



# **Lighting the Path to a Competitive, Secure Future**

**A White Paper by the National Photonics Initiative**

Webinar

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# Introduction

Tom Baer

NPI Advisory Committee Chair

Stanford Photonics Research Center

# Photonics

- Optics and photonics are the science and application of light.
- Photonics generates, controls and detects light to advance robotics, manufacturing, medical imaging, next-generation displays, defense technologies, biometric security, image processing, communications, astronomy and much more.
- Photonics forms the backbone of the Internet; guides energy exploration; and keeps men and women in uniform safe with night vision, GPS and physiological feedback on the battlefield.
- Photonics is addressing and solving the challenges of a modern world while enhancing our quality of life; improving our health, safety and security; and driving economic growth, job creation and global competitiveness.

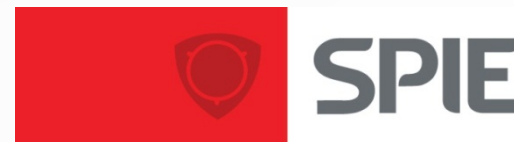
# A Lesson From History

- In 1998, the National Research Council released a report, “Harnessing Light,” which presented a comprehensive overview of the potential impact of optics and photonics on major sectors of the US economy.
- Several economies moved to advance their already strong optics and photonics industries.
- Historically the United States has been the world leader in deploying photonics research to power cutting-edge technologies, but global competition has put at risk this leadership position, which is causing a substantial loss of global market share to overseas competitors as well as thousands of US jobs.

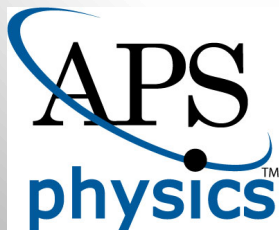
# A National Photonics Initiative

- In 2012, the National Research Council released the report *Optics and Photonics: Essential Technologies for Our Nation* that called for a National Photonics Initiative (NPI).
- The NPI will seek to:
  - Raise awareness about photonics and the impact of photonics on our everyday lives.
  - Increase collaboration and coordination among US industry, government and academia to advance photonics-driven fields.
  - Drive US funding and investment in areas of photonics critical to maintaining US competitiveness and national security.

- NPI Founding Sponsors:



- NPI Sponsors:



# NPI White Paper



- Authors include more than 100 experts from industry, academia and government.
- Collaborated to create a white paper to serve as a roadmap for guiding NPI advocacy and US funding and investment in five key photonics-driven fields:
  - advanced manufacturing
  - communications and information technology
  - defense and national security
  - energy
  - health and medicine
- New opportunities in these five fields offer the potential for even greater societal impact in the next few decades and a tremendous opportunity for US job creation.

# NPI White Paper Recommendations

- **Drive funding and investment in areas of photonics critical to maintaining US competitiveness and national security — advanced manufacturing, defense, energy, health and medicine, information technology and communications;**
- **Develop federal programs that encourage greater collaboration between US industry, academia and government labs to better support the research and development of next-generation photonics technologies;**
- **Increase investment in education and job training programs to reduce the shortage of technically skilled workers needed to fill the growing number of photonics-based positions;**
- **Expand federal investments supporting university and industry collaborative research to develop new manufacturing methods that incorporate photonics such as additive manufacturing and ultrashort-pulse laser material processing; and**
- **Collaborate with US industry to review international trade practices impeding free and fair trade and the current US criteria restricting the sale of certain photonic technologies overseas.**

# NPI Subcommittee on Advanced Manufacturing

Subcommittee Chair:

Mark Taggart

Laser Mechanisms Inc.



# Background

The logo for the National Photonics Initiative (NPI), consisting of the letters "NPI" in white, bold, sans-serif font inside a dark grey square.

- Apple's consumer electronic products, Intel's processing chips, Caterpillar's machinery, Ford's automobiles, and General Electric's aircraft engines and lighting products have realized a competitive advantage of photonics-based manufacturing.
- The use of photonics technologies in advanced manufacturing has improved key factors of products such as size, weight, performance and cost and is a driving force behind the revitalization of manufacturing in the United States.
- Strategic investment in the development of next-generation photonics manufacturing technology will help the United States secure a strong manufacturing future by increasing its industrial competitiveness in the global market.

# Recommendations



- Invest in the development and production of high-power laser technology and systems to advance manufacturing in the United States.
- Invest in a coordinated national effort to improve our understanding of laser-material interaction for applications in heavy industry and manufacturing for material processing of metals, ceramics, plastics, composites and glass.
- Invest in adopting higher-resolution technology for additive manufacturing.
- Create applied research and development institutions funded by public-private investment dedicated to photonics manufacturing innovations that are driven by industry needs.
- Develop two-year certificate and undergraduate degree programs in design and laser materials processing.
- Incorporate photonics technician training and certificate programs into existing education and retraining programs such as those for veterans.

# NPI Subcommittee on Communications & Information Technology

Subcommittee Chair:  
Steve Grubb  
Infinera

# Background



- Almost all data we receive today is encoded, disseminated and received using lasers, fiber optics and optical detectors.
- Over the past 30 years, innovations in optics, electronics and optical systems engineering increased performance and dramatically reduced communications costs.
- Despite impressive technical advances that fueled the exponential growth in data traffic, companies are seeking innovative new solutions to meet the continuing growth in demand.
- Without improvements to address the critical pain points of cost, power consumption, data rate and size, demand will outstrip capacity, which may lead to higher costs and could possibly even constrain the greater US and global economy.
- Integrated photonic circuits will be a critical competitive differentiator for applications ranging from telecommunications networks to data center links to computer and on-processor interconnects.
- The leaders of this revolution will gain sustainable advantages in national security and in advancing the infrastructure that enables our Internet-based economy.
- US leadership in the IT sector will drive high-value service and manufacturing jobs for years and decades to come and will launch spin-off technologies.

# Recommendations



- **Renew and increase federal funding for future generations of technology, with programs that allow access by researchers in publicly traded companies, private companies and universities.**
- **Uphold fair trade practices to ensure that intellectual property is protected in the telecommunications equipment market.**
- **Develop a healthy supply chain of trusted components and equipment for the US infrastructure such as a domestic commercial-grade facility for fabricating integrated photonics components, co-founded by industry and the government or secure US-based trusted sources for complete optical telecommunications systems.**
- **Increase state and federal funding for practical training and education in optics and photonics, and funding for NSF's National Center for Optics and Photonics Education.**
- **Re-evaluate US work visa policy so US employers attract and retain the best-qualified and trained employees, and create and improve training opportunities at home to better train and thus employ US residents.**
- **Adopt policies that promote the installation of next generation broadband infrastructure throughout US communities.**

# NPI Subcommittee on Defense & National Security

Subcommittee Chair:

James Horkovich

Directed Energy Professional Society

# Background

The logo for NPI (National Photonics Initiative) consists of the letters "NPI" in a bold, white, sans-serif font, centered within a solid black square.

- When US soldiers step onto the battlefield, their safety and ability to efficiently carry out their mission rests largely on optics and photonics technology.
- The ability to gather and transfer information quickly can be the deciding factor in times of conflicts.
- Current and future US superiority in intelligence, reconnaissance , and surveillance (IRS) and high-power laser capability is and will continue to be determined by photonic technologies.
- While defense needs are unique, the advanced technologies developed to meet those needs can be leveraged to drive new generations of high-tech commercial applications such as a high-speed, secure Internet and advanced medical imaging, diagnostics and treatments.
- Coordinated investment and associated technology development in remote sensing, photonic integrated circuit manufacturing, advanced lasers and cybersecurity will help ensure future military and economic security.

# Recommendations

- **Significantly increase investment in all elements of High-energy laser (HEL) systems and the full spectrum of high-energy laser technologies, and set a national vision for strategic and tactical high-power laser system implementation.**
- **Develop continuous, infrared gigapixel sensors with ability to image very wide areas at night or day in high-resolution 2D and 3D.**
- **Establish a photonic foundry service tailored to the needs and volumes of the military, which are much more demanding than most commercial specs.**
- **Invest in research to develop low-cost packaging solutions in the United States for photonics integrated circuits.**
- **Establish a national vision for R&D in photonics technologies to reinvigorate our science- and technology-driven defense workforce.**



# NPI Subcommittee on Energy

Subcommittee Member:

Tom Baer

Stanford Photonics Research Center

# Background

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- The United States is the second-largest consumer of energy in the world with a significant portion of US energy coming from other countries, influencing our foreign policy, and impacting our national security.
- Global demand for new energy sources represents a significant growth opportunity for US manufacturers and energy producers.
- Photonics-based technologies have the potential to reshape our energy future into one that is cleaner, more efficient and more secure.
- It is essential that the US expand existing federal programs funding and coordinating high-impact research in renewable energy ,encouraging and supporting greater industry, academia, government lab collaboration.

# Recommendations

The logo for the National Photovoltaic Institute (NPI) is located in the top right corner. It consists of the letters "NPI" in a bold, white, sans-serif font, centered within a solid black square.

- Increase funding for federal solar R&D supporting collaboration among industry, academia and national labs to work on longer-term, but commercially viable projects.
- Create a permanent industrial advisory committee for the Department of Energy (DOE) solar initiative to assist in documenting industry needs and to aid in developing a coherent national federal funding strategy.
- Establish an ongoing road mapping program for solar energy with input from industry, academia, national labs and government agencies with an emphasis on performance, cost, and market trajectories.
- Increase federal funding for basic materials research to support improvements in solid-state lighting performance.
- Increase federal funding to develop new manufacturing methods and technologies for solid-state lighting.
- Create a road map for sensing applications that includes fiber and free-space technologies covering all aspects of energy production and environmental impact monitoring. This activity should include an industry-based consortium to ensure relevance to near-term and longer-term commercial needs.

# NPI Subcommittee on Health & Medicine

Subcommittee Chair:  
Stephen Laderman  
Agilent Technologies, Inc.

# Background

The logo for the National Photonics Initiative (NPI) consists of the letters "NPI" in a bold, white, sans-serif font, centered within a solid black square.

- The United States enjoys a technologically advanced yet costly health care system.
- Photonics plays a key role in next generation health care, both in enhancing our ability to observe and measure symptoms as well as our capability to treat patients earlier with less invasive, more cost-effective methods.
- Photonics-based health care tools offer sensitivity, precision, speed and accuracy, enabling rapid, personalized diagnosis and effective therapy — key ingredients for high-quality, cost-effective care.
- The development of smaller, more portable, automated, point-of-care diagnostic devices has the potential to further improve health care and reach more patients.
- While the United States is the acknowledged world leader in biophotonics, medical devices and diagnostic products, other nations are making significant investments in medical instrumentation.
- A focused, photonics-driven effort in health care and medicine is needed to maintain the country's leadership position.

# Recommendations



- **Allocate research funds for advanced photonics research as an integral part of programs relying on novel measurements for the advancement of understanding human biology, and disease.**
- **Invest in the creation of an information technology infrastructure for sharing large amounts of medical and clinical data (e.g., well annotated medical images) and research into algorithms and software for analyzing such data.**
- **Prioritize development of imaging standards and software methods that automate the extraction, quantification and identification of regions of interest in multidimensional data sets.**
- **Fund the development of affordable, automated point-of-care diagnostic devices in areas of major medical needs such as infectious diseases, internal traumatic injuries and cardiac arrest, and invest in the development and enhancement of existing optical technologies suitable for innovative medical applications.**
- **Increase collaboration between US government, regulatory agencies and industry to create an accelerated process for advanced clinical trial designs for medical instrumentation and supporting clinical trials of promising new cost-savings methods.**
- **Increase medical expert and industry engagement in the evaluation of research proposals, and use their recommendations for medical applications as motivation and guidance for next steps in the commercialization process.**
- **Expand investment in multidisciplinary centers, such as universities with medical and engineering schools, at which critical developments that combine discoveries in multiple fields can be efficiently fostered.**

# Questions?

Overview & Energy-Tom Baer

Advanced Manufacturing- Mark Taggart

Communications & Information Technology- Steve Grubb

Defense & National Security-James Horkovich

Health & Medicine- Stephen Laderman

# For Additional Information



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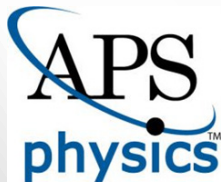
# Acknowledgements

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**Sponsors:** American Physical Society (APS), IEEE Photonics Society (IEEE) and Laser Institute of America (LIA).



**Collaborators:** Directed Energy Professional Society (DEPS), Infinera, Laser Mechanisms (Laser Mech), National Academy Sciences (NAS), Optoelectronics Industry Development Association (OIDA) and Stanford Photonics Research Center (SPRC).

