

Energy & Manufacturing Competitiveness Partnership

# Leverage.

Phase I Sector Study:  
Advanced Materials



U.S. Council on  
Competitiveness

## Leverage.

### Phase I Sector Study: Advanced Materials

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**U.S. Council on  
Competitiveness**



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## Letter from the Co-Chairs

On behalf of the U.S. Council on Competitiveness (Council), QuesTek Innovations LLC, and Worcester Polytechnic Institute, we are pleased to present the final report on the Energy and Manufacturing Competitiveness Partnership (EMCP) sector study dialogue on advanced materials, held on April 12, 2016 at the Council offices in Washington, D.C. *Leverage: Advanced Materials* is the second sector study report to come out of the EMCP in year one and provides a summary of the analysis, findings, and recommendations related to the manufacturing and use of advanced materials.

Sector studies are the heart of the EMCP's agenda of discovery and action, and they examine industrial competitiveness through the lens of the energy-manufacturing nexus. They identify the critical cross-cutting and distinct roadblocks in technology, talent, investment and infrastructure to leverage America's energy abundance and innovation ecosystem, rebuilding national competitiveness on a strong foundation of manufacturing capacity.

This sector study builds on the Council's long-standing work on advanced materials under the American Energy & Manufacturing Competitiveness Partnership, which hosted three dialogues on the topic in 2015. Among the key findings are the need for a digital database that can facilitate knowledge sharing across industries and sectors of the economy and the need to de-stigmatize once-revered manufacturing jobs. And while the details may differ, it is becoming increasingly clear that these issues are not only unique to the materials sector, but also cut across many regions and industries.

We recognize that none of this would be possible without the support of our members and key experts that provided their valuable input and unique perspectives and we thank them all for their work with us. We look forward to continuing engagement with national and regional leaders in industry, academia, national laboratories and government as we capture insights and recommendations across our sector dialogues and put forward an action plan to increase U.S. competitiveness.



*Dr. Aziz Asphahani, Chief Executive Officer, QuesTek Innovations LLC; Dr. Laurie Leshin, President, Worcester Polytechnic Institute; and the Honorable Deborah L. Wince-Smith, President & CEO, U.S. Council on Competitiveness.*

Sincerely,

The Honorable Deborah L. Wince-Smith  
President & CEO  
U.S. Council on Competitiveness

Dr. Aziz Asphahani  
Chief Executive Officer  
QuesTek Innovations LLC

Dr. Laurie Leshin  
President  
Worcester Polytechnic Institute

# Introduction



Co-chairs Dr. Aziz Asphahani, Chief Executive Officer, QuesTek Innovations LLC; the Honorable Deborah L. Wince-Smith, President & CEO, U.S. Council on Competitiveness; and Dr. Laurie Leshin, President, Worcester Polytechnic Institute, lead the dialogue discussion.

Advanced materials are critical building blocks that can drive significant enhancements in America's energy production, manufactured products and the overall economy. Early adoption of advanced materials by manufacturers can differentiate U.S. products from those of competitors by increasing performance and durability, decreasing production and maintenance costs and improving energy efficiency over the life cycle use of the product. Use of these new materials in commercial products also drives the market for the materials themselves.

The Energy and Manufacturing Competitiveness Partnership (EMCP) sector study dialogue on advanced materials, hosted on April 12, 2016, by the U.S. Council on Competitiveness (Council) in part-

nership with QuesTek Innovations LLC and Worcester Polytechnic Institute convened national leaders and materials experts from all sectors of the economy to discuss how the development and deployment of advanced materials can increase U.S. competitiveness. The day focused first on the current capabilities in U.S. national labs, universities and across the private sector in advanced materials, then moved to barriers and impediments to fully deploying the promise of advanced materials across the manufacturing and energy sectors and, finally, focused on solutions to these challenges across the Council's four cross-cutting pillars of competitiveness: **infrastructure, technology, investment** and **talent**.

# Takeaways & Recommendations

- **Promote the uptake of more public private partnerships (PPP) between the national laboratory system and industry partners, small businesses and universities.** The development stage of materials is suffering when it comes to scaling-up materials for mass production and use. Small and medium-sized businesses must have consistent access to laboratory spaces and other critical infrastructure and technologies. PPPs would allow designers to develop new innovative products, and the gathering of key university experts to perform fundamental research in science, engineering and technology areas under one location would connect American manufacturers to global markets.
- **Develop a national knowledge platform to ensure that accurate, pedigreed, curated and easily accessible data is developed to support the creation, processing, modeling and manufacturing of advanced materials.** The current digital knowledge database on materials is extremely limited and under-developed. As a result, there is a significant amount of usable data that cannot be absorbed because it is not connected or curated. The leap forward for technology in the area of advanced materials will likely come from the broad dissemination of tools with interoperability as a key enabler.
- **Gather critical masses of materials experts into business groups or entities to work with materials technologies as a collective effort to combine distinct knowledge bases and spur unique funding opportunities.** Materials experts operate separately from one another, which creates gaps in data management and further complicates the standardization needed to advance this field. Cross-functional collaboration throughout and between various small and medium-sized businesses can become part of leading expert groups specializing in accelerating both discovery and development of materials.

- **Dedicate area-specific pilot-plant facilities to collaborate with national laboratories, universities and small & medium-sized companies to accelerate deployment and decrease the commercialization time horizon for advanced materials.** Industry access to scientific and technical resources will help manufacturers develop and deliver new, innovative products to market and qualify materials in faster-paced, more efficient systems. Such pilot-plant facilities will help decrease the expected deployment time and accelerate the entire discovery-to-deployment cycle.  
  
In the absence of private sector support of the needed pilot-plant facilities, it is recommended that government agencies (e.g., DoE, DoD, NIST) take the lead by establishing a “Materials Genome Processing Center”, as the first pilot-plant facility that is needed to achieve the Materials Genome Initiative (MGI) goal of ensuring a manufacturing infrastructure for materials innovations.
- **Address the skills gap in the advanced materials and manufacturing sector by embracing an interdisciplinary approach to education that combines traditional materials science curricula with data science, modeling and simulation and computational sciences.** A recent survey revealed that respondents between 19 and 33 years old would select a manufacturing career last.<sup>1</sup> Reintroducing hands-on training at the K-12 level can address the misconceptions around the manufacturing sector and lack of knowledge regarding the emerging opportunities in advanced manufacturing, while partnerships between academia and industry designed to nurture cross-disciplinary skill sets at the undergraduate and graduate levels can ensure a strong talent pipeline.

<sup>1</sup> *Overwhelming Support U.S. Public Opinions on the Manufacturing Industry*, Deloitte United States (Deloitte Development LLC) and The Manufacturing Institute, 2014.

# Setting the Stage

Half of the growing global energy demand over the next 25 years is expected to come from clean energy. As America looks to make sustainable advancements in energy and manufacturing needed to remain competitive in this changing landscape, the need for rapid discovery, development and deployment of new materials is increasingly important.

Identified as one of fourteen key technical areas of manufacturing-focused technologies by U.S. Department of Energy's *Quadrennial Technology Review for 2015*,<sup>2</sup> advanced materials are critical building blocks that can drive American energy and manufacturing competitiveness. New alloys can be used to improve the efficiency of coal-fired power plants. Advanced composites have the potential to reduce the cost of wind power and drive down the production cost of wind turbines. Nuclear and renewable energies, as well as carbon capture storage (CCS) and the disposing of carbon dioxide waste, all rely on the integration of new, advanced materials.

Infrastructure projects now often incorporate innovative materials in their design due to the enhanced properties that can improve efficiency and sustainability as well. The transportation sector benefits from advanced materials by enabling the development of longer-range car batteries and lighter, faster and safer vehicles. Thermoelectric materials can convert a portion of the nearly 40 percent of an automobile's energy lost to waste heat in the exhaust gas into useful electricity.

Despite these numerous benefits, only a small fraction of materials make it to widespread commercialization. The amount of investment required to design, develop, manufacture and deploy advanced materials can shelve a project mid-stream or even inhibit a project from getting off the ground. Market incentives encourage firms to focus on low-risk, incremental improvements to existing technologies rather than investing in new and unproven transformational technologies. A lack of access to shared infrastructure and expertise often hinders industry, scientists and engineers in speed and cost on the path from design to production and commercialization.

Advanced materials and material technologies have the potential to increase American competitiveness in energy and manufacturing, making materials science and engineering central leverage points for American prosperity and future economic advancements. However, moving new materials into widespread adoption is larger in scope and more multifaceted than the capabilities of any one private or public entity. Bringing advanced materials into manufactured processes and products and deploying these materials in the marketplace requires a coordinated effort on the part of industry, academia and our national labs to support the requisite technologies, infrastructure, skills and investment needed in this crucial sector.

<sup>2</sup> Chapter 6: *Innovating Clean Energy Technologies in Advanced Manufacturing: Technology Assessments*, Quadrennial Technology Review 2015, U.S. Department of Energy, 2015.

# Stakeholder Dialogue



*Dr. Mark Johnson, Director of the Advanced Manufacturing Office, U.S. Department of Energy, delivers a lunchtime presentation to the dialogue participants.*

## Advanced Materials

The manufacturing of clean energy solutions and clean technologies has been at the forefront of American competitiveness for decades. In order to maintain and elevate competitiveness in manufacturing, the United States must address the challenges and capitalize on the opportunities regarding the design, production and scaling of advanced materials that often go into these and a variety of other new and innovative products.

The scope of these challenges and opportunities often includes defining policies, roadmaps and norms on which a range of entities across supply chains can agree. Accelerating the transition from discovery and development to commercialization and widespread adoption also requires creation of modeling and simulation tools, and creation of universally recognized standards and performance verification.

Additionally, these efforts cannot be undertaken alone but require coordinated public-private partnerships to promote quick and effective advancements.

The Energy and Manufacturing Competitiveness Partnership (EMCP) sector study dialogue on advanced materials gathered national leaders and experts to discuss important issues around accelerating U.S. competitiveness in advanced materials and enhancing U.S. manufacturing capability and capacity.

The day was divided into sections designed to address current capabilities in national labs, universities and across the private sector, barriers and impediments to fully deploying the promise of advanced materials across the manufacturing and energy sectors, and solutions to major challenges in each of the four key pillars of competitiveness: talent, technology, investment and infrastructure. Presentations from key leaders in these areas—as well as participant breakouts that each took a deeper dive into



*Dr. Jim Roberto, Associate Laboratory Director of Science & Technology Partnerships, Oak Ridge National Laboratory Dialogue, contributes to the discussions of the role of infrastructure in leveraging advanced materials.*

issues around talent, technology, investment and infrastructure—yielded robust conversations and, ultimately, a set of recommendations that will feed into the larger EMCP project and the Council’s action plan for the president-elect.

### **Advanced Materials: Infrastructure**

The infrastructure of the advanced materials sector has enabled the achievement of tremendous milestones with modeling and simulation driving rapid innovation. A variety of recent advancements have been made in high performance computing that will prove to be transformational in enabling greater predictive modeling and simulation power in the near future.

Current research efforts on advanced materials in our national laboratories, universities and private sector industries include a plethora of noteworthy accomplishments, with the Materials Genome Initiative (MGI) leading the way by reducing the cost and time associated with the deployment of advanced materials.

New advanced materials development efforts include the launching of the Energy Materials Network (EMN) as well as the expansion of Nanoscale Science Research Centers (NSCRs). Through collaboration with the U.S. Department of Energy and select national laboratories, these NSCR user facilities

operate as resource hubs for universities, scientific researchers and private sector users to host interdisciplinary research at the nanoscale level. Equipped with advanced tools and computing capabilities, each center specializes in specific fields such as nanomaterials, modeling and simulation, and electronic materials.<sup>3</sup>

Cross-sector partnerships in the form of national innovation centers—such as the Center for Materials Processing Data (CMPD), a consortium of industry, government and university members—are developing transient materials property data for process models and simulations (see Figure 2). These types of cross-sector partnerships have successfully bridged the gap between sector-specific problems and solutions. With the gathering of industry experts and university scientists, fruitful partnerships have launched significant accomplishments, such as national centers for advanced manufacturing, U.S. Department of Energy Innovation Hubs and Manufacturing Innovation Institutes (MIIs), which analyze lightweight materials, photonics and additive manufacturing.<sup>4</sup>

<sup>3</sup> *User Facilities: Nanoscale Science Research Centers (NRCs)*, Office of Science, U.S. Department of Energy, November 9, 2015.

<sup>4</sup> *Infrastructure for Advanced Materials Innovation: Presented to Council on Competitiveness Energy and Manufacturing Competitiveness Partnership Phase I Sector Study: Advanced Materials*. Jim Roberto, April 12, 2016.

## Figure 2: Center for Materials Processing Data (CMPD)

The Center for Materials Processing Data (CMPD) is a consortium of industry, government and university members developing transient materials property data for process models and simulations. For example, emissivity and heat transfer values as a function of temperature to be used in a casting simulation.

The Center is founded by ASM International (professional materials science society) with academic partners from Worcester Polytechnic Institute,

University of Connecticut and University of Buffalo. Pratt & Whitney represents the founding partner company.

This consortium creates access to greater amounts of high-quality, pre-competitive data at substantially lower cost than stand-alone methods can provide. Member organizations benefit from shared expertise, collaborative quality assurance, and development and use of best practices for qualifying data needed for modeling materials.

### Center Goals

<b>Generate</b>	Generate transient data for easy input into design and manufacturing models
<b>Mine</b>	Extract information from raw data collected from known reputable sources
<b>Verify</b>	Verify experimental and computational data and related models for pedigree
<b>Validate</b>	Validate existing and newly developed models with various data sources
<b>Disseminate</b>	Disseminate raw data and application information to consortium members
<b>Educate</b>	Train today's workforce and tomorrow's leaders on the use of Integrated Computational Materials Engineering Technologies (ICME)



*Dr. Zi-Kui Liu, Professor of Materials Science & Engineering, Penn State University, delivers a presentation on the role of technology in leveraging advanced materials.*

Despite these achievements, the scale-up of materials and pilot scale synthesis requires laboratory space and specific equipment beyond what is currently available, especially in the alloy manufacturing space, making accessibility to the appropriate environment a prominent obstacle for small and medium-sized companies and other entities without readily available access to laboratory space.

### **Advanced Materials: Technology**

One of the major advancements in technology around advanced materials has been the development of Integrated Computational Materials Engineering Technologies (ICME). By altering the way we determine the predictability of materials, the technology platform has proven to be a better alternative to the traditional, empirical methods of material development.<sup>5</sup>

For example, in 2010 QuesTek Innovations LLC developed Ferrium S53 Ultra High-Strength (UHS) steel, a corrosion-resistant, ultra-high strength steel that thrives under extreme conditions typically seen in the aerospace industry and the first UHS steel to be a fully computationally designed and qualified (see Figures 3 and 4).

The material outperforms its predecessor, incumbent steel that requires a hazardous, toxic plating to prevent stress corrosion cracking and reduce specific manufacturing costs.

The next leap forward for technology in the area of advanced materials will likely come from the broad dissemination of tools with interoperability as a key enabler. This can be facilitated by the digitization of information and massive electronic collaboration through knowledge databases. The current digital knowledge database on materials is extremely limited and underdeveloped. As a result, there is a significant amount of usable data that cannot be absorbed because it is not connected or curated. While one of the initial goals of the MGI was to develop this digital knowledge, there remains a significant amount of work to be done.

<sup>5</sup> *Quesstek's Proven ICME Success*, QuesTek Innovation, LLC, 2016.

**Figure 3. Ferrium S53 stainless steel used in main landing gear on the U.S. Air Force T-38 aircraft.**

Source: Ferrium® S53® Overview, Questek Innovations, LLC.



**Figure 4. Ferrium S53 stainless steel used as the helicopter mast on the United States Navy MH-60S helicopter designed and manufactured by Sikorsky Aircraft Corporation.**

Source: Ferrium® S53® Overview, Questek Innovations, LLC.



**Advanced Materials: Talent**

It is critical to develop a pipeline of well-educated and qualified students who have knowledge, skills, industry exposure and, most importantly, area-specific management training. A key challenge in the advanced materials sector, similar to many other sectors in the manufacturing space, is attracting talent and nurturing it through the early stages of post-secondary education through job training and on to career development. Students who are exposed to multiple concepts throughout the science, technology, engineering and mathematics (STEM) fields and are working across multi-disciplinary fields of study throughout their academic careers are more likely to be better equipped to explore and succeed at a career in the materials sector. A multi-disciplinary approach that includes a broad understanding of design, manufacturing and deployment of materials will be instrumental to the future of materials science workers. One area of tremendous potential is to leverage job training program opportunities at the community college level that are linked to or coordinated with local employers.

The advanced materials sector must develop the proper talent while fighting the prevailing negative public perception of the manufacturing industry. A recent survey revealed that out of seven career industries, respondents between 19 and 33 years old would select a manufacturing career last.<sup>6</sup> This problem is compounded by the aging of workers in the “baby boomer” generation, which will leave a difficult gap to fill in the pipeline of trained workers.

The Advanced Materials Systems (AMS) Framework for Collaborative Innovation, a solution-based agenda created by the World Economic Forum, looks to address some of the key challenges in this field including those around talent, but the changing complexity of the sector requires a shift in the mentality of the millennial generation and the de-stigmatization of a sector that, in the 1950s-1970s, held a highly-esteemed reputation.

<sup>6</sup> *Overwhelming Support U.S. Public Opinions on the Manufacturing Industry*, Deloitte United States (Deloitte Development LLC) and The Manufacturing Institute, 2014.



*Dialogue participants discuss the four pillars of competitiveness—talent, technology, investment and infrastructure—in afternoon break-out groups.*



*Mr. Adam Khan, Founder and CEO, Akhan Semiconductor; Mr. Carl Shurboff, Chief Operations Officer, AKHAN Semiconductor; and Mr. Greg Morin, Director of Strategy and Innovation, Argonne National Laboratory.*

### **Advanced Materials: Investment**

Investment in the advanced materials space can be viewed from two distinct perspectives: a scientific standpoint and an engineering standpoint. From a scientific perspective, investing in development of advanced materials allows for building knowledge and skill. Investing in the engineering of advanced materials generally leads to creating profitable business based on product development and deployment. In both scenarios, government support has been the leading source of funding (e.g., DoE and DoD).

Government agencies, such as the U.S. Department of Energy, have made considerable efforts to encourage collaboration and advancement through programs like the Office of Energy Efficiency and Renewable Energy (EERE) Small Business Voucher pilot, which allows small businesses to request national laboratory technical assistance to overcome challenges such as prototyping, modeling and simulations, validations of technology performance and many others.<sup>7</sup>

Targeted efforts such as the U.S. Department of Energy's Energy Materials Network (EMN) help to relieve this problem by collaborating with the national laboratories to dramatically decrease the time-to-

market.<sup>8</sup> By facilitating industry access to unique scientific and technical resources, this consortium will help manufacturers throughout the industry develop and deliver new, innovative products to the market. It is imperative that efforts such as this continue and more facility spaces collaborate with small and medium-sized manufacturers. Overall, deployment of advanced materials typically begins with small quantities of a material and often requires additional processes to scale-up and qualify materials into substantial quantities.

The public sector taking the lead on investment in advanced materials is a necessary, yet potentially troublesome long-term trend. Government funding cannot sustainably remain the only investment solution. As it stands, small and medium-sized businesses frequently lack access to the resources needed to operate in this space. By limiting access by these smaller businesses, the system in the United States essentially constrains young businesses or, in some cases, drives them out of the country by incentivizing their absorption into large, international companies. A less hostile environment in which new, small and medium-sized companies can access capital and therefore thrive and compete is necessary to ensure more materials make it to widespread commercialization.

<sup>7</sup> *About the Small Business Vouchers Pilot*, Small Business Vouchers Pilot, U.S. Department of Energy.

<sup>8</sup> *About the Energy Materials Network*, Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy.

# Moving Forward

In the first two sector studies of the Energy and Manufacturing Competitiveness Partnership on water and manufacturing and advanced materials, there have been a series of common themes that have come to light. As the Council continues to identify these key, cross-cutting issues underpinning American competitiveness at the intersection of energy and manufacturing, lessons learned and policy recommendations will be integrated into the forthcoming competitiveness agenda.

## **Advancing U.S. Biosciences**

On July 27, 2016, the Council hosted a workshop on Advancing U.S. Biosciences with Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Pacific Northwest National Laboratory and Sandia National Laboratories. This dialogue built upon the advanced biosciences research and development expertise at the national laboratories and the Council's long history of policy development and

advocacy for energy and manufacturing competitiveness. Addressing the four key pillars, the findings and key recommendations provide new approaches to funding, organizing and leveraging biosciences research and development among federal agencies, universities, national laboratories, industry and philanthropic entities in an integrated fashion.

## **Agricultural & Consumer Water Use**

The Council will continue its Phase 1 sector studies with a dialogue on Agricultural & Consumer Water Use on November 18, 2016, with co-chair Jim Hagedorn, Chairman and Chief Executive Officer, The Scotts Miracle-Gro Company. The Council is currently in the process of identifying university, laboratory and labor leaders to co-chair this study and looks forward to addressing the four key pillars, the challenges and opportunities concerning the agriculture sector and its impact on U.S. competitiveness.

### **Future EMCP Sector Studies:**

 **Aerospace**

 **Automotive**

 **Chemicals**

 **Construction & Engineering**

 **Consumer Goods & Appliances**

 **Energy**

 **Information Technology**

 **Pharmaceuticals & Healthcare**

 **Textiles**

# About the Energy & Manufacturing Competitiveness Partnership (EMCP)

The advanced materials sector study is part of a larger initiative of the U.S. Council on Competitiveness known as the Energy and Manufacturing Competitiveness Partnership (EMCP). The EMCP unites Council members to focus on the shifting global energy and manufacturing landscape and how energy transformation and demand is sharpening industries critical to America's prosperity and security.

The EMCP taps into a diverse membership of leaders from business, academia, the national laboratories and the labor community to understand the discrete and distinct challenges critical sectors of the U.S. economy face in the energy-manufacturing convergence and how decision-makers can bolster the critical pillars of competitiveness—technology, talent, investment and infrastructure.

Over the course of the three-year EMCP, the Council will develop an ambitious roadmap to focus national attention on the intersection of energy and manufacturing. Through a range of activities and dialogues such as the EMCP water and manufacturing sector study workshop, the EMCP will deliver action-oriented recommendations to decision-makers at the highest levels of government and industry.

The EMCP is especially designed to culminate with the delivery of a concrete competitiveness agenda ahead of the 2016 national elections, detailing and prioritizing the policies, tools and partnerships the incoming president and Congress should leverage to unleash a sustainable manufacturing renaissance in the United States.

PILLARS OF  
COMPETITIVENESS

TECHNOLOGY

TALENT

INVESTMENT

INFRASTRUCTURE



*The Energy & Manufacturing Competitiveness Partnership Concept Paper, August 2015.*

# About the U.S. Council on Competitiveness

## Who We Are

The U.S. Council on Competitiveness' mission is to set an action agenda to drive U.S. competitiveness, productivity and leadership in world markets to raise the standard of living for all Americans.

The U.S. Council on Competitiveness is the only group of CEOs, university presidents, labor leaders and national laboratory directors committed to ensuring the future prosperity of all Americans and enhanced U.S. competitiveness in the global economy through creation of high-value economic activity in the United States.

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## How We Operate

The key to U.S. prosperity in a global economy is to develop the most innovative workforce, educational system and businesses that will maintain the United States' position as the global economic leader.

The Council achieves its mission by:

- Identifying and understanding emerging challenges to competitiveness
- Generating new policy ideas and concepts to shape the competitiveness debate
- Forging public and private partnerships to drive consensus
- Galvanizing stakeholders to translate policy into action and change

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**Mr. Jeffrey Finkle**

President  
International Economic Development Council

**Dr. Norman Fortenberry**

Executive Director  
American Society for Engineering Education

**Mr. Richard Grefé**

Executive Director  
AIGA

**The Honorable Rush Holt**

Chief Executive Officer  
American Association for Advancement  
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**Mr. Peter Eckstein**

President  
IEEE-USA

**Dr. Dominik Knoll**

Chief Executive Officer  
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Former Associate Director, Computation, Lawrence Livermore National Laboratory

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Chairman and CEO, The Intellis Corporation; and Former Administrator, National Aeronautics and Space Administration (NASA)

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Partner, K&L Gates LLP; and Former United States Representative (TN)

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Former Director, Sandia National Laboratory; and Former President, Sandia Corporation

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**The Honorable Steven E. Koonin, Distinguished Fellow**

Director, Center for Urban Science and Progress, and Professor, Information, Operations & Management Sciences, Leonard N. Stern School of Business, New York University; and Former Second Under Secretary of Energy for Science, U.S. Department of Energy

**The Honorable Alan P. Larson, Distinguished Fellow**

Senior International Policy Advisor, Covington & Burling LLP; and Former Under Secretary of State for Economics, U.S. Department of State

**Mr. Alex R. Larzelere, Senior Fellow**

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Former Chief Executive, San Diego Regional Economic Development Corporation; and Former First Secretary of Trade & Commerce, State of California

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**Dr. Mohammad A. Zaidi, Distinguished Fellow**

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**Marcy Jones**

Special Assistant to the President/Office Manager

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Vice President, Innovation Policy & Programs

**Gourang Wakade**

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**William Council**

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Assistant Comptroller

## APPENDIX A

## EMCP Steering and Advisory Committees

**EMCP STEERING COMMITTEE**

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**Mauro Borges Lemos**  
CEO  
Companhia Energetica de Minas Gerais

**Richard Brodhead**  
President  
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**Curtis Carlson**  
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**William Goldstein**  
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**Harris Pastides**  
President  
University of South Carolina

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Chairman & CEO  
NanoMech, Inc.

**Ajita Rajendra**  
Chairman & CEO  
A. O. Smith Corporation

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Deputy Laboratory Director  
Lawrence Berkeley National Laboratory

**Lou Anna Simon**  
President  
Michigan State University

**Teresa Sullivan**  
President  
University of Virginia

**Subra Suresh**  
President  
Carnegie Mellon University

**Kim Wilcox**  
Chancellor  
University of California, Riverside

**Keith Williams**  
President & CEO  
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**W. Randolph Woodson**  
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Worcester Polytechnic Institute

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Director of Engineering, Technology & Quality  
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Clemson University

**Katherine Banks**  
Dean of Engineering  
Texas A&M University

**Richard Benson**  
President  
University of Texas at Dallas

**Nora Brownell**  
Founding Partner  
ESPY Energy Solutions, LLC

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**Dona Crawford**  
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Whirlpool Corporation

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Michigan State University

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Professor of Mathematical Sciences & Vice Provost for Research  
Worcester Polytechnic Institute

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## APPENDIX B

## Participants

**Pamir Alpay**

Department head, Materials Science & Engineering  
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Worcester Polytechnic Institute

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QuesTek Innovations LLC

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Technology Program Business Development  
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Executive Vice President & Chief of Staff  
U.S. Council on Competitiveness

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Metallurgist—Materials Science and Engineering  
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Senior Fellow Discipline Lead  
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Lawrence Livermore National Laboratory

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Director, Advanced Manufacturing Office  
U.S. Department of Energy

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Penn State University

**Jessica Lovingood**

Policy Analyst  
U.S. Council on Competitiveness

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Worcester Polytechnic Institute

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Vice President & Chief Engineer  
Baker Hughes

**Dane Morgan**

Materials Science & Engineering  
University of Wisconsin—Madison

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Director, Strategy & Innovation  
Argonne National Laboratory

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Applied Materials, Inc.

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Program Manager  
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Engineering Manager—Materials & Manufacturing  
Simulation  
Caterpillar

**Gregory Olson**

Walter P. Murphy Professor of Materials Science  
& Engineering  
Northwestern University

**Tresa Pollock**

Alcoa Professor—Materials  
University of California—Santa Barbara

**Douglas Ramsey**

Business Development & Senior Program Manager  
—Engineered Products and Solutions  
Alcoa Technology

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Associate Laboratory Director—Science &  
Technology Partnerships  
Oak Ridge National Laboratory

**Andreas Roefols**

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Argonne National Laboratory

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Worcester Polytechnic Institute

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President & CEO  
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Siluria Technologies

**Kevin Zeik**

General Manager—Research  
U.S. Steel Corporation

## APPENDIX C

# Agenda

## MORNING

### 8:30 Registration and Light Breakfast

### 9:00 Welcoming & Opening Remarks

Laurie Leshin  
President  
Worcester Polytechnic Institute

Aziz Asphahani  
Chief Executive Officer  
QuesTek Innovations LLC

Deborah L. Wince-Smith  
President & CEO  
U.S. Council on Competitiveness

Building upon more than a decade of work on energy and manufacturing policy, the Council launched the Energy and Manufacturing Competitiveness Partnership (EMCP). This C-suite group of leaders from the private sector, academia, labor and the national laboratories is assessing the challenges faced by America's energy and manufacturing sectors, and will present to national policymakers and private sector leadership a roadmap for concrete actions all stakeholders in our economy must take to leverage the seminal opportunity presented by today's energy and manufacturing landscape. Critically, this initiative approaches America's diverse industrial landscape not as a monolith, but as a network of distinct but interdependent productive sectors, each with its own challenges and opportunities. The EMCP will explore how crosscutting factors play out within each sector, identify the discrete factors shaping different sectors and assess common challenges and opportunity threads across all sectors.

### 9:30 Capabilities

To set the stage for the day, speakers will discuss current capabilities in our national labs, universities and across the private sector in advanced materials.

Gregory Olson  
Walter P. Murphy Professor of Materials Science and Engineering  
Northwestern University

### 10:15 Barriers & Impediments

Despite tremendous progress, there remain regulatory, market and policy barriers and impediment to fully deploying the promise of advanced materials across the manufacturing and energy sectors.

David U. Furrer  
Senior Fellow Discipline Lead  
Pratt & Whitney

Diran Apelian  
Alcoa-Howmet Professor of Engineering  
Director, Metal Processing Institute  
Worcester Polytechnic Institute

### 11:00 Coffee Break

### 11:15 Solutions: Infrastructure, Technology, Investment and Talent

The Council's sector studies are designed to gather subject matter expertise on key sectors of the U.S. economy and explore the Council's four cross-cutting pillars- infrastructure, technology, investment and talent- to produce tangible policy recommendations for future growth and development in energy and manufacturing. The presenters will incorporate reflections from the earlier sessions in their discussion of these four pillars of competitiveness.

#### Technology

Tresa Pollock  
Department Chair, Materials  
University of California—Santa Barbara

#### Talent

Zi-Kui Liu  
Professor of materials & Science Engineering  
Penn State University

#### Infrastructure

Jim Roberto  
Associate Laboratory Director for Science & Technology Partnerships  
Oak Ridge National Laboratory

**Investment**

Aziz Asphahani  
Chief Executive Officer  
QuesTek Innovations LLC

**AFTERNOON****12:00 Networking lunch****12:45 Presentation: Administration Perspective**

Mark Johnson  
Director, Advanced Manufacturing Office  
U.S. Department of Energy

**1:15 Breakout Sessions (in parallel)**

Participants will break into four groups, each of which will address the same set of questions around the challenges and opportunities in advanced materials related to talent, technology, investment and infrastructure.

**Breakout**

Aziz Asphahani  
Chief Executive Officer  
QuesTek Innovations LLC

**Leaders**

Zi Kui Liu  
Professor of Materials & Science Engineering  
Penn State University

Tresa Pollock  
Department Chair—Materials  
University of California—Santa Barbara

Jim Roberto  
Associate Laboratory Director for Science & Technology  
Partnerships  
Oak Ridge National Laboratory

**2:45 Coffee Break****3:00 Debriefing from Breakout Leaders**

Participants will reconvene and breakout leaders will report back on key themes.

**3:30 Connecting Key Themes**

William Bates  
Executive Vice President & Chief of Staff  
U.S. Council on Competitiveness

**3:45 Conclusion & Next Steps**

Laurie Leshin  
President  
Worcester Polytechnic Institute

Aziz Asphahani  
Chief Executive Officer  
QuesTek Innovations LLC

Deborah L. Wince-Smith  
President & CEO  
U.S. Council on Competitiveness

**4:00 Workshop concludes**

APPENDIX D

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*Arizona State University*

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*University of California, Davis*

Pradeep K. Khosla  
*University of California, San Diego*

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*The George Washington University*

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**Founder**

John A. Young  
*Hewlett-Packard Company*



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**Energy and Manufacturing Competitiveness Partnership (EMCP)  
Advanced Materials Sector Study**

Over the past year, Council on Competitiveness dialogues looking at advanced materials have identified several challenges and opportunities regarding the design, production and scaling of advanced materials to accelerate the transition from discovery to manufacturing.

Examples include:

- Early adoption of advanced materials by manufacturers to make products more competitive, higher performing, less expensive, more energy-efficient over the life cycle use of the product, and differentiated from competition in the market. Use of advanced materials in commercial products also drives the market for the materials themselves, promoting the manufacture of advanced materials.
- The need to organize and make readily available to manufacturers the materials qualification data coming from fundamental research.
- Enhancing awareness and accessibility of unique materials research infrastructure in publicly-sponsored research laboratories for manufacturers (particularly for small and medium-sized manufacturers in a supply chain).
- Use of an Integrated Computational Materials Engineering (ICME) platform for mining an extensive database on materials, product properties and manufacturing process performance for materials design and manufacturing optimization.
- Developing shared materials processing capabilities for scaling materials innovations from the gram-scale to the kilogram scale during extended application qualification.
- Designing materials for manufacturing that are both more sustainable and recyclable

Moving new materials into widespread adoption is larger in scope and more multi-faceted than the capabilities of any one private or public entity. The scope often includes defining policies, roadmaps and norms on which a range of entities across the supply chain can agree, creating computational modeling and

Advanced Materials Sector Study  
Page 2 of 2

simulation tools to accurately predict the behavior and performance of materials in final products, creating universally recognized standards and common development plans, and verifying the performance of new materials through a range of characterization and qualification activities. Many of these steps require agreement and input across a wide range of stakeholders.

Addressing these challenges would accelerate U.S. competitiveness in advanced materials and enhance U.S. manufacturing capability and capacity.

#### **Key Questions for the Sector Study to Address**

1. What key barriers hinder development and deployment of advanced, more sustainable materials in all sectors?
2. What potential “platform” technologies- those technologies or investments that could benefit a number of different classes of advanced materials- would be most effective at accelerating new materials into the marketplace?
3. To what degree can the right shared infrastructure de-risk potential investments in new advanced materials?
4. What are the barriers to wider adoption and use of computational materials design and testing?
5. What are the necessary steps in a roadmap for the next 2-5 years that ensure effectiveness, accessibility and differentiation from existing public-private partnerships?
6. How can a national initiative to integrate advanced materials into manufactured processes and products better, faster, and cheaper encourage participation across the private sector- across industries, companies of all sizes, and technological expertise?

#### **The EMCP Methodology**

*Energy and manufacturing are inextricably linked with America’s new found energy abundance creating a window of opportunity for the nation. How this opportunity manifests across different sectors of the economy is the central question of the EMCP. For each sector study, the EMCP will explore four cross-cutting pillars—technology, talent, investment and infrastructure—with the end goal to find commonalities across sectors as well as key differences or even policy conflicts.*



**U.S. Council on Competitiveness**

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