can consume as much power as a small city. For example, two semiconductor facilities planned for New York could use more power than six percent of the state's electricity usage in 2021.[39] To meet increasing demand for electric power, the Department of Energy projects that the U.S. power grid could nearly double in capacity from 2022 to 2050.[40]

**The breakout and rapid scaling of AI is producing unexpected demand.** The AI boom is rapidly increasing demand for compute power, placing pressure on data centers in the United States and abroad, and the supply of electricity that powers them. The IEA reported that data centers' total electricity consumption globally could double to more than 1,000 terawatt-hours by 2026.[41] That's roughly equivalent to the electricity consumption of Japan. In the United States, a new study reports that data centers could consume up to nine percent of electricity generation by 2030, more than double the consumption today.[42]

U.S. private sector AI leaders are beginning to turn to nuclear energy to meet their escalating power needs to support AI. Microsoft struck an

38 Investing in the Rising Data Center Economy, McKinsey & Company, January 17, 2023.

39 Surge in Chip Fabs Could Make Renewable Energy Targets Harder to Reach, Times Union, January 15, 2023.

40 U.S. Electric Capacity Mix Shifts from Fossil Fuels to Renewables in AEO2023, Today in Energy, Energy Information Administration, U.S. Department of Energy April 13, 2023.

41 Electricity 2024, Analysis and Forecast to 2026, International Energy Agency, January 2024.

42 Press Release, EPRI Study: Data Centers Could Consume up to 9% of U.S. Electricity Generation by 2030, Electric Power Research Institute, May 28, 2024.

"Having access to reliable, affordable energy is crucial because that drives our competitiveness as a nation. Make no mistake about it. Our energy costs are the biggest single competitive advantage other than the talent that we have in this country."

**Gregory Hill**
President and Chief Operating Officer
Hess Corporation

unprecedented deal to restart the Three Mile Island nuclear power plant, committing to purchase 100 percent of its power for 20 years. The plant could generate the equivalent of energy needed to power 800,000 homes.[43] It also signed an agreement to purchase electricity from a Helion nuclear fusion power plant scheduled for deployment in 2028.[44] Amazon inked an agreement to buy power from the Susquehanna nuclear power plant to support a data center complex in Pennsylvania.[45] Amazon also announced that it has signed three new agreements to support the development of nuclear energy projects—including enabling the construction of several new small modular reactors.[46] Google signed an agreement to purchase nuclear energy from multiple small modular reactors to be developed by Kairos Power.[47] And venture funding is beginning to flow into companies in this domain.[48] These leading hyperscalers may disrupt the nuclear industry, and drive the advancement and deployment of "new" nuclear.

By a wide margin, Northern Virginia is the data center capital of the world. Data centers accounted for 24 percent of Virginia Power's (the largest-investor-owned utility in the state) electricity sales in 2023. The utility is exploring the use of small modular nuclear reactors to meet future growth in demand, adding to its already significant use of nuclear energy to provide carbon-free power generation.[49]

**The pathway to net zero remains ambitious, but challenging, requiring a transformation of the global economy.** Recently, Bloomberg put a $215 trillion price tag on achieving net zero.[50] For example, a dramatic acceleration of clean energy deployment would be required for the United States to achieve a carbon-free U.S. electricity sector by 2035. In 2023 renewables accounted for about 21 percent of U.S. utility-scale electricity generation, and nuclear about 19 percent.[51] The Department of Energy estimates that reaching carbon-free electricity by 2035 would likely require solar to supply 40 percent of U.S. electricity, but provided only about 4 percent in 2023, and wind would need to provide about 36 percent but provided only about 10 percent in 2023.[52] Annual solar deployment would need to grow by 20 percent each year for the rest of the decade and be maintained to 2035. The cost of solar components would need to fall significantly

43 Microsoft Deal Would Reopen Three Mile Island Nuclear Power Plant to Power AI, Washington Post, September 20, 2024.

44 Helion Announces World's First Fusion Energy Purchase Agreement with Microsoft, Helion, May 10, 2023.

45 Microsoft Deal Would Reopen Three Mile Island Nuclear Power Plant to Power AI, Washington Post, September 20, 2024.

46 Amazon Signs Agreements for Innovative Nuclear Energy Projects to Address Growing Energy Demands, Amazon, October 16, 2024.

47 New Nuclear Clean Energy Agreement with Kairos Power, Google Blog, October 14, 2024.

48 Microsoft Deal Would Reopen Three Mile Island Nuclear Power Plant to Power AI, Washington Post, September 20, 2024; 2024 Generative AI Predictions, CB Insights.

49 Powering Your Every Day, Dominion Energy, 2023 Annual Report.

50 New Energy Outlook 2004. BloombergNEF, May 21, 2024, https://assets.bbhub.io/professional/sites/24/847353_NEO24_ExecSum.pdf

51 FAQ: What is U.S. Electricity Generation by Energy Source? Energy Information Administration, U.S. Department of Energy, February 29, 2024.

52 Solar Futures Study, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, September 2021; FAQ: What is U.S. Electricity Generation by Energy Source? Energy Information Administration, U.S. Department of Energy, February 29, 2024.

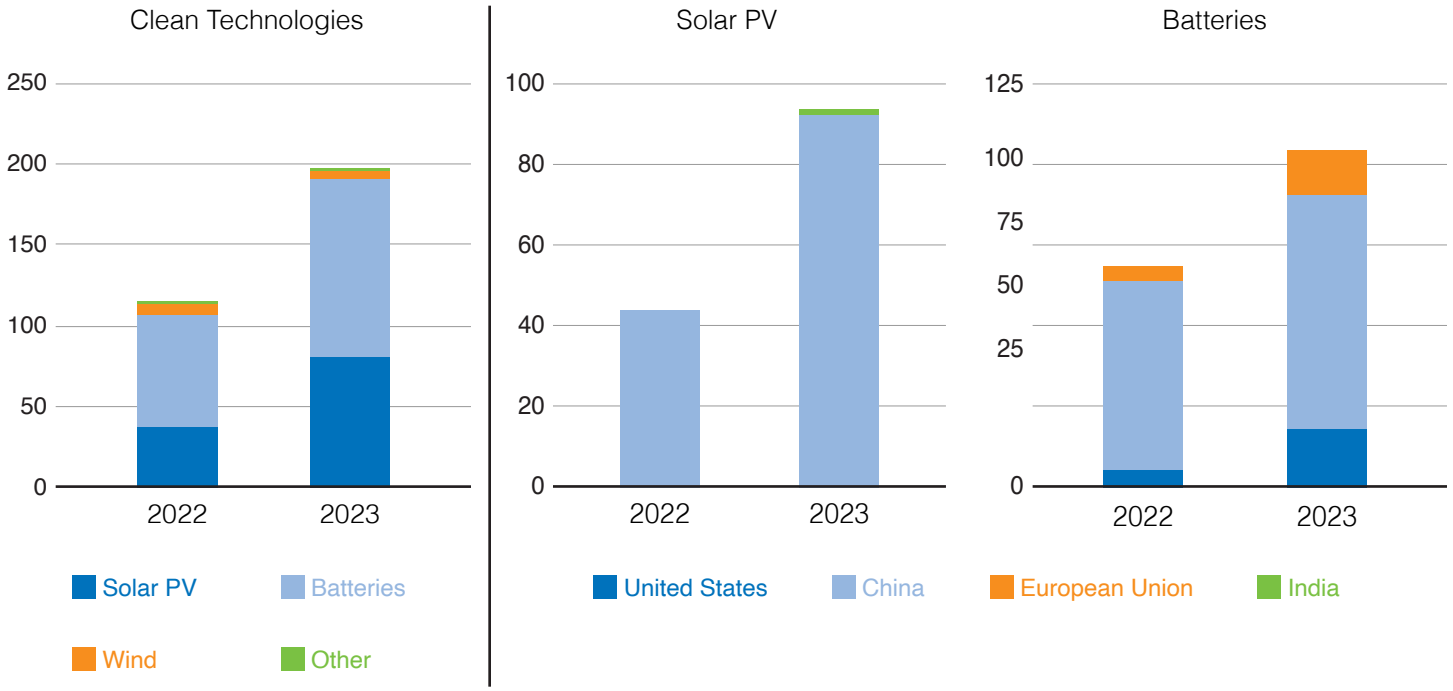
to make this broadly affordable. For wind, the levelized cost of energy would need a 50 percent reduction to make wind electricity cost-competitive nationwide.[53]

Globally, clean energy investment has risen by 40 percent since 2020, reaching an estimated $1.8 trillion in 2023.[54] While some clean energy supply chains are bogged down, for example wind, there is an accelerating pace of change in other areas. For example, in 2020, one in 25 cars sold was electric; in 2023, it was one in five. More than 500 gigawatts of renewables generation capacity was set to be added in 2023—a new record. More than $1 billion a day is being spent on solar deployment.

While progress is being made, a pathway to limiting global warming to 1.5 °C is very difficult. The recent IPCC 6th Synthesis Report states that global warming is more likely than not to reach 1.5°C even under the very low GHG emission scenario and likely or very likely to exceed 1.5°C under higher emissions scenarios. In the IEA's 2024 Global Energy Outlook Announced Pledges Scenario—which assume the full and timely implementation of national energy and climate goals, including net zero emissions targets—the share of fossil fuels meeting global energy demand would still be 35 percent by 2050. In this scenario, IEA projects that global warming would increase to 1.7 °C.[55]

## Clean Technology Manufacturing Investment by Technology and Region, 2022–2023

Source: Advancing Clean Technology Manufacturing: An Energy Technology Perspectives Special Report, International Energy Agency, May 2024.




53 U.S. Department of Energy, FY 2025 Congressional Budget Justification, Volume 4, Energy Efficiency and Renewable Energy, March 2024.

54 Bringing Down the Cost of Capital is Key to Unlocking Clean Energy Growth in Emerging Economies, International Energy Agency News, February 8, 2024.

55 World Energy Outlook 2024, International Energy Agency, October 2023.

**Cost competitiveness in clean energy technology favors China.** China alone accounts for more than 80 percent of global solar PV module manufacturing capacity,[56] while and major economies are subsidizing clean energy production and erecting trade barriers. Solar PV manufacturing costs in China are around 35-65 percent lower than in the United States and Europe. The cost of manufacturing the main components of onshore wind turbines is estimated at around $385/kW in China compared to between $485/kW-$535/kW in Europe and the United States, and costs for manufacturing battery cells are 20-35 percent lower.[57]

The main upfront cost that contributes to overall production costs is the capital expenditure to set up a clean energy manufacturing plant, and the associated financing costs. China is the lowest-cost region for manufacturing capital investment for all technologies and for all manufacturing steps. Cost for clean technology manufacturing facilities in the United States and Europe are between 70-195 percent more expensive per unit of output capacity. Operational costs differentials and clean energy manufacturing subsidies contribute to the cost gaps even more. Also, China has protected its home market for solar PV, wind power-generation, and EV batteries.[58]

**Nuclear energy holds a major solution to the U.S. and global clean energy challenge, and new market opportunities for the United States.** The one technology that could significantly advance a pathway to carbon free, baseload electricity now is nuclear. It has the lowest $CO_2$ emissions per megawatt-hour, the lowest land use, and the highest capacity factor of any major generating energy source.[59] For example, a typical commercial nuclear reactor provides the clean energy equivalent of more than 3 million solar panels or more than 430 utility-scale wind turbines. A 1,000 megawatt nuclear facility needs about one square mile to operate, while wind farms require 360 times more land to produce the same amount of electricity and solar PV plants require 75 times more space.[60]

In addition, nuclear power has the highest economic impact of any power generation source, as measured in GDP increase per dollar invested. Nuclear power plants have approximately 300 percent of the jobs per GW (gigawatt) when compared to wind power, and the pay of nuclear workers is approximately 50 percent higher than that in the wind or solar sectors.[61]

The United States faces significant competition from China in the nuclear industry. For example, the United States leads in the development of nuclear energy technologies, but has fallen behind China and Russia in deployment. As of April 2024, China has 23 commercial reactors under construction, another estimate indicates 30 under construction, and the United States has none. The United States has the largest nuclear fleet, with 94 reactors, but it took nearly 40 years to add the same nuclear power capacity China added in 10 years.[62] Also, China is rapidly building the world's first onshore small modular nuclear reactor, scheduled for operation in 2026. China may use its domestic nuclear capacity and experience as a springboard for reactor exports.

56 Advancing Clean Technology Manufacturing: An Energy Technology Perspectives Special Report, International Energy Agency, May 2024

57 Advancing Clean Technology Manufacturing: An Energy Technology Perspectives Special Report, International Energy Agency, May 2024

58 Advancing Clean Technology Manufacturing: An Energy Technology Perspectives Special Report, International Energy Agency, May 2024; The Future of European Competitiveness, European Commission, September 2024.

59 Pathways to Commercial Liftoff: Advanced Nuclear, U.S. Department of Energy, September 2024.

60 3 Reasons Nuclear is Clean and Sustainable, and INFOGRAPHIC: How Much Power Does a Nuclear Reactor Produce? Office of Nuclear Energy, U.S. Department of Energy, June 2022 and July 2022.

61 Pathways to Commercial Liftoff: Advanced Nuclear, U.S. Department of Energy, September 2024.

62 China Continues Rapid Growth of Nuclear Power Capacity, In-Brief Analysis, U.S. Energy Information Administration, U.S. Department of Energy, May 6, 2024; Nuclear Power in China, World Nuclear Association, August 13, 2024.

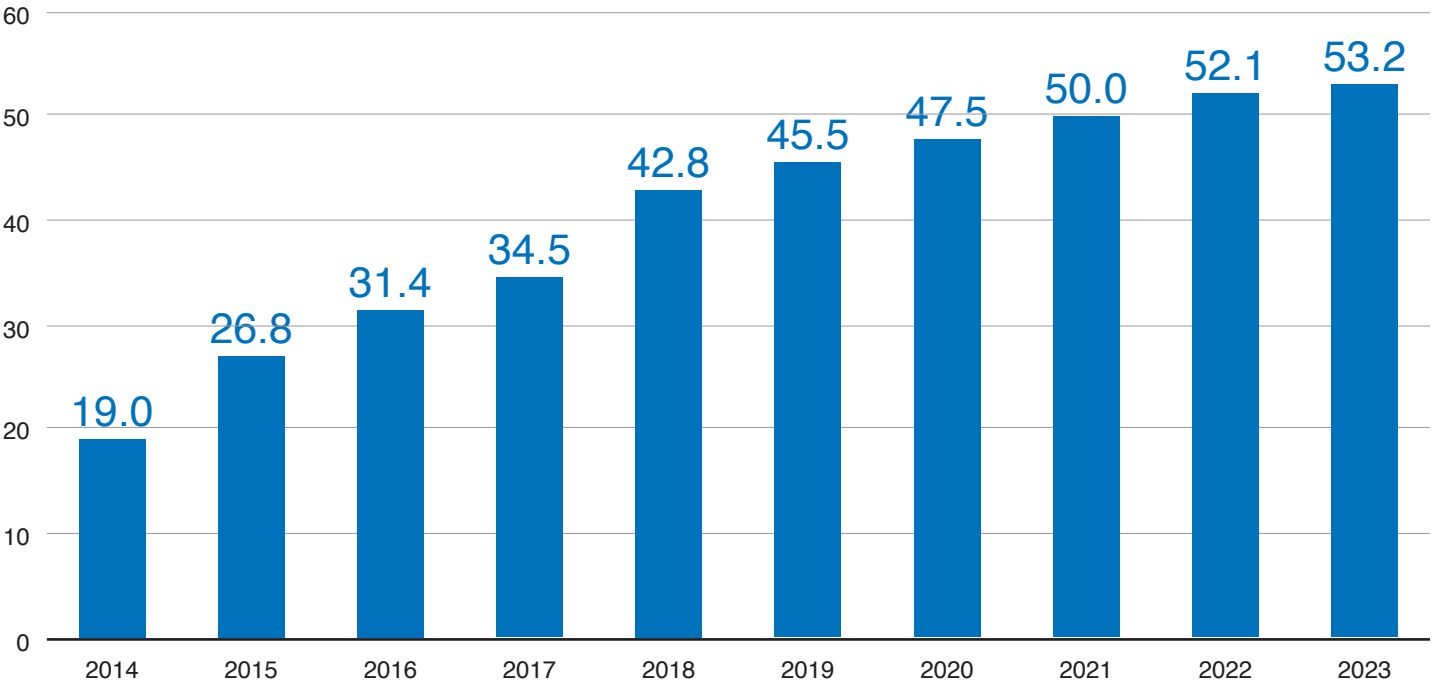
## Nuclear Offers a Unique Value Proposition for a Net Zero Grid

Source: Pathways to Commercial Liftoff: Advanced Nuclear, U.S. Department of Energy, September 2024.


| | Clean? | Firm? | Low Land Use? | Low Transmission buildout? | Concentrated Local Economic Benefits? | Direct Heat Applications? |
|---|---|---|---|---|---|---|
| Nuclear | High | High | High | High | High | High |
| Geothermal | High | High | High | Low | Low | Low |
| Hydropower | High | Low | Low | Low | High | Low |
| Renewables + LDES | High | Low | Low | Low | Low | Low |
| Renewables: Offshore | High | Low | High | Low | Low | Low |
| Renewables: Onshore | High | Low | Low | Low | Low | Low |
| Natural Gas + CCS | Low | High | Low | High | Low | Low |
| Coal + CCS | Low | High | Low | High | High | Low |
| Natural Gas | Low | High | Low | High | Low | Low |
| Coal | Low | High | Low | High | High | Low |

## Annual Installed Net Nuclear Power Capacity in China (2014–2023), Gigawatts

Source: U.S. Energy Information Administration and the International Atomic Energy Agency



The United States has a golden opportunity to leverage its edge in nuclear energy technologies to both leap frog into competitive leadership in global nuclear energy markets and accelerate the U.S. pathway to carbon-free electricity.

**Major breakthrough as researchers achieve nuclear fusion ignition.** After 60 years of work, on December 5, 2022, researchers at Lawrence Livermore National Laboratory's National Ignition Facility for the first time anywhere by any approach achieved a fusion experiment that produced more fusion energy than the laser energy required to trigger the reaction—a huge advancement for the field, repeated in four subsequent experiments.[63] Nuclear fusion has the potential to deliver an inexhaustible supply of cheap clean energy. The United States has 25 companies working on different concepts, and most of the investment. In 2023, the Department of Energy awarded $43 million to eight of these companies to fund R&D and deliver within 18 months an early fusion pilot plant design.[64] Many commercial companies are targeting the early 2030s for putting fusion energy on the grid, and a few start-ups have even more aggressive timelines.

## SECTION D

## China—the United States Most Formidable Strategic Competitor Spreads Its Wings

**The PRC is the only competitor with both the intent to reshape the international order and, increasingly, the economic, diplomatic, military, and technological power to do it. Beijing has ambitions to create an enhanced sphere of influence in the Indo-Pacific and to become the world's leading power. It is using its technological capacity and increasing influence over international institutions to create more permissive conditions for its own authoritarian model, and to mold global technology use and norms to privilege its interests and values.**

**National Security Strategy**
White House, October 2022

**China has continued to pose as the most formidable strategic competitor the United States has ever faced.** China seeks to supplant the United States as the world's economic, technological, military, and geopolitical leader. It is using every tool in its arsenal to build a science and technology capability rivaling those of the United States. It seeks to achieve and use its technological superiority for economic, political, and military gain. For example, China now rivals the United States in DNA-sequencing equipment and some foundational research. Beijing's large volume of genetic data potentially positions it to lead in precision medicine and agricultural biotechnology applications.[65]

**Members of Congress and the FBI have raised alarms about U.S. research collaborations with China and China's expanding footprint on American university campuses.** While the scientific community generally views the free and

63 Fusion Ignition and the Path to Inertial Fusion Energy, https://lasers.llnl.gov/news/fusion-ignition-and-the-path-to-inertial-fusion-energy.

64 Preconceptual design addresses the same issues as a conceptual design but at lower levels of fidelity and with greater uncertainties.

65 2024 Annual Threat Assessment of the U.S. Intelligence Community, Office of the Director of National Intelligence, February 2024.

**China seeks to become a world S&T superpower and to use this technological superiority for economic, political, and military gain.** Beijing is implementing a whole-of-government effort to boost indigenous innovation and promote self-reliance, and is prioritizing advanced power and energy, AI, biotechnology, quantum information science, and semiconductors. Beijing is trying to fast-track its S&T development through investments, intellectual property acquisition and theft, cyber operations, talent recruitment, scientific and academic collaboration, and illicit procurements.

Annual Threat Assessment of the U.S. Intelligence Community
Office of the Director of National Intelligence, February 2024

In 2008, China invested $115 billion in R&D. By 2022, its investment had increased to $533 billion (constant dollars)—a 363 nearly 240 percent increase.

Source: OECD Main Science and Technology Indicators

open exchange of information as vital to scientific research, China has employed a variety of mechanisms to influence and exploit the openness of the U.S. research enterprise. These include foreign talent recruitment programs, forming partnerships with U.S. research universities, setting up research centers in the United States, financing joint research programs, and sending students to the United States for science and engineering graduate studies. Instances uncovered include U.S. researchers failing to disclose foreign funding and associations; theft of intellectual property; and violations of the peer review process by sharing confidential grant applications.

Congress and the Executive Branch have instituted new disclosure requirements on applicants for federal R&D funding, especially regarding foreign support, and specific policies governing federal employee and grantee participation in foreign talent recruitment programs. Scrutiny on international collaboration has created pressures at universities, and tension in balancing international R&D collaboration, and protecting U.S. technology and U.S. taxpayers' expectations that they will benefit from public R&D investments made at U.S. universities and national laboratories.

**China continues to expand its role in multilateral institutions and other initiatives to advance its geopolitical goals and write the rules of the 21st century economy in its own state-directed model.** China aims to expand its influence abroad through multinational forums and China-branded initiatives such as the Belt and Road Initiative, the Global Development Initiative, and the Global Security Initiative—promoting an alternative to existing, often Western-dominated international development and security fora. As part of this effort, Beijing seeks to champion development and security in the Global South.[66] China's financial commitments to the UN's regular budget have more than doubled since 2015, making it the second-largest contributor after the United States.[67]

In international law, or the rules and norms that govern relations between countries, China actively participates in fora it believes it can influence but deliberately undermines fora and laws that conflict with its objectives. For the former, its efforts are focused on setting rules of the road in emerging areas of international law that could have substantial future commercial impact, such as cyber gov-

66 2024 Annual Threat Assessment of the U.S. Intelligence Community, Office of the Director of National Intelligence, February 2024.

67 Is China Contributing to the United Nations' Mission?, China Power Project, Center for Strategic and International Studies.

> China seeks to influence global governance organizations by promoting new initiatives to rework the norms underpinning these institutions, attempting to change the way they work. Through Beijing's Global Security Initiative, China's leaders hope to undermine U.S. leadership in international security affairs, establishing a role for China in mediating international conflicts and normalizing its selective application of its principle of "noninterference."
>
> U.S. China Economic and Security Review Commission

ernance and space.[68] In 2023, China announced its Global AI Governance Initiative to bolster international support for its vision of AI governance.[69]

China seeks to advance its preferred standards around the world through both the BRI and participation in international standards bodies. For example, through the BRI, China uses its initial sales of digital infrastructure to set accompanying technical standards for these networks. The success of Chinese technology companies setting China-favored technical standards in many BRI host countries is making it difficult for Western companies to sell similar technologies in these regions. According to a Council on Foreign Relations report, China's Action Plan for Standards Connectivity for the Joint Construction of the Belt and Road calls for uniform technical standards across BRI host countries, and 49 of them have signed agreements on mutual standards recognition.[70]

**China's Belt and Road Initiative (BRI) is the world's largest international infrastructure financing and development program.** It has served as a tool for China to expand its influence with other countries. Through the BRI, banks and companies supported by the Chinese government have financed and built power plants, railways, highways, ports, and telecommunications infrastructure around the world. In addition, in 2022, President Xi committed to increase the number of international laboratories built in countries participating in the Belt and Road Initiative to 100 over five years.[71]

**As part of its geostrategy, China seeks to exert power in trade through its Maritime Silk Road.** Ten years ago, China had stakes in 44 ports around the world. Today, it owns or operates about 100 ports and terminals in 50 countries spanning every ocean and continent, and along some of the world's most strategic waterways. For example, the CCP effectively controls or has major investments in 20 European ports that are crucial to NATO and the U.S. Navy.[72]

The U.S. government prohibits the Department of Defense from using any port using the Chinese government-owned logistics software platform called LOGINK.[73] LOGINK raises national security and competitiveness concerns. It could provide China with key insight into shipping, cargo valuations, and destination and routing information to identify supply chain weaknesses, and trace the commercial shipping of military cargo.

**Chinese automakers seek to dominate connected vehicle technologies in the United States and globally, posing threats to national security.** These technologies include computer systems that control vehicle movement and col-

68 U.S. China Economic and Security Review Commission, 2023 Report to Congress, Executive Summary and Recommendations, November 2023.

69 2024 Annual Threat Assessment of the U.S. Intelligence Community, Office of the Director of National Intelligence, February 2024.

70 International Infrastructure Projects: China's Investments Significantly Outpace the U.S., and Experts Suggest Potential Improvements to the U.S. Approach, U.S. Government Accountability Office, September 2024.

71 China's Belt and Road Initiative is Boosting Science—The West Must Engage, Not Withdraw, Nature, October 24, 2023.

72 China Has Acquired a Global Network of Strategically Vital Ports, Washington Post, November 6, 2023.

73 Section 825, Countering Adversary Logistics Information Technologies, U.S. National Defense Authorization Act for Fiscal Year 2024.

## China's Belt and Road Initiative: China Spreads its Wings Across the Globe

China's Belt and Road Initiative (BRI), initially focused on Asia, Europe, and Africa, now encompasses more than 100 countries. (Another estimate by Fudan University in Shanghai says 150 countries.) BRI projects in energy, ICT, manufacturing (industrial parks and trade zones), and transportation (rail, roads, ports, and airports) seek to vertically integrate China's production supply chains, technology infrastructure, and transportation networks. The effort involves technology and financial integration that expands the use of China's digital platforms and currency. It seeks to expand Chinese firms' presence overseas, create new markets for China's goods and services, and secure access to foreign sources of agriculture, energy, and strategic commodities.

In 2023, President Xi emphasized areas of focus to include "high quality development"; intermodal and green infrastructure; pilot digital trade zones; science and technology cooperation; and cooperation in energy, tax, finance, think tanks, media, and culture. China's global outward foreign direct investment stock was $2.9 trillion in 2022, up from $34.7 billion in 2001.

China's strategic investments aim to advance national economic and foreign policy goals. A handful of state firms that report directly to the central government operate most projects. Projects appear to seek interconnection and interoperability in transportation (e.g., rail gauges), energy (e.g., power grid), and communications (e.g., 5G), allowing potential Chinese control of sensitive infrastructure and related services. Projects in cobalt, lithium, and nickel support PRC battery and electric vehicle industrial policies.

These Chinese entities are expanding overseas in many sectors that China restricts to foreign investors in China (e.g., construction, transportation, finance, and communications). China does not offer reciprocal market access for the rights it secures in other countries, challenging a core tenet of the global trading system and giving Chinese firms asymmetric advantages over competitors.

Under its military-civil fusion program and China Standards 2035 initiative, China is developing standards that promote civilian and military interoperability, including in various technologies and infrastructure such as ports. In addition, China's projects offer alternatives to a range of U.S.-led networks and standards.

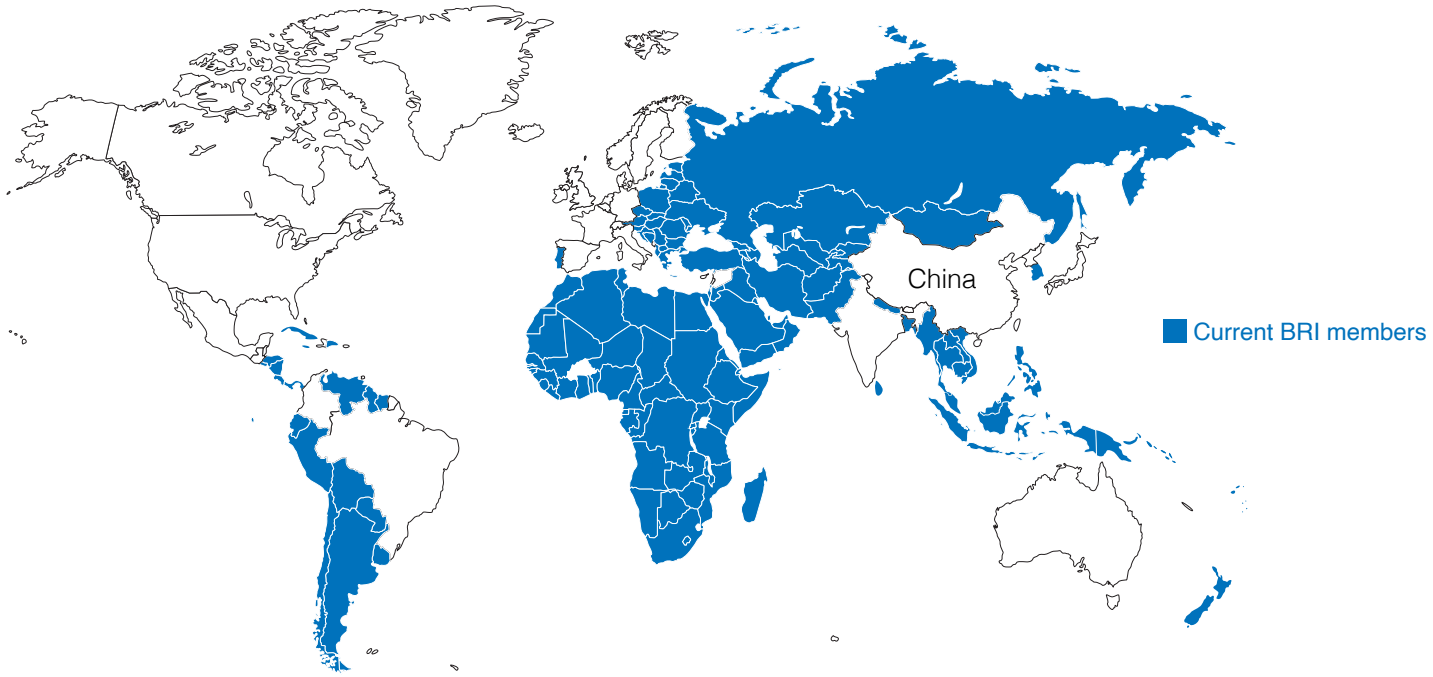
Source: China's "One Belt, One Road" Initiative: Economic Issues, Congressional Research Service, May 16, 2024.

lect sensitive driver and passenger data as well as cameras and sensors that enable automated driving systems and record detailed information about American infrastructure. These vehicles' hardware, software, and increasing connectivity creates opportunities to collect and exploit sensitive information such as information about geographic areas or critical infrastructure, and present opportunities for malicious actors to disrupt the operations of infrastructure or the vehicles themselves. In September 2024, the U.S. Department of Commerce issued a notice of proposed rulemaking that would, if finalized as proposed, prohibit the sale or import of connected vehicles that incorporate certain technology and the import of particular components themselves from countries of concern, specifically the People's Republic of China and Russia.[74]

74 FACT SHEET, Protecting America from Connected Vehicle Technology from Countries of Concern, The White House, September 23, 2024.

## Countries That Have Signed BRI Agreements with China

Sources: Fudan University (data); Map Resources (map). | GAO-24-106866




**China is central to global supply chains, and could leverage those during a crisis.** In an April 2020 speech, President Xi noted his intentions to increase global supply chain dependencies on China, with an aim of controlling key supply chains and being able to use those supply chain dependencies to threaten and cut off foreign countries during a crisis, posing a significant risk to U.S. and Western manufacturing and consumer sectors for purposes of political or economic gain.[75]

**The U.S. intelligence community assesses China as the most active and persistent cyber threat to the U.S. government, private sector, and critical infrastructure networks.**[76] In February 2024, the Cybersecurity and Infrastructure Security Agency, National Security Agency, and Federal Bureau of Investigation released an advisory warning that People's Republic of China state-sponsored cyber actors seek to pre-position themselves on IT networks for disruptive or destructive cyberattacks against U.S. critical infrastructure in the event of a major crisis or conflict with the United States. This includes U.S. communications, energy, transportation, and water and wastewater systems infrastructure.[77]

In September 2024, the Justice Department announced a law enforcement operation that disrupted a botnet consisting of more than 200,000 consumer devices in the United States and worldwide; 48 percent of the infected devices—more than 120,000—were U.S. nodes. A People's Republic of China state-sponsored hackers

75 2023 Annual Threat Assessment of the U.S. Intelligence Community, Office of the Director of National Intelligence, February 2023.

76 2024 Annual Threat Assessment of the U.S. Intelligence Community, Office of the Director of National Intelligence, February 2024.

77 PRC State-Sponsored Actors Compromise and Maintain Persistent Access to U.S. Critical Infrastructure, Cybersecurity and Infrastructure Security Agency, February 7, 2024.

"The…United States finds itself competing with autocratic governments investing heavily in technological innovation. Competing with a government. You are not only competing with the companies and the technology and the people, you are competing with the person making the rules."

**Dr. Albert Pisano**
Dean, Jacobs School of Engineering, University of California, San Diego

deployed botnet malware infecting numerous types of Internet-connected devices, including small-office/home-office routers, internet protocol cameras, digital video recorders, Internet of Things devices, and network-attached storage devices. The malware connected these infected devices into a botnet, which was used to conduct malicious cyber activity disguised as routine internet traffic. This malicious cyber activity successfully attacked multiple U.S. and foreign corporations, universities, government agencies, telecommunications providers, and media organizations.[78]

## SECTION E

### Expanding the Footprint of the U.S. Innovation Ecosystem

**Globalization, rapid technological change, the hollowing of U.S. manufacturing, and shift to a service economy have changed the dynamics of what makes places thrive. Some places in the United States have leveraged these changes into an upward economic spiral, and others made successful transitions to a new future for their places. At the same time, these changes have left many rural areas, and U.S. cities and towns up and down the coasts and across the nation behind. In the 21st century, a capacity for innovation and a robust innovation ecosystem are increasingly key elements of what makes places thrive.**

**The federal government has made significant investments in regional hubs and innovation ecosystems beyond the U.S. coastal superstars.**

- In 2023, the Department of Energy awarded $7 billion to launch seven Regional Hydrogen Hubs.
- In 2023, the National Science Foundation selected ten inaugural Regional Innovation Engine hubs—on technologies such as advanced energy, biotech, advanced materials, advanced computing, semiconductors, robotics and advanced manufacturing, and disaster prevention and mitigation. If the engines progress toward their milestones, they could receive $160 million each over ten years.

78 Press Release, Court-Authorized Operation Disrupts Worldwide Botnet Used by People's Republic of China State-Sponsored Hackers, U.S. Department of Justice, September 18, 2024; Joint Cyber Security Advisory, People's Republic of China-Linked Actors Compromise Routers and IoT Devices for Botnet Operations, Federal Bureau of Investigation, Cyber National Mission Force, and National Security Agency, September 18, 2024.

- In 2023, to fulfill authorities appropriated under the CHIPS and Science Act, the Department of Defense awarded nearly $240 million to eight regional innovation hubs that form its Microelectronics Commons.
- In 2024, the U.S. Department of Commerce awarded $504 million to 12 technology hubs across the United States on technologies ranging from autonomous systems, quantum, and biotech to energy, critical minerals, semiconductor manufacturing, and materials manufacturing.

**New U.S. hubs are emerging in surprising places driven by homegrown innovation strategies—across a range of geographies.** These rising stars have some things in common, including:

- A long-term commitment and the engagement of state and regional government, industry, and university leaders;
- A leveraging of economic assets on hand, and a willingness to take risks and make investments in the future;
- Front facing universities actively engaged in economic development initiatives and in partnering with businesses;
- A presence of research institutes and programs in fields and disciplines vital to the local industrial base, alongside an industrial base actively bringing forth their priorities and problems to universities to help address and solve;
- Aggressive approaches to building places and processes for industry-university collaboration;
- An education and workforce training strategy aimed at meeting industry's evolving needs; and
- A focus on strengthening existing assets to reach for industries of the future.

As these places develop, a virtuous circle is often created—building assets that attract even more of them:

- Businesses come to tap the suppler base, and the intellectual, financial, institutional, logistical, and physical assets available in the region.
- Firms specializing in the hub's industry or technology—for example, law firms and design firms—come too.
- The opportunities generated draw entrepreneurs, capital, and educated and skilled workers to the region and, in turn, the talented workforce attracts even more firms.

**Yet, while some places have prospered, globalization and economic shifts have left behind many rural areas, and U.S. cities and towns.** Many rural places and small towns have suffered a downward spiral of economic decline, community distress, social despair, and lack of hope. The government and other institutions have not always paid attention to these declining cities and towns, and rural communities. Underserved and underdeveloped urban communities have issues similar to rural communities.

A Department of Commerce study offers some insights.[79] Geographic inequality—the spread between high-income and low-income places—has steadily widened in the United States. The growing gap is at least as much about the top places pulling away as it is about the bottom places falling further behind.

79 Geographic Inequality on the Rise in the U.S., Office of the Under Secretary for Economic Affairs, U.S. Department of Commerce, June 15, 2023.

There is strikingly less geographic mobility. This makes closing economic gaps harder, since people are less likely to move where incomes are higher and opportunities richer. When places have moved-up in economic rankings, it is almost always because an industry or a particular company took root and created a sustainable agglomeration that drives income growth, mobility, and workforce development that lifted educational attainment.

The challenges hindering economic development and growth vary in communities across the country. In some places, it is housing affordability. Some places lack infrastructure or struggle to attract talent, while others need to create opportunities for existing residents. Places with little opportunity lose their young people and, if there is not a population to build on, companies are not going to be able to grow there and scale-up. Lack of a diverse industrial base can be a problem because industries and companies rise and fall.

Cities and towns in decline, and rural areas do have assets, innovative people, and come up with creative solutions. But they may be missing other things such as institutions of excellence, infrastructure such as broadband, functional public schools, and public services. Places with higher capacity are better prepared for boosting regional and national competitiveness in a range of technology fields.

**The role of many universities in the U.S. innovation ecosystem has evolved.** COVID-19 delivered a still propagating shockwave to universities–one that is having a longer term, transformative impact on academia. The global pandemic has disrupted nearly every aspect of universities' multi-faceted mission, and has forced major changes in incredibly short timescales. Their rapid shift to online learning has been

"It is harder to thrive in places that aren't thriving."

**Jed Kolko**
Former Under Secretary for Economic Affairs
U.S. Department of Commerce

unprecedented in the global education system, and they have been pressed into action to provide COVID-related services to the community. They have been forced to improvise, innovate, and make changes in ten months that otherwise would have taken years. [80]

After that experience, many universities are taking a fresh look at their investments, approaches to learning, collaborations inside and outside of the institution, and their roles as members of the community and as developers of solutions for social and sustainability problems. There is greater focus on research translation and commercialization. And they are leading the development of new regional innovation initiatives and technology hubs. For example, universities lead 6 of the 10 National Science Foundation Regional Engines, 5 of the 8 Department of Defense semiconductor manufacturing hubs, and 10 of the 17 Manufacturing USA centers.

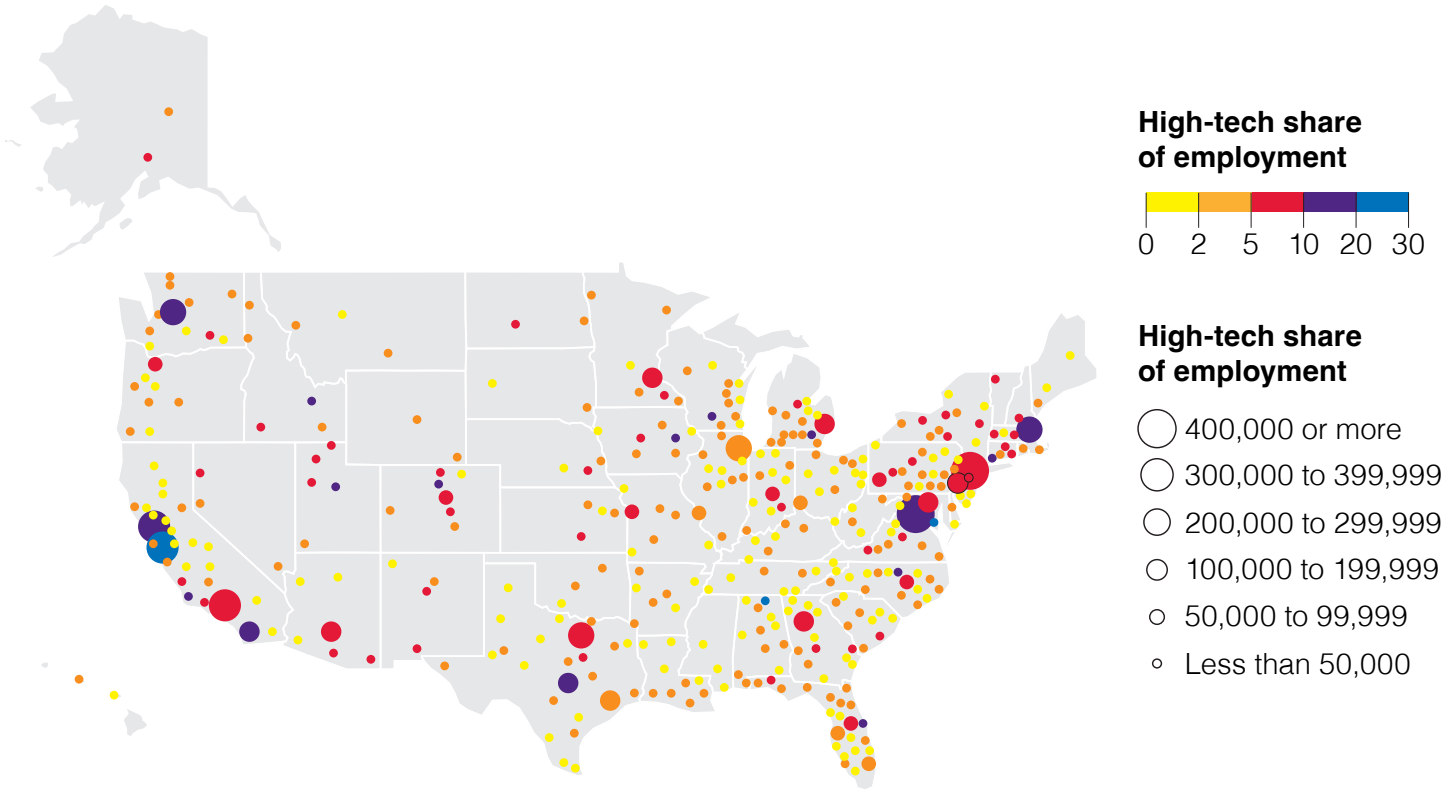
**Some universities have undertaken significant efforts to build strong ties with industry in R&D and workforce training, creating a more seamless economic and innovation ecosystem.** Examples include:[81] inviting companies to locate facilities on or near campus, creating specialized degree programs aligned with the region's industries, establishing industry advisory boards, placing student interns in nearby companies, taking university research and expertise directly to industry through specialized innovation

80 Shift: Universities in Transformation, How COVID-19 Shaped the Universities of the Future, Global Federation of Competitiveness Council, 2022.

81 These examples and best practices were gathered during Council on Competitiveness fora including: the 2022 and 2023 National Competitiveness Forum, 2023 Summer Meeting of the National Commission on Competitiveness Frontiers, 2023 National Commission Phase 2 Launch Summit, and 2024 Competitiveness Conversations Across America.

## High Tech Employment and Employment Share in 2020 in U.S. Metropolitan Statistical Areas

Source: U.S. Census Bureau, Business Dynamics Statistics of U.S. High Tech Industries (BDS-HT), www.census.gov/programs-surveys/ces/data/public-use-data/experimental-bds/bds-high-tech.html.




campuses or technology centers, creating an office devoted to engaging and fostering partnerships with industry, partnering with industry on joint development projects, establishing corporate endowed chairs, and corporate funding of masters and Ph.D. fellows and student scholars. Just a very few examples:

- Clemson University has created five Innovation Campuses across South Carolina to take its research and expertise directly to industry—centers on advanced automotive research, energy, human genetics, biomedical engineering, and advanced materials.
- The University of California Davis runs the Mondavi Institute for Wine and Food Science to support the state's wine and food industries.
- Volkswagen, Eastman, and other companies have located operations at the University of Tennessee's Research Park, where industry, university faculty, graduate students, and post-doctoral students work together.
- Purdue University has created a semiconductor degrees program, and corporate leaders serve on a Semiconductor Degrees Leadership Board to ensure education programming is relevant to industry.

"The university environment is changing a lot. We have been through a very transformational time these last few years…we have a widened appetite for doing things in ways that we would have never considered before."

**Joan Gabel**
Chancellor, University of Pittsburgh, and Academic Vice-Chair, Council on Competitiveness

"We are best when we work with our local problems, our local communities, our local industry, and with the local wisdom."

**Suresh Garimella**
President, University of Arizona, and Council on Competitiveness Executive Committee

Universities are good at identifying what is needed in a community or region because they are embedded in these places. And translating their research does not have to be commercialization, but rather solutions to community problems.

**Universities face a financial squeeze that will require new ways of thinking about their physical assets.** The university failure rate is increasing. There are roughly 4,000 colleges and universities in the United States. There has been about a 10 to 12 per year failure rate, which has accelerated over the last couple of years to more than 30 per year, an alarmingly high growth rate, particularly when those failures are the colleges and universities most closely touching underserved populations.

The end of a 30-year run of low-interest financing for university facilities is over, as well as the end of an ever-accelerating tuition growth rate, which is going to start capping the income potential for universities and limit the off-balance sheet debt they have been using for growth. There are hundreds of billions of dollars in deferred maintenance backlog at colleges, universities, and health systems across the country. These institutions need capital to deliver the type of educational, research, and industry partnership outcomes needed.

Universities generally land about $0.70 of income for every dollar of research expenditure. That is not a sustainable model. There is only so much that can be done internally to bend the cost curve. A university can try to move its research to lower cost things such as data and analytics. But to maintain a robust research enterprise, there is going to have to be new ways of thinking.

If income is limited and there are few expenses to cut, universities must get more out of existing assets. This is an opportunity to rethink use of university infrastructure and how that can impact innovation, entrepreneurship, and growth in surrounding communities.

## The Council's Competitiveness Conversations Across America

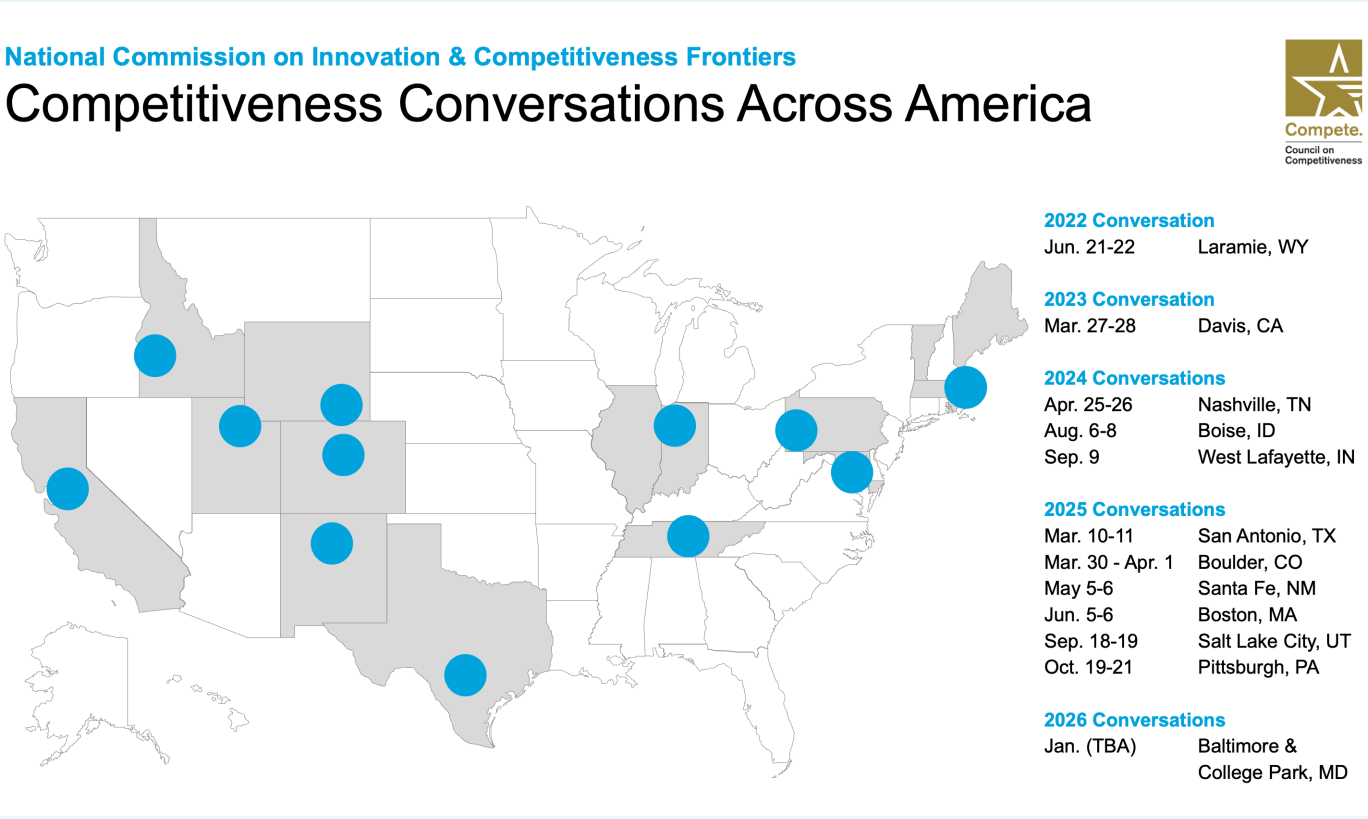
Building on the foundational *Competing in the Next Economy* report released in December 2020, which recognized the need to expand innovation beyond traditional hubs and to include every community in the innovation economy, the Council on Competitiveness formally launched its **Competitiveness Conversations Across America** leadership series in 2024. These Conversations look under the hood of new regional economic engines, convening regional and national leaders to identify best and "next" practices to strengthen innovation-based growth and amplify local success for national deployment.

The initiative began with pilot events at the University of Wyoming and University of California Davis, officially launching in Nashville, Tennessee. Subsequent Conversations have taken the Council to Boise, Idaho, and the Indiana-Illinois Corridor.

Each Conversation has highlighted the unique innovation ecosystems of these regions, yielding valuable insights about building thriving innovation ecosystems.

Participants learned in Tennessee the power of radical collaboration among diverse industry leaders and uncovered several other cross-cutting themes and important factors of innovation economies, including:

- Leadership is broad and deep. While current and former governors have been the flagbearers, engagement in building manufacturing and innovation capacity is broad—across industry, academia, and government—and deep—from the state capital down to city halls. Efforts to build innovation ecosystems are undergirded by a web of diverse partnerships crossing these sectors.



- Leaders of companies that brought operations to the State said a key factor in their decision was that Tennessee is a good place to work and raise a family. The State's natural assets enhance its attractiveness as a place to live. No state income tax and a good business environment are added benefits.
- Business leaders stressed the importance of the State's vision for the future. These companies were considering where they were going to invest billions of dollars and grow in the decades ahead. They wanted assurance that the State's infrastructure, workforce pipeline, R&D, and energy could support that growth and their supply chains.
- K-12, higher education, and workforce training providers partner with industry to develop the workers businesses need.
- Education and training on-ramps meet people where they are in their careers and offer many options for attaining knowledge and skills needed for advancement.
- Tennessee is building on current assets as a springboard to future industries. For example, a coalition of more than 100 public and private entities—including more than 50 companies and every technical school, two-year college, and four-year university in the state—is working to make Tennessee a destination for mobility innovation. Different entities are developing different parts of the ecosystem including research capabilities, the supplier base, and regulation.

Building from the Tennessee Conversation, Boise showed off a vibrant pioneering innovation culture despite facing "growing pains," and the Indiana-Illinois Conversation held in West Lafayette, Indiana, introduced the concept of "curated densification" where the region is focusing its strategic efforts on just a few platform innovation sectors..

Participants in these Conversations have included leaders from global firms and academic institutions, promoting collaboration to align talent, technology, investment, and infrastructure. The series is set to continue in 2025 and 2026 with planned events that will focus on:

- San Antonio (March 10–14, 2025): Cyber-resilient infrastructure
- Boulder (March 31–April 1, 2025): Climate resilience and quantum technologies
- Santa Fe (May 5–6, 2025): AI, research security, clean tech, and climate change
- Boston (June 5–6, 2025): Convergence of blue and green economies
- Salt Lake City (September 2025): Health sciences and information technology
- Pittsburgh (October 2025): Robotics, high-performance computing, and healthcare
- Baltimore and College Park (January 2026): Quantum technologies and climate change

Through these dialogues, the Council is are uncovering a new narrative of innovation, where regions previously overlooked are emerging as significant contributors to U.S. technological progress and building-up their regional economies by harnessing the power of new technology and advanced manufacturing.

## SECTION F

## America's X-Factor: Economic Dynamism, The Engine of U.S. Competitiveness

**A tornado of revolutionary technologies is sweeping the landscape, transforming every domain of human activity at every scale. During the next two decades, the evolving dimensions, disruptions, pace, and impacts of technological change are likely to increase and fundamentally reshape civilization—its economy, business, society, and human experiences. These technologies—and the products and services they enable—will revolutionize entire industries, drive economic growth, and transform how people work, live, learn, interact, and experience the world.**

**The source and size of a nation's long-term prosperity is the productivity with which it utilizes its human, capital, and natural resources to produce goods and services. Now and into a future, a nation's ability to redeploy these resources and tune its economic engines with speed and efficiency to ride waves of change—its economic dynamism—will be a fundamental determinant of its competitiveness, economic growth, and ability to create wealth.**

**What should the United States expect on this precipice of major disruption and transformation?** Artificial intelligence is expected to lead to a massive global transformation of the economy, society, human activity, and national security. For example, AI could change how society operates, change employment, and transform lifestyles. It is poised to drive a reordering of production, distribution, and consumption, resulting in a major industrial transformation. Because it offers the ability to mine the ever-expanding data universe—at scale with efficiency and speed—AI is already delivering dramatic results in scientific discovery and innovation.

### How Henry Ford's On-Site Powerhouses Fueled America's Industrial Revolution

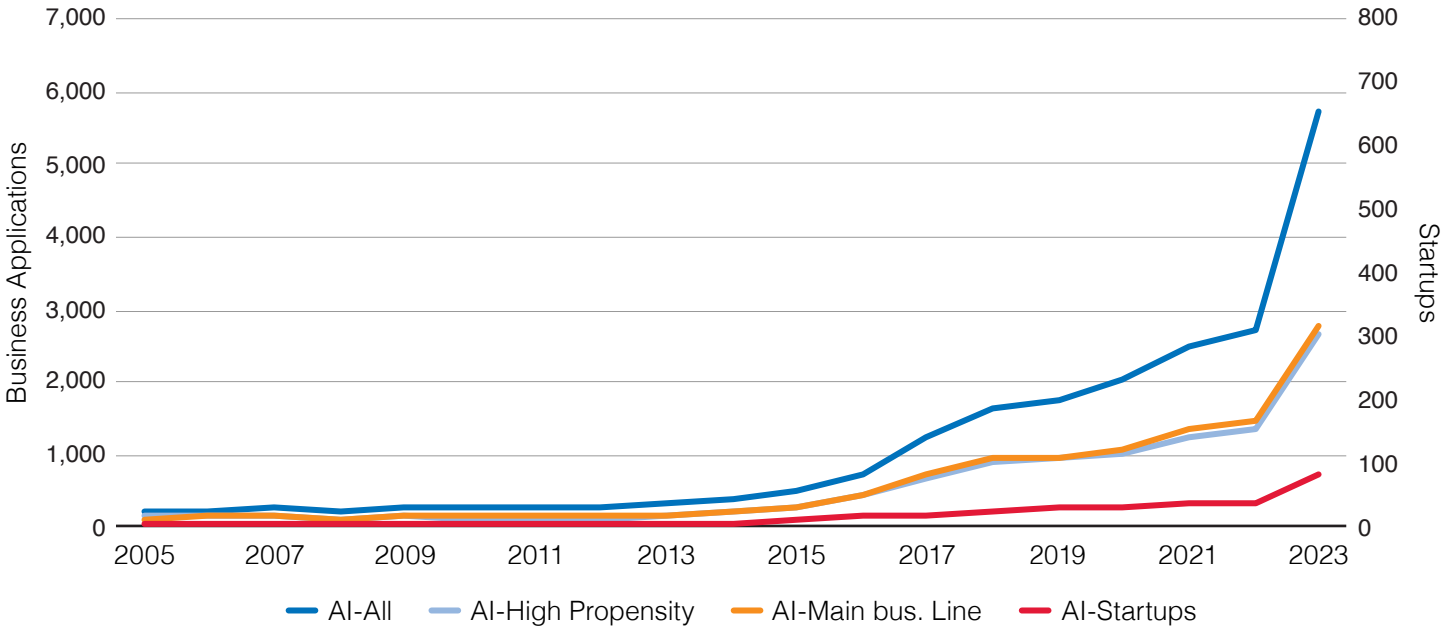
In an historical parallel example, as game-changing mass production began to scale, so did the demand for electricity to power the machines and assembly lines that drove a major transformation of U.S. manufacturing as well as the economy as a wide range of cheaper goods became available to millions of consumers. Mass production and moving assembly line pioneer Henry Ford built his own on-site powerhouses to generate the electricity needed for his Highland Park plant—the largest manufacturing facility in the world when it opened in 1910—and, in 1920, to power the massive River Rouge manufacturing complex.

AI is going to have game-changing impact on national security—potentially creating a major discontinuity at the cusp of Intelligent Age warfare. National security leaders are already applying Ai across the defense enterprise—in intelligence, surveillance, and reconnaissance; logistics and maintenance; command and control; weapons and vehicles. As AI converges with autonomous systems, including machine-to-machine applications, there will be new approaches to defense. With AI, the military could operate at the extremes of the time scale, with systems operating at gigahertz speed, dramatically increasing the tempo of battlefield action.

AI could disrupt labor at every level of the economy—task, job, organizational, industry, occupational, and labor market—and it will have an

## AI Business Applications and Formations Per Year

Source: Starting Up AI, E. Dinlersoz, et.al., Center for Economic Studies, Census Bureau, August 2024.




impact on employment and occupations historically unaffected much by automation such as doctors and financial advisors.

**The United States is reorganizing around AI.** Statistical data suggest AI is rapidly scaling in the United States, and the economy is beginning to reorganize around this game-changing technology. Business applications filed over the period 2004-2023 from startups that aim to develop AI technologies or produce goods or services that use, integrate, or rely on AI took a sharp upward turn beginning in 2022. (High propensity business applications transition to employer status with a much higher likelihood (23.9 percent) than non-high propensity (5.3 percent) over the same period.)[82]

In another potential sign of realignment in the economy, the scaling of AI is increasing the demand for compute power, placing pressure on data centers in the United States and the supply of electricity that powers them. As a result, AI leaders from the digital sector—Microsoft, Google, and Amazon—are pursuing nuclear energy to meet their power needs, and could disrupt and drive change in the energy sector.

**During technology revolutions, economic growth, and eras of disruption, change and displacements are inseparable.** The digital revolution has been one of the most disruptive events across the continuum of civilization, an unprecedented whirlwind of creative-destruction that has reshaped the economy, industry, society, and the human experience. The restructuring of an economy around powerful technologies is inherently disruptive, both creating and destroying businesses, markets, and jobs.

In the process, there are new market opportunities and new business formation, supply chains realign, labor markets shift, there is need for new skills, and investment capital flows in new directions. New activities supplant old ones, and more productive and innovative firms out-compete their

82 Starting Up AI, E. Dinlersoz, et.al., Center for Economic Studies, Census Bureau, August 2024.

## Automotive Manufacturing: A Microcosm of Technological Change, Disruption, and Dynamism in Action

Since the early 20th century, the American automotive industry has been one of the country's most innovative and important industries. Over the course of its history, it has experienced significant disruption and technological change—its transition from a craft-based industry to mass production, globalization of automotive manufacturing, the competitive challenge represented by Japanese auto makers total quality and just-in-time production methods that eventually scaled worldwide, the digitalization of vehicles, and pressure from competitors, customers, and regulators to improve vehicle energy efficiency.

**Today, the automotive industry is undergoing major transformation across numerous dimensions of its market, technology, operation, and supply chain.** Under environmental pressure and new customer incentives to drive a new direction in car purchases, the industry is shifting more production to electric vehicles which means vast changes in its technology, production, materials, supply chain, and fueling infrastructure.

Vehicles—products of a traditionally hardware and mechanical-based industry—are increasing in their internal digital content and driver controls, and their digital connection to infrastructure. Estimates suggest that electronics and software could represent as much as 50 percent of a vehicle's value by 2030. In the industry, AI is likely to be applied in design, production, in optimizing supply chains, improving logistics, and improving labor productivity. This increased digitalization will further integrate the industry in the digital and software supply chain. The transition to EVs and increasing digitalization are shifting the skill base in the industry, with greater demand for digital, software, and data science skills. For example, the Bureau of Labor Statistics projects that employment of data scientists in motor vehicle manufacturing will increase by more than 32 percent over 2023-2033.

The automotive parts industry is reorganizing with new market entrants from outside the traditional industry, for example, new players producing electric motors, batteries, automotive electronics, software. And new entrants from outside the auto industry are developing autonomous vehicles.

rivals, growing faster and taking market shares away from lower performers. If countries make it difficult to move workers from old jobs to new jobs, they choke off the very process of change that allows new jobs and activities to supplant the old.[83]

Countries with more dynamic economies—those with less friction in their economic system—tend to be more competitive and productive, and leverage new technology for greater economic gains. There is pain in these transformations as industries shift, and people and places can be left behind–raising the demand for new pathways for

83 How Economies Grow: The CED Perspective on Raising the Long-Term Standard of Living, A Statement by the Research and Policy Committee of the Committee for Economic Development, May 2003.

adjustment and assistance to help citizens navigate the change waves. However challenging, this dynamic process is the essential engine of innovation, productivity, economic growth, and rising standards of living.

**U.S. economic dynamism wins the Digital Age.** A recent economic analysis of longer-term productivity trends in the United States and Europe has found the United States systematically outperforms key global competitors. Take the EU as an example. In comparative productivity performance over 1996-2023, U.S. productivity rose at more than double the pace of the euro area, and nearly twice as fast as the EU. So, by the end of 2023, U.S. productivity levels were 3 1/2 times higher than the euro area and 2 1/2 times higher than the EU.[84]

The study credits that higher productivity to greater dynamism in the U.S. economy. As the digital revolution has unfolded, the U.S. economy is less tightly regulated, has a more flexible labor market, rewards innovation and has a financing system that drives it, and the legal system creates orderly resolution of failures. This has allowed U.S. companies to change operating procedures, management practices and incentives, and to redeploy workers and resources—all essential for reorganizing around game-changing technology.

**The European Commission's own recent competitiveness assessment echoes this analysis about dynamism.[85]** It shows that a wide gap in GDP has opened up between the EU and the United States, driven mainly by the previously referenced slowdown in European productivity growth. This GDP gap (at 2015 prices) has gradually widened from slightly more than 15 percent in 2002 to 30 percent in 2023. The EC's assessment identifies digital technology as the key driver of the widening U.S.-EU productivity gap.

According to the EC assessment, the dynamic U.S. economy has nurtured new, innovative technologies and investment followed, redirecting resources towards sectors with high potential for productivity growth. In contrast, Europe, with low dynamism, is stuck in a static industrial structure with few new companies rising up to disrupt existing industries or develop new growth engines. Over time, these differences in dynamism and the resulting productivity have had a significant economic impact on Americans: on a per capita basis, real disposable income has grown almost twice as much in the United States as in the EU since 2000.[86]

84 Productivity Surge: Mirage of Miracle, Marco Annunziata, Just Think, March 16, 2024.

85 The Future of European Competitiveness, Part A, European Commission, September 2024.

86 ibid.

## Factors Contributing to Level of Economic Dynamism: United States vs. Europe

### Innovation Ecosystem

**The United States invests more in R&D than the EU.** In 2022, the United States spent 3.6 percent of GDP on R&D compared to the EU's 2.1 percent of GDP.[87]

**U.S. researchers and innovators cooperate more with other partners than researchers and innovators in the EU.** In the EU, collaboration networks for research and innovation rarely extend across national or regional borders. In the United States, research and innovation collaborations across States are much more common, accounting for almost one-third of collaborations overall, almost 2.5 times more than the EU.[88]

### Capital

**The U.S. financial ecosystem that supports innovation is more developed compared to the EU financial ecosystem.** The share of global VC funds raised in the EU is only 5 percent, compared to 52 percent in the United States. Since 2013, there have been 137 VC funds larger than $1 billion in the United States compared to 11 in the EU.[89]

**The EU has insufficient equity financing and less long-term capital.** EU companies seeking funding for early-stage innovation generally turn to bank debt financing, considered unsuitable for supporting innovation development. And, the EU is undersupplie with long-term capital due to underdevelopment of pension funds. In 2022, the level of pension assets in the EU was 32 percent of GDP while U.S. total pension assets amounted to 142 percent of GDP.[90]

> In pharmaceuticals, the median approval time for new medicines in 2022 by European regulatory agencies was 430 days compared with 334 days in the United States. Once a new medicine has been approved by the European Medicines Agency, there are 27 different procedures to decide on national pricing and reimbursement.

**The United States has uniform tax policies that benefit R&D.** In the United States, the Research and Experimentation Tax Credit and Orphan Drug Tax Credit apply nationwide. The U.S. system includes Bonus Depreciation and Section 179 Expensing, which allow immediate deductions for a significant portion of the purchase price of eligible business property, including R&D equipment. There is no harmonized tax policy around research among EU member states.[91]

### Regulation

**EU companies face a heavier regulatory burden than companies in the United States.** About 3,500 pieces of federallegislation and about 2,000 resolutions were passed over the past three Congresses (2019-2024). During the same period, the EU passed around 13,000 acts–on top of national actions.[92]

87 Data updated; OCED Main Science and Technology Indicators.

88 The Future of European Competitiveness, Part B, European Commission, September 2024

89 The Future of European Competitiveness, Part A, European Commission, September 2024.

90 The Future of European Competitiveness, Part B, European Commission, September 2024.

91 The Future of European Competitiveness, Part B, European Commission, September 2024.

92 The Future of European Competitiveness, Part A, European Commission, September 2024.

- Regulation is seen by more than 60 percent of EU companies as an obstacle to investment.
- In 2023, 55 percent of EU small and medium-sized enterprises flagged regulatory obstacles and the administrative burden as their greatest challenge.

Source: The Future of European Competitiveness, European Commission, September 24, 2024.

**The EU has about 100 technology-focused laws, and more than 270 regulators active in digital networks.[93]**
Many EU laws dictate specific business practices to avert potential risk. For example, the EU AI Act imposes additional regulatory requirements on general purpose AI models that exceed a pre-defined threshold of computational power—a threshold which some state-of-the-art models already exceed.

### Labor Mobility

**Labor mobility within the EU is limited compared to within the United States, due to language, cultural, and regulatory barriers.[94]**
For example, access to many professions is regulated by EU Member States and requires specific professional qualifications.[95]

## Differences in Dynamism Have Real Impact

**Differences in economic dynamism between the United States and the EU have had real competitive and economic impact.** For example, from 2013 to 2023, the EU's share of global tech revenues dropped from 22 percent to 18 percent, while the U.S. share rose from 30 percent to 38 percent. And a testament to the dynamism inherent in the U.S. financial system, U.S. household savings are around a quarter of the EU level, 3.2 percent vs. 12.7 percent. However, despite their higher savings, EU households have considerably lower wealth than their U.S. counterparts. Between 2009 and 2023, net household wealth increased by 151 percent in the United States, compared with only 55 percent in the euro area.[96] This gap largely reflects the greater capacity of the U.S. financial system to transform household savings into high-yielding investments, partly owing to the greater depth and efficiency of the U.S. capital market.

**Despite the higher economic dynamism exhibited by the United States, there are troubling long-term trends.** High-growth firms are critical engines of innovation and economic growth, and punch well above their weight in creating jobs and fostering productivity growth. However, in the United States, the share of firms that are high-growth has steadily decreased over the past four decades, driven by falling firm entry rates and stagnating growth among existing firms. The trend is particularly pronounced among young and small firms, and the decline is found in all sectors.[97]

93 ibid.

94 Labour Market Adjustments in Europe and the U.S.: How Different?, R. Beyer and F. Smets, ECB Working Paper Series, No 1767, 2015.

95 Occupational Regulation in the European Union: Coverage and Wage Effects, M. Koumenta and M. Pagliero, British Journal of Industrial Relations, Volume 57, Issue 4, 2019 and Occupational Energy Regulations and their Effects on Productivity in Services, OECD, 2020.

96 Data from Federal Reserve Economic Data for the United States, and ECB Distributional Wealth Accounts for the euro area.

97 High-Growth Firms in the United States: Key Trends and New Data Opportunities, Kim, et.al., Center for Economic Studies, Census Bureau, March 2024.

## U.S. Dynamism Crucial in Crisis and Key to Resiliency: The Case of COVID-19

When COVID-19 hit sending the U.S. population into lock-down, U.S. dynamism ramped up and massive changes occurred in less than year and often in just days:

- Millions of white collar workers shifted to telework practically overnight. Companies quickly reengineered work processes, reworked communications, reconfigured management and work teams, rolled out new digital strategies, and altered supply chains, manufacturing, and modes of product and service delivery in response to dramatic demand shifts.
- Digital strategies that had been planned for rollout over months or years, were scaled in days.
- The home delivery sector scaled its workforce by hundreds of thousands.
- New procedures were put in place to protect workers in manufacturing, warehousing, and retail.
- With hand sanitizer in short supply, distilleries shifted production to make it.
- Sports protective equipment makers shifted to making face shields for medical workers, and fashion houses turned to sewing masks.
- Companies switched production over from packaging and quantities designed for use by commercial establishments, to packaging and quantities suitable for home use.
- Hotels vacant due to stay-at-home orders were put to use housing medical workers.
- Telehealth scaled.
- Many restaurants shifted to take-out operations, and some set up small convenience stores where patrons waited for their carry out food orders.
- The research community mobilized to develop tests, and developed a vaccine faster than ever before.

## About the Council on Competitiveness

For 39 years, the Council on Competitiveness (Council) has championed a competitiveness agenda for the United States to attract investment and talent, and spur the commercialization of new ideas.

While the players may have changed since its founding in 1986, the mission remains as vital as ever—to enhance U.S. productivity and raise the standard of living for all Americans.

The members of the Council—CEOs, university presidents, labor leaders and national laboratory directors—represent a powerful, nonpartisan voice that sets aside politics and seeks results. By providing real-world perspective to Washington policymakers, the Council's private sector network makes an impact on decision-making across a broad spectrum of issues—from the cutting-edge of science and technology, to the democratization of innovation, to the shift from energy weakness to strength that supports the growing renaissance in U.S. manufacturing.

The Council's leadership group firmly believes that with the right policies, the strengths and potential of the U.S. economy far outweigh the current challenges the nation faces on the path to higher growth and greater opportunity for all Americans.

## Contact

For more information, please contact:

**Mr. Chad Evans**
Executive Vice President
Chief Operating Officer
Secretary and Treasurer to the Board
cevans@compete.org

**Council on Competitiveness**
900 17th Street, NW
Suite 700
Washington, D.C. 20006

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