American Energy & Manufacturing Competitiveness Partnership

Strengthen.

Dialogue 5

Compete.

Council on Competitiveness

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AEMC PARTNERSHIP DIALOGUE 5

Letter from the President

On behalf of the Council on Competitiveness (Council), I am pleased to release *Strengthen,* a report on the American Energy & Manufacturing Competitiveness (AEMC) Partnership Dialogue 5 held on April 16, 2014 at the University of California, Berkeley in Berkeley, California. The AEMC Partnership, a three-year effort between the Council on Competitiveness and the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy (EERE), brings together national leaders to address a rapidly shifting national and global energy landscape—and to uncover actions that can be taken now to enable America to bolster its energy, manufacturing and economic competitiveness over the next 20 years and beyond.

Building on the momentum and incorporating valuable insights garnered from the first year of the AEMC Partnership, the Council and EERE developed a detailed public-private partnership (PPP) case-study aimed at bridging gaps in the innovation ecosystem to foster a more dynamic and resilient U.S. manufacturing sector. The Council convened key stakeholders from industry, academia, and the national laboratory system at this fifth dialogue to gather input and refine potential PPP concepts.

I extend a special thanks to my partner David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy, as well as the entire EERE team for all their hard work and significant, thoughtful contributions to this dialogue and the larger AEMC Partnership.

I would also like to thank our co-host for the dialogue Dr. Nicholas Dirks, Chancellor of the University of California, Berkeley, and the entire University of California, Berkeley team engaged in making this dialogue a success.

Strengthen is divided into two sections. The first is a primer developed in advance of AEMC Partnership Dialogue 5 to provide a background on PPPs, detail the PPP case-study and provide a summary of the work completed through the AEMC Partnership to date. Section two provides a summary, synthesis, and distillation of the proceedings of the April 16, 2014 dialogue held at the University of California, Berkeley.

As envisioned in the design of the AEMC Partnership dialogue series, the outcomes of these progressive dialogues drive the thought-leadership needed to create public-private partnership initiatives. These initiatives were highlighted at the inaugural AEMC Summit in Washington, D.C. on December 12, 2013 and will continue to be highlighted at the 2014 AEMC Summit in Washington, D.C. on September 17, 2014. This summit will highlight the barriers and challenges to developing more competitive U.S. clean energy and manufacturing sectors as well as the opportunities—or leverage points—that can have the greatest impact on national prosperity.

None of this can happen, however, without the input and support of energy and manufacturing stakeholders throughout the country. The Council on Competitiveness looks forward to continuing to engage national and regional leaders in industry, academia, national laboratories, and government as it continues to capture insights and recommendations from this and future dialogues, and sets forward a path of action to increase U.S. competitiveness and meet the goals of the AEMC Partnership.

Sincerely,

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

The AEMC Partnership dialogues are an open exchange of ideas. The opinions and positions presented in this report are those of the Council on Competitiveness or the individuals who offered them. The opinions and positions in the report do not reflect official positions of the federal government.

AEMC PARTNERSHIP DIALOGUE 5

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Chancellor
University of California, Berkeley

The Honorable David T. Danielson
Assistant Secretary for Energy Efficiency and Renewable Energy
U.S. Department of Energy

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

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Lawrence Berkeley National Laboratory

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Lockheed Martin

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Co-Founder and Chief Business Officer
Plotly

Mr. Craig Carson
President and Chief Executive Officer
JECO Plastic Products

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Deloitte Services LP

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The Export-Import Bank of the United States

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EPS Business Technology
Alcoa, Inc.

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Director
Advanced Manufacturing Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

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President
Oregon BEST

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Director
Argonne National Laboratory

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Sandia National Laboratories

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Council on Competitiveness

AEMC PARTNERSHIP DIALOGUE 5

Agenda
April 16, 2014

MORNING

8:00 Registration and Light Breakfast

8:30 Welcome and Opening Remarks

Dr. Nicholas Dirks
Chancellor
University of California, Berkeley

The Honorable Deborah L. Wince-Smith
President and CEO
Council on Competitiveness

The Honorable David T. Danielson
Assistant Secretary for Energy Efficiency and Renewable Energy
U.S. Department of Energy

9:00 Briefing on the Goals and Objectives of the Clean Energy Manufacturing Initiative

Ms. Elizabeth Wayman
Director
Clean Energy Manufacturing Initiative
U.S. Department of Energy

9:15 The AEMC Partnership: Where we have come from and presenting a PPP Case-Study

In this session, the development of the PPP through the AEMC Partnership dialogue series will be shared, highlighting the barriers to clean energy manufacturing. These barriers could be addressed in a problem-focused PPP using several tools or a tool-based PPP reaching out to many industry sectors. The Council will present a tool-based PPP case-study for participants to evaluate throughout the day the effectiveness of a PPP to address these barriers.

Mr. Chad Evans
Executive Vice President
Council on Competitiveness

Dr. Clara Smith
Senior Policy Director
Council on Competitiveness

9:45 Aligning Forces in Clean Energy Manufacturing through a PPP Facilitating Access to Extraordinary Resources and Capabilities

Throughout the 2013 AEMC Partnership dialogue series, three barriers have been highlighted as important to unleashing the potential for clean energy manufacturing, specifically in the areas of deploying advanced materials faster and facilitating scale up of clean energy technology manufacturing in the United States: insufficient access to capital, insufficient access to shared infrastructure, and high technical risks. Discussants will offer their opinions on the significance of these barriers. They are also asked to provide suggestions on how to overcome these barriers through participation in a tool-based PPP, for example, around advanced computing.

Moderator

Dr. Peter Littlewood
Director
Argonne National Laboratory

First Respondents

The Honorable Jennifer M. Granholm
Former Governor and
Distinguished Practitioner of Law and Public Policy
University of California, Berkeley

Mr. Brad Markell
Executive Director
Industrial Union Council
AFL-CIO

Dr. Sethuraman Panchanathan
Senior Vice President
Office of Knowledge Enterprise Development
Arizona State University

Mr. William Sobel
Chief Executive Officer
System Insight, Inc.

Mr. Frank Wolak
Vice President
FuelCell Energy

10:45 Coffee Break

11:00 How Advanced Computing Can Transform Business

In this session, the benefits of collaborations between national laboratories and industry that apply advanced computing to industry problems will be described.

Speaker

Dr. Dawn Manley
Deputy Director of Chemical Sciences
Sandia National Laboratories

11:30 Lab Tour: UC Berkeley Innovation and Invention Labs

12:30 Lunch

1:00 Differentiate: Luncheon Presentation and Discussion

In this session, other high-profile PPPs that have recently been created will be discussed and differentiated from a tool-based PPP, such as one focused in advanced computing, using the barriers they address, the opportunities they create, and the partners they include.

Introduction

Ms. Elizabeth Wayman
Director
Clean Energy Manufacturing Initiative
U.S. Department of Energy

Speaker

Dr. Mark Johnson
Director
Advanced Manufacturing Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

1:30 Stakeholder Leadership Presentations

In this session, stakeholders will provide TED-style talks describing how participating in a tool-based PPP, in this case one focused in advanced computing, will facilitate their business and how their participation will contribute to enhancing and strengthening the innovation ecosystem.

Moderator

Mr. Chad Evans
Executive Vice President
Council on Competitiveness

Speakers

Strengthening the Innovation Ecosystem
Dr. Horst Simon
Deputy Director
Lawrence Berkeley National Laboratory

Deploying Advanced Materials into the Marketplace Faster, Collapsing the Research, Development, and Deployment Cycle
Dr. Jon Schaeffer
Senior Engineering Manager
GE Power & Water

Promoting Access, Understanding, and Investment to Drive Competitiveness
Dr. Mark Cotteleer
Director
Deloitte Services LP

Transforming U.S. Manufacturing Competitiveness
Mr. Sanket Amberkar
Senior Director, Innovation, New Ventures & Energy
Flextronics

Accessing Capital and Scaling Manufacturing
Mr. Craig Carson
Chief Executive Officer
Jeco Plastic Products

Building Confidence to Invest in Manufacturing
Mr. Rodney Heiple
Director, EPS Business Technology
Alcoa, Inc.

3:00 Coffee Break

3:15 AEMC Partnership PPP Next Steps

Discussants will provide their thoughts on how a PPP or collaborative effort might look moving forward, regardless of government interaction. What should the Department of Energy be involved in, and what should occur without the Department's involvement?

Moderator

Mr. Steven Betza
Director, Hardware Engineering & Advanced Manufacturing
Lockheed Martin

First Respondents

Dr. David Dornfeld
Will C. Hall Family Chair in Engineering
Professor of Mechanical Engineering
University of California, Berkeley

Dr. William Goldstein
Director
Lawrence Livermore National Laboratory

Dr. Nag Patibandla
Managing Director
Applied Materials, Inc.

Dr. Adam Powell
CTO and Co-Founder
INFINIUM

Dr. Cynthia Powell
Director, Office of Research and Development
National Energy Technology Laboratory

4:15 The Path Forward

Dr. David Dornfeld
Will C. Hall Family Chair in Engineering
Professor of Mechanical Engineering
University of California, Berkeley

The Honorable David T. Danielson
Assistant Secretary for Energy Efficiency
and Renewable Energy
U.S. Department of Energy

The Honorable Deborah L. Wince-Smith
President and CEO
Council on Competitiveness

4:45 Conclude

PART 1
AEMC Partnership Dialogue 5 Primer

PART 1: AEMC PARTNERSHIP DIALOGUE 5 PRIMER

Executive Summary

On April 16, 2014 the Council on Competitiveness and the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy (EERE) and the University of California, Berkeley (UC Berkeley) co-host the AEMC Partnership Dialogue 5. This dialogue is the fifth in a series of progressive dialogues convened as part of the AEMC Partnership—a three-year effort to bolster American competitiveness through advanced clean energy manufacturing and increased energy productivity, and to address the dynamic changes affecting the national and global energy landscape.

Along with the four progressive dialogues in 2013, the Council and EERE convened more than 500 CEOs, university presidents, national laboratory directors, and other stakeholders from across America at the Inaugural AEMC Summit. Participants discussed actions to unleash the potential of a U.S. manufacturing renaissance by creating the conditions in this country to promote energy efficiency, renewable technologies adoption, and deeper investment in energy technology manufacturing.

AEMC Partnership Dialogue 5 gathers leaders from industry, academia, non-profit organizations, and the national laboratory system to discuss specific barriers to U.S. clean energy manufacturing competitiveness and evaluate a public-private partnership case-study focused on increasing the access and use of tools for manufacturing, such as advanced computing.

The PPP case-study, focused on facilitating use of advanced computing resources of the national laboratory and university research systems, is scoped and designed to be a platform to facilitate collaborations among the nation's world-class innovation institutions—small and medium-sized enterprises (SMEs), large multi-national companies, universities, national laboratories, and investors. It targets several manufacturing barriers by increasing access to shared innovation infrastructure and access to capital while reducing the technical risk/uncertainty to the innovation process. By incorporating workforce development programs, it can also increase the domestic talent pipeline, both in science, technology, engineering, and mathematics (STEM) education and in middle-skill jobs.

AEMC Partnership Dialogue 5 is another step in the ongoing conversation around increased U.S. energy, manufacturing, and economic competitiveness, and leads into the upcoming 2014 AEMC Summit that will take place in Washington, D.C. on September 17th at the Ronald Reagan Building and International Trade Center.

PART 1: AEMC PARTNERSHIP DIALOGUE 5 PRIMER

The American Energy and Manufacturing Competitiveness Partnership Overview

The AEMC Partnership is a 3-year effort by the Council and EERE to bring together national leaders to address a rapidly shifting energy and manufacturing landscape. In a series of progressive dialogues over 2013 and 2014, participants consider actions that can be taken now to bolster American competitiveness in these areas. This is a new partnership formed under the DOE Clean Energy Manufacturing Initiative (CEMI)—a strategic integration of and commitment to manufacturing efforts focusing on American competitiveness in clean energy manufacturing. The goals of the CEMI and AEMC Partnership are to:

- **Increase U.S. competitiveness in the production of clean energy products:** Strategically investing in technologies that leverage American competitive advantages and overcome competitive disadvantages; and
- **Increase U.S. manufacturing competitiveness across the board by increasing energy productivity:** Strategically investing in technologies and practices to enable U.S. manufacturers to increase their competitiveness through energy efficiency, combined heat and power, and taking advantage of low-cost, domestic energy sources.

The AEMC Partnership is broadly divided into two phases, mapping the landscape and the AEMC Partnership progressive dialogue series. AEMC Partnership activities in 2013 are depicted in Figure 1. Brief summaries of both phases are provided in the Appendix of this Primer.

Figure 1. Timeline of 2013 AEMC Partnership activities

Phase One: Mapping the Landscape

To cultivate topics for the progressive dialogue series, and to provide a foundation for the larger goals of the AEMC Partnership, the Council performed an extensive literature review and mapped 184 past and current research efforts across the United States and around the globe concerning three core topics:

- Linkages between manufacturer efforts in energy efficiency and renewable energy and manufacturing competitiveness;
- Energy-related barriers to manufacturing competitiveness; and
- Models for PPPs for fostering competitive industries.

The literature review is documented in the Council publication, *The Power of Partnerships*, and its companion piece, *A Summary of Public-Private Partnerships*.[1] The barriers identified during this literature review are also provided in the Appendix of this Primer as Figure 12.

Phase Two: The AEMC Partnership Progressive Dialogue Series

The second phase of the AEMC Partnership includes a total of four progressive dialogues in 2013, leading into AEMC Partnership Dialogue 5, in which participants generate new insights pertaining to the overall goals of the AEMC Partnership, as well as inform the creation of a public-private partnership concept to further advance the initiative's goals.

Reviewing Previous AEMC Partnership Dialogues

The inaugural dialogue, held in Washington, D.C. on April 11-12, 2013, laid out the objectives of the AEMC Partnership and began examining a range of PPPs. Dialogue 2, hosted by President Lloyd Jacobs of the University of Toledo on June 20th, continued the discussions sparked during the inaugural dialogue. This dialogue focused on Toledo as a case-study for successful informal and formal partnerships that can drive regional manufacturing transformation, in this case by leveraging materials science and engineering.

AEMC Partnership Dialogue 3, hosted by Dr. Mark Little, Senior Vice President and Chief Technology Officer of GE and Director of the GE Global Research Center at the GE Global Research Center in Niskayuna, New York, presented five specific PPP concepts for dialogue participants to discuss and critique to continue the process of focusing potential PPPs. Discussions during Dialogue 3 continued to determine specific technology areas, barriers and opportunities for the five presented PPP concepts capable of increasing the competitiveness of clean energy manufacturing in the United States.

Dialogue 4, hosted by Mr. Michael Splinter, Chairman of the Board of Applied Materials, and Dr. Omkaram Nalamasu, Chief Technology Officer of Applied Materials, focused squarely on evaluating two PPP concepts and honing their attributes. These two PPP concepts were presented to the Department of Energy at the Inaugural American Energy and Manufacturing Competitiveness Summit on December 12th, 2013 in Washington, D.C.

1 Both of these documents are available at http://www.compete.org/about-us/initiatives/aemcp/.

Setting the Stage for AEMC Partnership Dialogue 5

As described previously, the Council identified and documented twenty unique manufacturing barriers in *The Power of Partnerships* during Phase One of the AEMC Partnership. During Phase Two of the AEMC Partnership, regional and national clean energy manufacturing stakeholders from the public and private sectors shared insights and validated this list of barriers.

Many efforts to target manufacturing barriers exist across the country, including initiatives in government agencies such as the Department of Energy and the Department of Defense, the Advanced Manufacturing National Program Office (AMNPO), the National Network for Manufacturing Innovation (NNMI), the National Institute of Standards and Technology Advanced Manufacturing Technology Consortia (AMTech) program, and the Energy Innovation Hubs (DOE Hubs). Stakeholders agreed that certain barriers including trade policy, regulatory certainty, structural costs and public and cyber infrastructure, exist outside the scope of the AEMC Partnership.

While addressing these issues is extremely important, the AEMC Partnership works to differentiate itself while aligning efforts in relevant initiatives through the Clean Energy Manufacturing Initiative. Throughout the AEMC Partnership progressive dialogue series, participants have argued that a clean energy manufacturing public-private partnership could target three relevant barriers: Insufficient access to capital—high capital requirements, high pre-production costs, and high costs for new technologies; technical uncertainties—technical risk and imperfect information; and insufficient access to innovation infrastructure.

- **Capital Requirements**
  This barrier refers to two “valley of death” zones where innovators struggle to meet their capital requirements. The traditional valley of death mentioned in innovation literature occurs at the development, demonstration and prototyping stages. Often overlooked, however, is a second valley of death that typically emerges at the point of scale-up production at approximately $30 million—$100 million investment.

  Example: These valleys of death are exacerbated by current venture capital (VC) investment trends. While VC and private equity (PE) continue to offer a shrinking pool of resources in terms of total capital committed and deals executed, the public markets have improved significantly as major clean energy index funds are up. Nonetheless, VC and PE have started focusing more on projects with shorter payback times; almost 40 percent of the 2013 venture capital investments are focused in the software industry, with only 5 percent devoted to industrial and energy projects. While some industrial and energy projects continue to receive support from the VC community, even increased support, the number of recipients of VC funding in the industrial and energy field is decreasing rapidly.[2]

2 National Venture Capital Association and PricewaterhouseCoopers. “Annual Venture Investment Dollars Rise 7% and Exceed 2012 Totals, According to the MoneyTree Report” January 17, 2014. Available at: http://www.nvca.org/index.php?option=com_content&view=article&id=344&Itemid=103

- **Industrial Innovation Infrastructure & Expertise**

  This barrier refers to a lack of access to shared infrastructure and expertise on which industry scientists and engineers can draw to increase speed and lower costs on the path from prototype to production and commercialization. Typically, innovation infrastructure refers not only to shared research and testing equipment, but also to university or national laboratory personnel with specialized knowledge and skills.

  Example: Early evidence has revealed that shared infrastructure is a differentiating factor between places where many firms start-up but fail to scale, such as the United States, and places where scale-up occurs, such as Germany.[3] As described in the Report of the MIT Taskforce on Innovation and Production, "it's impossible to understand the different fates of manufacturing in the United States and Germany without comparing the density and richness of the resources available in the industrial ecosystem across much of Germany to the thin and shrinking resources available to U.S. manufacturers across much of our country." A differentiating resource in the German system—at least relative to the United States—is the network of Fraunhofer Institutes (a network of 80 research units and 60 institutes that partner with industry to provide a wide variety of services for businesses of all sizes with a particular emphasis on SMEs that do not maintain their own R&D departments). German firms able to tap into the Fraunhofer network—among other publicly supported shared assets—often find themselves competitively positioned against U.S. and other global manufacturers.

- **Overcoming Technical Uncertainty & Imperfect Information**

  Market incentives encourage firms to focus on low-risk incremental improvements to existing technologies rather than investing in new and unproven transformational technologies. Often, innovators and investors lack adequate information to make informed decisions. These high technical risks dampen the incentives to the increased creation and use of new technologies.

  Example: The creators and suppliers of advanced materials that could result in significant weight savings per vehicle in the automotive industry need to prove that the new material is applicable for a particular component. Engineers can pull the specifications and properties of dual phase 600 steel from a database and immediately understand if it will work for the application. For carbon fiber, on the other hand, the carbon fiber producer, the coating supplier, the resin supplier, the material supplier and the component manufacturer must often produce the part before the properties can be tested and understood. This process can take a number months or several years for a single company to complete. To complicate matters, the effects of variability in the properties of a raw material are not always understood throughout the component value chain. In this situation, a seemingly innocuous substitution in a raw material could have unforeseen effects on the performance of a component in its end-use application.[4]

3 Massachusetts Institute of Technology, "Report of the MIT Taskforce on Innovation and Production in the Innovation Economy Report", Editors: Richard M. Locke and Rachel Wellhausen, February 2013.

4 Anecdote shared at the AEMC Partnership Dialogue 2 and in other conversations.

These barriers were rarely discussed in isolation; they were couched in opportunities. The two PPP concepts that emerged from the 2013 dialogue series reflect this approach. Increasing access to capital, facilitating access to shared infrastructure, and lowering technical risks are central to the Manufacturing and Energy Technology Accelerator (META) and the Clean Energy Materials Accelerator (CEMA) described further below, yet the opportunities targeted in these PPPs are particularly distinctive. The former focused on a particular stage of the development process (scale-up) of any clean energy technology, and the latter targeted a specific technology platform of advanced materials. While each of these PPP concepts were built around specific activities, this set of barriers has been central to AEMC Partnership from the beginning.

Manufacturing and Energy Technology Accelerator

This PPP concept is a new, physical and virtual collaborative resource platform designed to connect the nation's world-class innovation institutions—SMEs, large multinational companies, universities, national laboratories, etc.—to facilitate the transition of cutting-edge clean energy technologies into products, processes, or services that are manufactured in the United States.

Clean Energy Materials Accelerator

This PPP concept focuses on reducing the risks associated with deploying newly developed materials in commercial products and processes by creating a platform to identify and address common challenges; increasing access to existing materials qualification and characterization tools; and creating standards for advanced materials with leaders in industry, academic, government, and other organizations.

PART 1: AEMC PARTNERSHIP DIALOGUE 5 PRIMER

A Tool-based PPP to Advance the Goals of the AEMC Partnership

After gathering input from stakeholders and deliberating on ways to achieve the goals of the Manufacturing and Energy Technology Accelerator and the Clean Energy Materials Accelerator PPP concepts, the Council and EERE considered a more foundational approach to lowering the barriers targeted by these PPPs. Increasing access through a PPP to national innovation capabilities, such as advanced computing, could engage a broad industrial community and address new materials discovery and accelerate the development and commercialization of clean energy technologies. The manufacturing sector requires that methods and materials be proven before deployment, and thus may benefit from using advanced computing as a transformative tool that can cut costs and time to market by optimizing designs and manufacturing processes.

The Department of Energy has an unparalleled resource with the potential to increase U.S. competitiveness—the national laboratory complex. Within the wide-array of expertise, capabilities and scientific user facilities housed at these global centers of innovation and excellence, one tool amenable for immediate high impact application is advanced computing. High Performance Computing (HPC) demonstrates a proven advantage in shortening time-to-market, optimizing production lines, quickly developing advanced materials, and transforming research and development within small and large companies. The national laboratory complex has a history of partnering with industry to apply advanced computing to industry problems and while many good examples of success exist, [5,6,7] the broader community has not yet benefited. Selected examples of these partnerships are described below:

HPC for Advanced Materials

Goodyear Tire and Rubber Company

In 2003 and 2004, the Goodyear Tire and Rubber Company found itself in a definite slump, suffering declining revenues and losing out to its two main competitors, France's Michelin and Japan's Bridgestone. In response, Goodyear leveraged its high performance computer clusters and its ongoing collaborative relationship with the Sandia National Laboratories to change the way it developed tires. Rather than designing, building and testing physical prototypes, Goodyear engineers used modeling and simulation to test virtual models and significantly cut time to market. The result was the Assurance® all-weather tire featuring TripleTred Technology®, shown in Figure 2, a complex product with over 18 components blended together.

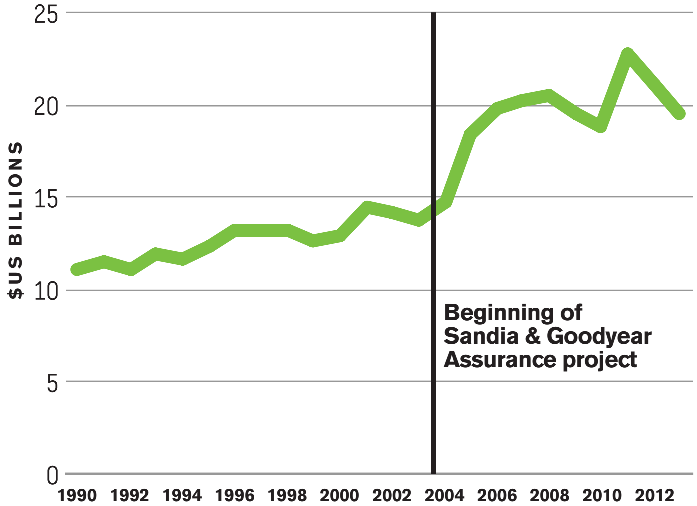
5 Council on Competitiveness. Case Study: Goodyear Puts the Rubber to the Road with High Performance Computing. 2009. More information available at: http://www.compete.org/publications/detail/685/goodyear-puts-the-rubber-to-the-road-with-high-performance-computing/.

6 Albuquerque Business First. "Los Alamos honors team for work with P&G." August 2013. Available at: http://www.bizjournals.com/albuquerque/blog/morning-edition/2013/08/los-alamos-honors-team-for-work.html.

7 Los Alamos National Laboratory. Chevron, GE form Technology Alliance. February 2014. Available at: http://www.lanl.gov/newsroom/news-releases/2014/February/02.03-chevron-ge-tech-alliance.php.

Figure 2. Complex Layering of Material Used in a Goodyear Tire

Figure 3. Goodyear Tire & Rubber Company Annual Revenue, 1990-2013



Goodyear accessed shared infrastructure—HPC—at Sandia National Laboratory, and they were able to reduce their technical risk. Expenditures on tire building and testing dropped from 40 percent of the company's research, design, engineering and quality (RDE&Q) budget to 15 percent, and the team created a tremendously successful product. This product helped Goodyear not only climb out of the financial hole it was in, but create revenue and begin a path to launch additional new product lines that resulted in record profits (Figure 3).

HPC for Supply Chain Efficiency

JECO Plastic Products, LLCs

To secure a prospective automotive client, JECO Plastic Products needed to ensure that a requested design change did not undermine the strength and performance of their plastic pallet. Tedious trial-and-error physical design and testing was deemed inefficient and too time-consuming to meet the expectations of the client.

Through the National Digital Engineering and Manufacturing Consortium (NDEMC) Midwest Pilot, JECO Plastic Products was able to access shared innovation infrastructure and team with both the Ohio Supercomputing Center and Purdue University to design a complex custom pallet with HPC. By employing HPC, the company was able to simulate and analyze the custom pallet in a highly predictive and time-efficient manner, reducing their technical uncertainty.

Improvements to the JECO pallet product increased sales revenue (Projected Revenue shown in Figure 5), increased payroll by 35 percent at their plant, and placed the company in contention for additional high-margin, domestic and export business projects. While JECO still searches for capital to invest in its products and processes, the access to shared infrastructure—HPC—allowed the company to reduce their technical uncertainty, and increase their access to capital.[8]

Figure 4. JECO Plastic Products plastic pallet simulation results illustrating the stress and strain for a given load.

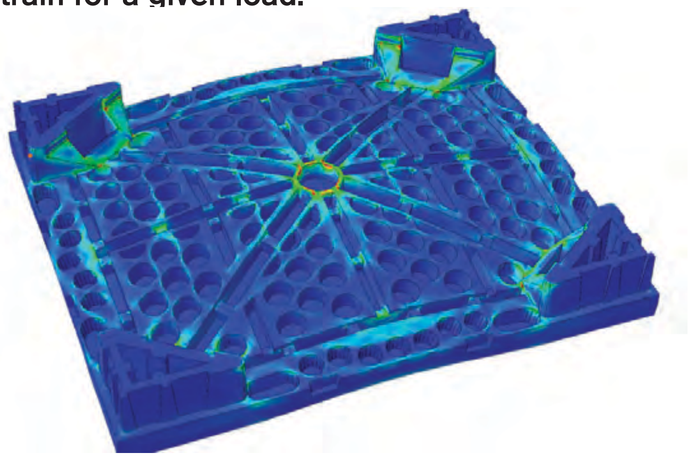
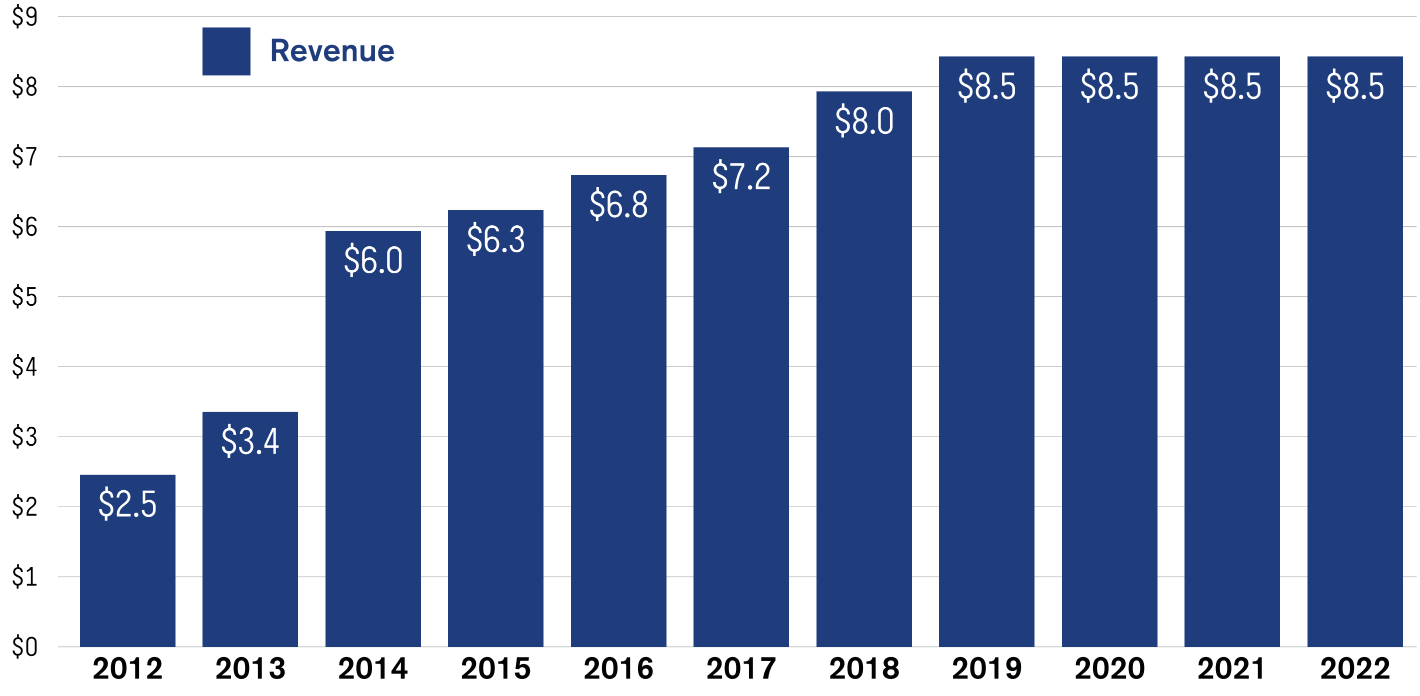


Figure 5. Projected Annual Revenue, millions $US



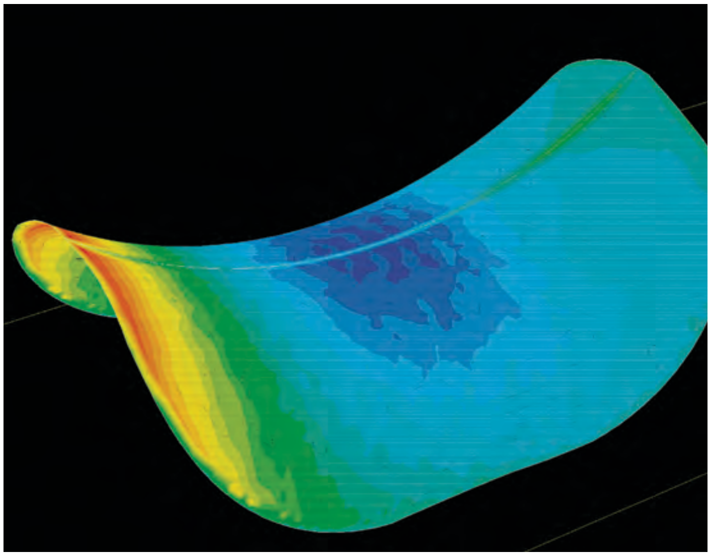
8 Council on Competitiveness. 2013. More information available at: http://www.purdue.edu/in-mac/documents/20121113%20Jeco%20Final%20Case%20Study%20by%20CoC.pdf

HPC for Optimal Manufacturing

Procter & Gamble

Procter & Gamble manufactures products Americans use everyday—from laundry detergent to diapers to potato chips. In manufacturing Pringles potato chips, Procter & Gamble found that many chips soared off the production line, rather than traveling to their canisters. To solve this problem, Procter & Gamble collaborated with Los Alamos National Laboratory to apply High Performance Computing and better understand the airflow around each chip (Figure 6). By accessing this shared infrastructure, Procter & Gamble was able to reduce technical uncertainty and modify production so potato chips wound up in containers, not on the floor.[9]

Figure 6. Simulated Pressure from Airflow Around a Pringles Potato Chip



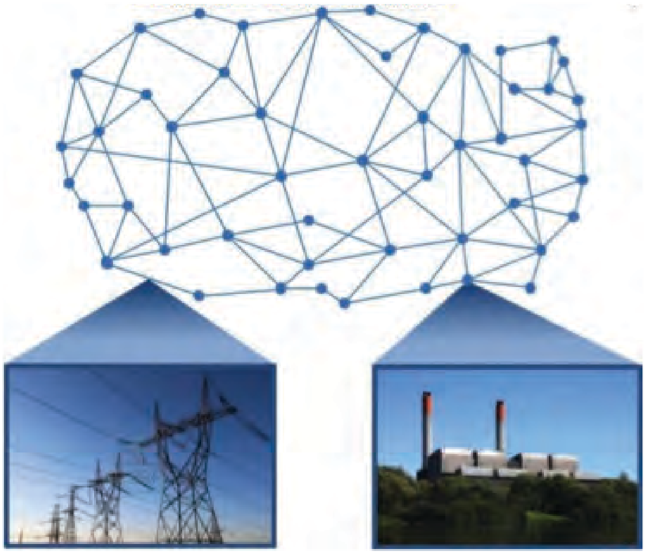
HPC to Optimize Products

GE Energy Consulting

Today's power system planning tools simulate systems that are far larger and more complex than even those just a few years ago. By developing and customizing GE's Concorda Positive Sequence Load Flow (PSLF) Software, GE Energy provides clients a comprehensive set of state-of-the-art tools to assess the economic and technical performance of interconnected power systems.

One of the many things PSLF is used for is to determine the stability of the electricity grid if electrical equipment is removed from the system (Figure 7) and inform planners and system operators how to operate under abnormal system conditions. For

Figure 7. Depiction of an electricity grid analyzed for stability when elements are removed



9 Fortune Magazine and the Council on Competitiveness. 2007. More information available at: http://www.compete.org/images/uploads/File/PDF%20Files/FORTUNE_Spurring_Aug07.pdf.

a sample system with 4,217 pieces of electrical equipment, the completion of a full set of consecutive calculations on a single desktop computer is estimated to take 23.5 days. Because this timeframe is impractical for an operator who must complete sets of these calculations on a daily basis, operators must choose a small number of these scenarios estimated to most likely cause problems that can be completed.

As part of the hpc4energy incubator, the collaborative GE Energy Consulting and Lawrence Livermore National Laboratory (LLNL) team parallelized the PSLF code to run on High Performance Computing machines. By parallelizing the PSLF software, the time required to run the entire set of 4,217 calculations was reduced 23 minutes. By accessing the shared infrastructure of the national laboratories at Lawrence Livermore National Laboratory, GE Energy Consulting was able to reduce technical uncertainty and provide their clients with improved software capable of meeting their needs.[10]

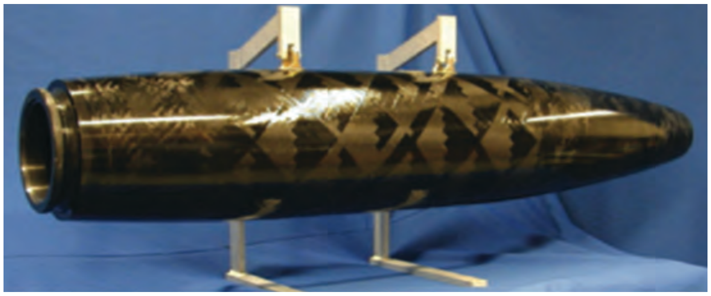
HPC Decreases Both Development Costs and Time to Market

Lawrence Livermore National Laboratory

In a traditionally risk-averse sector such as national defense, LLNL applied High Performance Computing to develop a product in record time. In 2010, LLNL partnered with the Air Force Research Laboratory, the Air Armament Center, and a Department of Defense manufacturer to deliver highly effective, low-collateral-damage munitions known as BLU-129/B to the U.S. Air Force. The prototype munitions were designed in 9 months and manufactured for the field in 18 months. For the BLU-129/B, 95% of the final design was completed using modeling and simulation. Experiments then verified that the new munitions performed exactly as intended.

The typical munitions design process takes 4 to 6 years, where a prototype is built, tested, and revamped based on the results. LLNL's long-term investments in computational codes, computing and manufacturing infrastructure and engineering expertise enabled the development of this munitions with less time and resources. By applying modeling and simulation to the needs of its customer, LLNL was able to increase the attainable strength of composites, develop better manufacturing processes to build stronger joints and significantly enhance knowledge of the mechanisms of munitions.[11]

Figure 8. Carbon-fiber composite case developed during the BLU-129/B project



10 Lawrence Livermore National Laboratory. GE Energy Consulting: Improving PSLF Simulation Performance and Capacity. 2012. More information available at: http://hpc4energy.org/incubator/ge-energy-consulting-improving-pslf-simulation-performance-and-capability/.

11 Lawrence Livermore National Laboratory. March 2013. More information available at: https://str.llnl.gov/content/pages/march-2013/pdf/3.13.1.pdf.

PART 1: AEMC PARTNERSHIP DIALOGUE 5 PRIMER

PPP Case-Study: Advanced Computing

This PPP is scoped and designed to be a platform to facilitate collaborations among the nation's world-class innovation institutions—SMEs, large multi-national companies, universities, national laboratories, and investors—to steward projects across the valleys of death through the use of the advanced computing resources of the national laboratory and university research system.

Summary

The mission of this partnership is to reduce the technical risk of developing, manufacturing and deploying new technologies through expanded use of advanced computing modeling, simulation, and analysis, in order to increase the innovative capacity of U.S. companies in the energy and manufacturing sectors.

Outcomes

- Increased access to research and development support services as shared infrastructure, increased linkages between innovation ecosystems;
- Increased competitiveness of clean energy products;
- Increased operational efficiency and productivity of U.S. business;
- Increased investment in manufacturing workforce development; and
- Lowered risk for investment.

Services

- Provide access and use of advanced computing to reduce technical uncertainty in industry projects;
- Increase the support and awareness of modeling and simulation software for U.S. supply chain companies and SMEs in advanced computing;
- Provide access to Tiger Team experts (who can also link project needs to other resources); and
- Provide HPC and manufacturing workforce development services.

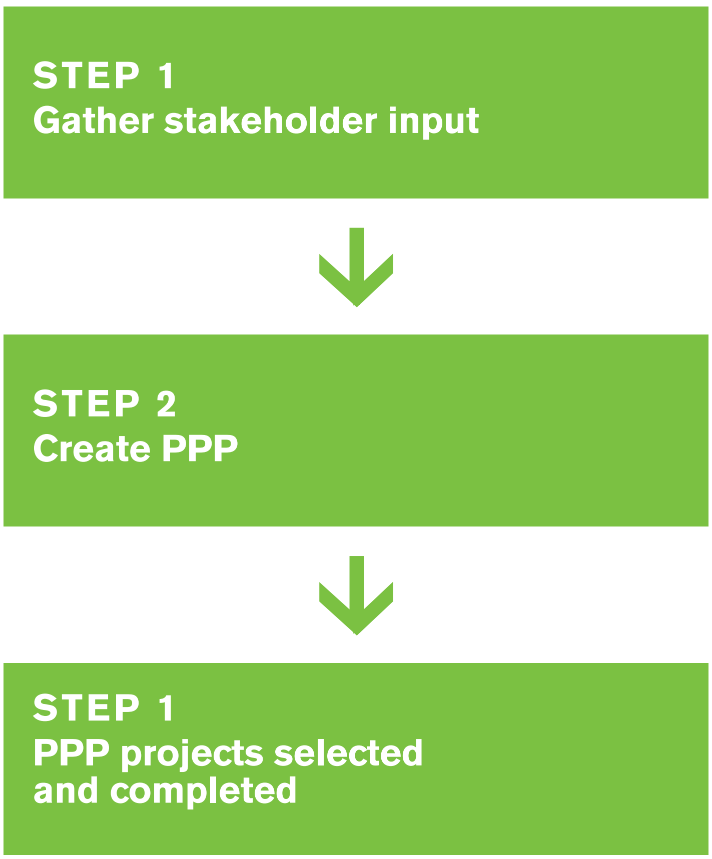
Process

In creating a public-private partnership, several stakeholders with different interests must align to collectively work toward lowering the targeted barriers. The Council believes that choosing a tool such as advanced computing as the focus for the PPP helps stakeholders establish collaborative relationships. The Council presents the following process for this advanced computing PPP case study (Figure 9).

Step 1: Gather Input from Stakeholders

As described in the AEMC Partnership overview, the AEMC Partnership convened four dialogues in 2013 to gather input from stakeholders on interest in participating in a PPP, fields that a PPP could be focused on, and different mechanisms that should be built into the structure of a PPP. During AEMC Partnership Dialogue 5, the Council and EERE will continue to gather input from stakeholders, specifically on the case study presented.

Figure 9. AEMC Partnership PPP Process



Step 2: Create PPP

Utilizing input from the AEMC Partnership, EERE will create a detailed Request for Information to the public around the creation of a public-private partnership to continue gathering stakeholder input. This will be followed by a Request for Proposals for the private sector (industry, independent software vendors, and investors), university, national laboratory, and non-profit organizations to form a consortium that will shepherd innovative products through their entire development cycle and compete for the management and direction of the partnership. EERE will select a consortium whose proposal best meets the requirements in the RFP. The winning consortium will create the PPP and select Focus Areas for projects to be included in the PPP.

Step 3: PPP projects selected & completed

The Executive Committee and PPP Director will release a Request for Proposals for potential projects to be included in the PPP from three different types of companies: start-up companies and SMEs outside of supply chains, supply chain companies, and original equipment manufacturers (OEMs) or large companies. Using selection criteria, projects will be selected by the Technical Advisory Board and presented to the Executive Committee for final approval. The Executive Committee selects interesting and relevant projects that are funded using different mechanisms (Figure 10).

Projects from OEMs and large companies could be funded with their own contributions. Supply chain company projects could be funded in part by their OEM and in part by the government contribution. Projects from start-up companies or SMEs outside of OEM supply chains could be funded in part by the government contribution and in part by the company or through an application for a government voucher. This process provides OEM and large companies with access to innovation outside of their own R&D cycle and that of their supply chain companies.

Selected projects begin work with partners in the universities and/or national laboratories. Project Managers and Tiger Teams will work with project teams to ensure completion in a 1–2 year timeframe. Final results for each project will be presented to the Executive Committee.

Figure 10. Possible project selection process

In response to an RFP, projects are submitted to the PPP in defined focus areas.	**Start-up Company/SME Projects Submitted** ↓	**Supply Chain Company Projects Submitted** ↓	**OEM/Large Company Projects Submitted** ↓
Projects selected with Technical Advisory Board making recommendations to Executive Committee. The Technical Advisory Board will have representatives from participating universities and national laboratories, who will assess projects according to their feasibility and to the resources they can apply.	**Start-up Company/SME Projects Selected** ↓ Projects funded 50% by DOE PPP contribution. Companies fund 50% or apply for government voucher.	**Supply Chain Company Projects Selected** ↓ Projects funded 50% by DOE PPP contribution. 50% by OEM.	**OEM/Large Company Projects Selected** ↓ Projects funded 100% by OEM/large company.

Functional Elements of the PPP

Management

The PPP Executive Committee will consist of representatives from EERE and 4 to 5 consortium partners. The Executive Committee will choose Focus Areas for the PPP and elect and delegate members to serve on a Technical Advisory Board with expertise in the Focus Areas. The Executive Committee will select a Director and managing organization to carry out operational activities and execute the mission of the PPP.

Program Managers

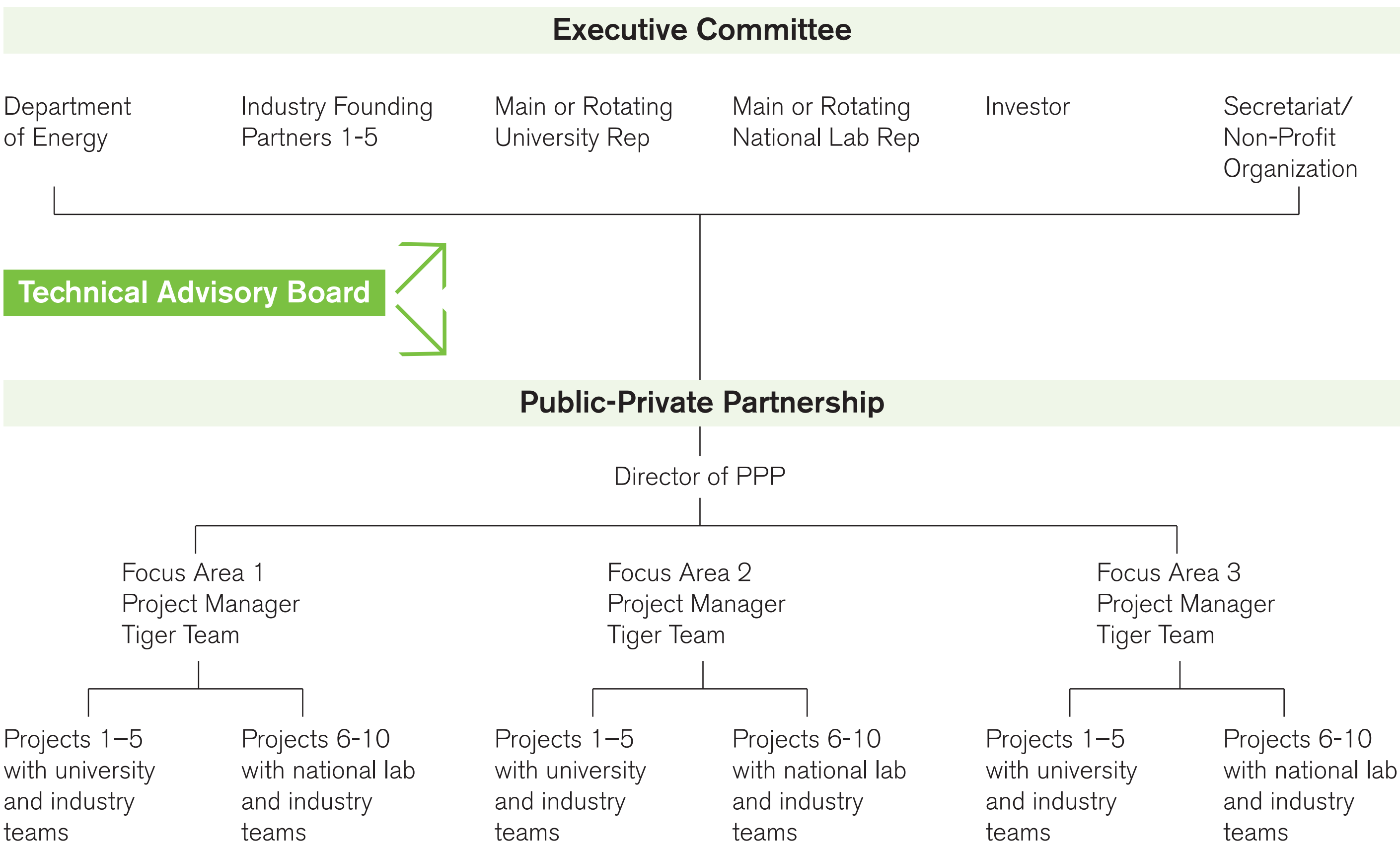
Program Managers will work with project teams within focus areas to ensure projects meet milestones and assist by matching expertise with needs as they arise. Program Managers will also manage the Tiger Teams available to selected project teams.

Tiger Teams

The Tiger Teams, constituted from the nation's innovation institutions such as universities, national laboratories, independent laboratories, and the Manufacturing Extension Program, are assigned to solve technical problems through onsite collaboration and consultation. Tiger teams may help design or guide projects by analyzing for manufacturability or other optimal characteristics that can be answered using advanced computing.

Tiger Teams provide an opportunity to integrate fellowship programs. Fellows from academia, national laboratories, or for-profit companies may work with Tiger Team experts on projects and learn valuable skills that U.S. manufacturing firms seek. Over time, the Tiger Team experts and fellows will begin to form a national network of manufacturing excellence.

Figure 11. Possible PPP Organization



Participation

Industry: OEM/Large Company

Industry organizations with more than $1 billion in revenue in 2013 may participate in this public-private partnership as Industrial Founding Partners by co-funding at $300,000 for selected projects from companies in their supply chain or funding their own research for selected projects with national laboratory and/or university partners. If funding research projects in their own interests through this PPP, Industrial Founding Partners commit employees and resources to support project advancement.

PPP Industrial Founding Partners will participate in the Executive Committee, help select projects through representatives on committees, and their financial contribution to the PPP will sponsor one or more projects from companies within their supply chain.

Value Proposition:

- Define the problems for projects sought in the RFPs, allowing founding members to potentially diversify their supplier base while simultaneously creating increased competition in their supply chain—driving further improvements in the supply chain;
- Access to the bright and innovative entrepreneurs in SMEs, supply chain companies, and start-up companies in the U.S. clean technology arena;
- Access to technologies and innovations ready for scale-up with significant risk reduction to mass-manufacture technologies of strategic interest to founding members;
- Leverage federal dollars to evaluate innovative and scalable technologies; and
- Early access to licensing, partnering, and/or acquisition deals.

Industry: SMEs, Start-ups, Entrepreneurs, and Technologists

Supply chain organizations of PPP Industrial Founding Partners are encouraged to submit project proposals to this PPP. Work in selected projects will be co-funded by the organization's OEM and the Department of Energy.

SME and start-up companies outside the supply chain of the PPP Industrial Founding Partners are encouraged to apply through the open proposal process. Work on projects selected from companies outside supply chains will be partially supported by the Department of Energy's original contributions to the PPP while the remainder will be funded by the SME or start-up company or through a Department of Energy voucher system.

As a precondition to being selected as a PPP project, the award recipient is expected to have existing capital from venture capital or business revenue.

Value Proposition:

- Earn access to technical, management, and financial resources to reduce the technical risk of prototypes and innovations through advanced computing;
- Identify early-on the needs of potential customers and potential strategic investors and orient their innovation and efforts toward industry-relevant needs; and
- Connect to potential buyers who may provide the capital infusion needed to scale production.

Industry: Independent Software Vendors

Independent software vendors are important actors in the advanced computing ecosystem as they provide a platform for users at all points in the supply chain to apply modeling and simulation to their needs.

Independent software vendors are encouraged to participate in the PPP as Industrial Founding Partners or in collaboration with the PPP Executive Committee to ensure proper support and utilization of their products, possibly providing free trial access for their software for selected projects. They may also participate as a member of the Tiger Teams, providing training for SMEs and supply chain companies to better use their software.

Value Proposition:

- Access to advanced computing experts at national laboratories and universities that can help parallelize and strengthen software for use on high performance computing systems;
- Increase the user community for their software product; and
- Identify early-on the needs of customers and improve the capabilities of their software.

National Laboratories

To participate in this PPP, national laboratories must pledge to contribute and dedicate a portion of the tool at some threshold level (in this case, available computing time at more than 1 million supercomputing core-hours) to projects selected in this PPP, fund a portion of the remaining time for researchers (that not funded by the Department of Energy or industry participants) and commit researchers to two or more projects at a rate of 15 percent full time equivalent per project. For national laboratories participating in this PPP, the Department of Energy and industry participants will fund a portion of the time and resources to complete the project.

Value Proposition:

- Connect researchers to problems in industry and develop expertise that can be applied to DOE mission specific pursuits and
- Increase awareness in industry around the expertise and capabilities in the national laboratories.

Universities

To participate in this PPP, universities must pledge to contribute and dedicate a portion of available computing time or other needed resource, and fund the remaining portion of the tool access and resources needed to complete selected projects (that not funded by the Department of Energy or industry participants). Universities may also contribute to the PPP by providing seminars for start-up companies, SMEs and supply chains companies on advanced computing resources to increase their manufacturing competitiveness or pair students and professors with industry projects. For university participation in this PPP, the Department of Energy and industry participants will fund a portion of their time and resources.

Value Proposition:

- Connect researchers to problems in industry;
- Connect their students to possible job opportunities in industry, government and national laboratories; and
- Increase awareness in industry around expertise and capabilities in the universities.

Government

The Department of Energy will provide $2 million in funding for the first year of the PPP operation. Representatives from the Department of Energy would participate in the Executive Committee and Technical Advisory Board to ensure coordination across other initiatives in the government and with research efforts within the Department of Energy.

Value Proposition:

- Improve access of small, medium and large enterprises to resources in the innovation ecosystem;
- Steward and increase access of technical and manufacturing expertise through the use of Tiger Teams;
- Increase American competitiveness and spur greater domestic manufacture of innovative technologies;
- Create high-quality, enduring jobs for Americans in the clean technology industry; and
- Assist innovations and technologies to enter the marketplace.

Investors

Financial actors, such as investors, commercial lenders corporate finance arms of the Industrial Founding Partners, and public institutions play an important role in the innovation ecosystem. Investors are encouraged to participate in the PPP as Industrial Founding Partners or in collaboration with the PPP Executive Committee to provide projects access to investment opportunities. By including investors in the PPP, innovative and promising projects may be better transitioned through the valleys of death.

Value Proposition:

- Provide high quality deals to investors;
- Access to the bright and innovative entrepreneurs in SMEs, supply chain companies, and start-up companies in the U.S. clean technology arena; and
- Reduce investment risk through built-in due diligence.

PART 1: AEMC PARTNERSHIP DIALOGUE 5 PRIMER

Looking Forward

AEMC Partnership Dialogue 5 presents barriers to manufacturing in the United States and a PPP case-study for consideration by stakeholders across the innovation ecosystem—industry, academia, government, national laboratories, and non-profit organizations. This PPP case-study was selected based on feedback from participants at the 2013 AEMC Partnership progressive dialogue series and as a way to achieve the goals of the two PPP concepts presented at the Inaugural AEMC Summit to the Department of Energy.

The dialogue on April 16, 2014 at the University of California, Berkeley allows EERE and the Council to gather feedback from the community of stakeholders tapped through their participation in the AEMC Partnership. EERE will consider this feedback as it moves forward in the creation of a relevant and engaging public-private partnership with organizations across the innovation ecosystem.

PART 1: APPENDIX

The American Energy & Manufacturing Competitiveness Partnership-to-Date

Phase One: Mapping the Landscape

To cultivate topics for the progressive dialogue series, and to provide a foundation for the larger goals of the AEMC Partnership, the Council performed an extensive literature review and mapped 184 past and current research efforts across the United States and around the globe during Phase One concerning three core topics:

- Linkages between manufacturer efforts in energy efficiency and renewable energy and manufacturing competitiveness;
- Energy-related barriers to manufacturing competitiveness; and
- Models for PPPs for fostering competitive industries.

The literature review is documented in the Council publication, *The Power of Partnerships*, and its companion piece, *A Summary of Public-Private Partnerships*. These reports provide the foundation for the AEMC Partnership and answers to the following questions:

What prevents the United States from leading in the manufacturing of clean energy and energy efficient products or increasing energy productivity throughout the manufacturing sector?[12]

- High capital requirements;
- Lack of innovation infrastructure;
- Low investment in advanced manufacturing technology;
- Structural costs;
- Public and cyber infrastructure;
- Trade policy; and
- Clean energy market risks.

What are the essential ideas and strategies necessary to co-create a successful clean energy manufacturing PPP?

- Strong leadership;
- Clear, compelling mission;
- Early funding stream to establish a PPP, usually from the public sector; and
- Flexible intellectual property practices that draw corporate participation.

As the AEMC Partnership dialogue series progresses, participants discuss and expand on the findings in these reports.

12 A comprehensive list of barriers to manufacturing advanced technology is shown in Figure 12.

Figure 12. Barriers to the Manufacturing of Innovative and Advanced Technologies

Enabling Innovation

Capital Requirements
(1) underinvestment in basic research due to private sector inability to assume risk/reward ratio, (2) the "valley of death" at the development & demonstration stages and (3) a second "valley of death" for new SMEs at the point of scaling production.

Innovation Infrastructure
A lack of shared infrastructure and expertise on which companies and entrepreneurs can rely to develop and produce products more quickly and less expensively—often at universities or national labs.

Low Investment in Advanced Manufacturing Technologies
Low investment in technologies that lend advantage to manufacturers, e.g. additive manufacturing, sensors, robotics, artificial intelligence.

Securing the Talent Pipeline

Talent: STEM
Scarcity of people with science, technology, engineering and mathematics skills (spans K-12 through graduate education).

Talent: Middle Skills
Scarcity of people to fill—at current wages—jobs that require more than high school but not 4-year degree.

Improving the Business Climate

Pre-Production Costs
High up-front costs of development, infrastructure, and meeting price/ performance of incumbent energy sources and producers.

Structural Costs
Expense of corporate taxes, employee benefits, tort litigation, regulatory compliance, and energy.

Fiscal, Regulatory and Statutory Uncertainty
Inconsistent or unpredictable treatment by tax, regulatory or standards bodies that distort market behavior or investment decisions.

Public & Cyber Infrastructure
Quality of roads, rail, waterways, dams, transport, energy systems, communication networks, etc.

Trade Policy
Cost for manufacturers to source and export globally versus competitors, export controls, and distortions from foreign subsidies.

Addressing Clean Energy Market Risks

Externalities / Public Goods
The true cost of a product or behavior is not captured in its market price.

High Costs
High up-front cost associated with demonstration, production, and purchase of advanced technologies inhibit cost-competitiveness with incumbent energy technologies.

Technical Risks / Uncertainty
Market incentives that encourage firms to focus on low-risk incremental improvements to existing technologies.

Low Demand
A lack of demand for efficient energy because it is often indistinguishable to consumers at the point of consumption and because it can be more expensive.

Imperfect/Incomplete information
Lacking adequate information to make informed decisions.

Hidden Costs / Transaction Costs
Unaccounted costs that can skew benefit analysis.

Imperfect Competition/Gold Plating
Markets with limited producers or sellers lead to higher prices or inflexible bundling of products & services.

Access to Capital
Investments are inhibited by strict payback periods and organizational rules and procedures that place lower priorities through capital budgeting procedures and investment appraisals.

Split Incentives
Where benefits do not accrue to the person or organization seeking to adopt them.

Bounded Rationality/Behavioral Factors
Constraints on consumers' time, attention and ability to process information skewing decision-making.

Phase Two: The AEMC Partnership Progressive Dialogue Series

The second phase of the AEMC Partnership includes a total of four progressive dialogues in 2013, leading into AEMC Partnership Dialogue 5, in which participants generate new insights pertaining to the overall goals of the AEMC Partnership—as well as informing the creation of a public-private partnership concept to further advance the initiative's goals.

Summary of the Inaugural AEMC Partnership Dialogue

The inaugural dialogue convened and engaged over 100 senior leaders from industry, government, academia, labor, and the national laboratory system. Co-hosted by the Honorable Deborah L. Wince Smith, President and CEO of the Council, and the Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy at the U.S. Department of Energy, the dialogue laid the foundation for future discussions by gathering input on fields in the clean energy manufacturing sector that could benefit from the creation of a public-private partnership and evaluate the benefits and challenges of different PPP structures—all with an eye toward enhancing the competitiveness of the U.S. manufacturing sector.

An important function of the inaugural dialogue was to identify, understand, and discuss the opportunities offered by clean energy manufacturing. Much of this exploration was intended to highlight the convergence of market forces, public interest, and private sector strategies making clean energy manufacturing compelling for public-private collaboration. In her opening remarks, Ms. Wince-Smith noted:

"Half of the new electricity-generating capacity installed to meet the growing global energy demand during the next 25 years is expected to come from clean energy. Furthermore, businesses, governments, and communities are embracing energy saving behaviors and technologies. These market and political forces are converging to create the national will to invest in developing, manufacturing, and deploying

The Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy; the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; Mr. Jason Miller, Special Assistant to the President for Manufacturing Policy, National Economic Council; Ms. Elizabeth Wayman, Director, Clean Energy Manufacturing Initiative, U.S. Department of Energy; and Mr. Chad Evans, Executive Vice President, Council on Competitiveness.

clean energy technologies, as well as ensuring that all industrial sectors of our economy are using energy efficiently to, in turn, drive industrial productivity."

This quotation conveys the sense of urgency expressed at the dialogue and around the country as to the importance of developing a clean energy manufacturing strategy and increasing energy productivity broadly in the U.S. manufacturing sector. With this common understanding of the current clean energy manufacturing landscape, the AEMC Partnership tasked dialogue participants to generate ideas around two main themes:

- Leverage points in national investment in the clean energy manufacturing landscape—e.g. foundational technologies, road mapping, standards, policy tools, supplier relationships, domestic production barriers, etc.—with the potential to produce exponential impact and competitive advantage for all manufacturing sectors; and
- Public-private partnership concepts that would best use these leverage points and launch the United States ahead of international competitors.

The Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; Dr. Pradeep Khosla, Chancellor, University of California, San Diego; and Dr. J. Michael McQuade, Senior Vice President, Science & Technology, United Technologies Corporation.

The exceptional cross-section of industry, academic, labor, national laboratory and public sector leaders in attendance produced a robust discourse. Some key insights regarding potential leverage points and public-private partnership concepts from the inaugural dialogue include the following:

Insights on Potential Leverage Points

- Scaling technologies from prototypes to mass-manufactured products;
- Building a workforce that understands the challenges of scaling the production of newly created technologies in the United States;
- Developing and deploying advanced materials; and
- Increasing access to tools including modeling and simulation, robotics, automation, sensor technologies, and additive manufacturing into the manufacturing sector.

Insights on Public-Private Partnerships

- Designing the project with input from all stakeholders and with the outcome in mind greatly increases the likelihood of success;
- Charging the indirect cost of research facilities and equipment to the private sector is a barrier to private sector participation in a PPP;
- Facilitating the progress and success of a PPP is contingent on strong leadership by a single entity, such as a board, company, or other administrative body; and
- Creating boundaries and trust through intellectual property agreements is essential to develop an environment attractive for broad stakeholder participation.

Summary of AEMC Partnership Dialogue 2

AEMC Partnership Dialogue 2 convened 40 regional and national clean energy manufacturing stakeholders from industry, academia, the national laboratories, non-profit organizations, and the public sector at the University of Toledo in Toledo, OH. Co-hosted by Ms. Wince-Smith; Dr. Danielson; and Dr. Lloyd Jacobs, President of the University of Toledo, this regionally-focused, nationally-cultivated conversation followed directly from key themes strategically culled from the inaugural dialogue and leveraged the deep industrial history embedded in the Toledo region.

Dialogue 2 participants strengthened the conversation around creating a PPP by identifying essential inputs to the development of the successful Toledo solar energy cluster PPP: industry leadership from an established manufacturing base; access to shared infrastructure; access to patient, diverse, and consistent funding; complementary policy tools; in-kind equipment contributions; talent spillover; and a focus on first-to-market differentiated technologies.

With these contributions, discussions at Dialogue 2 moved beyond the high-level exploration and ideation of the foundational inaugural dialogue into determining actionable outcomes in preparation for

Dr. Jay Kim, Professor, Department of Mechanical Engineering, University of Cincinnati; Dr. Lorry Wagner, President, Lake Erie Energy Development Corporation; the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; Dr. Lloyd A. Jacobs, President of the University of Toledo; and the Honorable David T. Danielson, Assistant Secretary of Energy Efficiency and Renewable Energy, U.S. Department of Energy.

AEMC Partnership Dialogue 2 Participants.

Dialogue 3. This strategy was reflected in the smaller size of the dialogue, which created an action-oriented atmosphere, as well as the make-up of the assembled group. Participants were selected based on their expertise in the dialogue content and, more broadly, experience in manufacturing and public-private partnerships.

Participants suggested many PPP concepts at AEMC Partnership Dialogue 2. Five of the 17 ideas received strong support from participants at AEMC Partnership Dialogue 2:

- Fellowship program promoting personnel exchange between innovation institutions;
- Advanced materials design, qualification, and certification;
- Rapid prototyping and demonstration of new technologies utilizing modeling & simulation tools and Big Data;
- Building a virtual platform where companies can submit industrial innovations and seek crowd-source funding; and
- Building a virtual portal that allows industry and research institutions to match real-world problems and challenges to solutions.

These PPP concepts centered on lowering several of the barriers shown in Figure 12: capital requirements, innovation infrastructure; pre-production/high costs; high technical risk/uncertainty; imperfect/incomplete information; and access to capital.

These ideas and recommendations are documented in the Council's post-report, *Bridge.* Leadership teams at the Council and EERE evaluated and formulated these thoughts—in concert with private and public innovation leaders—into PPP concepts presented at AEMC Partnership Dialogue 3.

Summary of AEMC Partnership Dialogue 3

AEMC Partnership Dialogue 3 engaged over 60 leaders from industry, academia, non-profit organizations, and the national laboratory system. Co-hosted by Ms. Wince-Smith; Dr. Danielson; and Dr. Little; this dialogue strategically evaluated five PPP concepts capable of driving the overarching goals of the AEMC Partnership. Summaries of these five PPP concepts and the method for evaluation along with the findings from Dialogue 3 are documented in *Evaluate,* the post-report for the dialogue.

Mr. Chad Evans, Executive Vice President, Council on Competitiveness; the Honorable Paul Tonko, U.S. House of Representatives; the Honorable Deborah L. Wince-Smith, President and CEO, Council on Competitiveness; the Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy; Ms. Elizabeth Wayman, Director, Clean Energy Manufacturing Initiative, Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy; Ms. Jetta Wong, Deputy Director, Clean Energy Manufacturing Initiative, Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy; and Dr. Mark Little, Senior Vice President and Chief Technology Officer, General Electric and Director, GE Global Research.

"We are a nation of collaboration. We have tribes within this nation–tribes of universities, national laboratories, numerous tribes in industry, and our government–federal and state. Through these discussions, we can find ways to collaborate, work together, to do something big and important for our nation."

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

Dialogue 3 participants were strategically placed in five parallel working group sessions to discuss:

- **Innovation Exchange Fellowship Program**
  This PPP concept targets the insufficient access to shared innovation infrastructure and talent: STEM manufacturing barriers by developing manufacturing leadership and enhancing knowledge spillover in the innovation ecosystem. This is accomplished by expanding the intersections and points of exchange between the private sector and U.S. national laboratories and research universities through a fellowship program.
- **Leveraging the Innovation Ecosystem**
  This PPP concept targets the insufficient access to shared innovation infrastructure and high technical risk/uncertainty manufacturing barriers by increasing accessibility to key national laboratory and university resources. This is accomplished by providing manufacturers competitive user grants to reduce fees and lowering barriers to use existing facilities by creating an easy-to-use collaboration agreement.
- **Advanced Materials Characterization, Experimentation, and Standardization**
  This PPP concept targets the insufficient access to shared innovation infrastructure, high pre-production costs; and high technical risk/uncertainty manufacturing barriers of increasing the use and commercialization of existing advanced materials. This is accomplished by ensuring new materials function reliably and predictably before integration into new technologies and systems by increasing accessibility to key national laboratory and university materials characterization resources and by convening materials stakeholders across the creation and user community to create materials standards faster.
- **Facilitating the Transition of Prototypes to Deployable Products**
  This PPP concept targets the insufficient access to shared innovation infrastructure, access to talent: middle skills; high pre-production costs; high technical risk/uncertainty; and insufficient access to capital manufacturing barriers to increasing the graduation of prototypes into

The Honorable Shirley Ann Jackson, President, Rensselaer Polytechnic Institute, and former University Vice Chair, Council on Competitiveness; and the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness.

commercial markets. This is accomplished by improving communication and transparency into the private sector and increasing access to resources.

- **Industrial Kickstarter and Manufacturing Marketplace**
  This PPP concept targets the high technical risk/uncertainty and insufficient access to capital manufacturing barriers to transitioning prototypes into commercial markets. This is accomplished by convening investors, entrepreneurs, and manufacturers to front-fund and crowd-fund promising new technologies.

While all five PPP concepts were supported for the benefits they could unleash in the innovation ecosystem, two PPP concepts received widespread support from stakeholders present: Advanced Materials Characterization, Experimentation, and Standardization and Facilitating the Transition from Prototypes to Commercially Deployable Products. By identifying these concepts as areas as ripe for engagement by the public and private sectors through a PPP, the AEMC Partnership identified two fields that affect the manufacturing and energy sectors. Collaborating to address one or both of these fields in the near term will bolster dramatically U.S. energy, manufacturing, and economic competitiveness into the future.

Summary of AEMC Partnership Dialogue 4

AEMC Partnership Dialogue 4 engaged over 50 regional and national leaders from industry, academia, non-profit organizations, and the national laboratory system. Co-hosted by Ms. Wince-Smith; Mr. Michael Splinter, Executive Chairman of the Board, Applied Materials, Inc.; and Dr. Omkaram Nalamasu, Senior Vice President and CTO, Applied Materials; this dialogue evaluated two PPP concepts capable of driving the overarching goals of the AEMC Partnership.

The Council and EERE worked together to further conceptualize two PPP concepts selected by the participants during AEMC Partnership Dialogue 3. In addition to tapping into insights from the previous three dialogues and *The Power of Partnerships*, the Council undertook a survey campaign that tapped into national leaders from the private sector, the national laboratories, and universities to help construct and critique these models. The resulting PPP concepts were presented to Dialogue 4 participants to be explored and evaluated. Full summaries of these PPP concepts and findings from Dialogue 4 are presented in *Focus,* the AEMC Partnership Dialogue 4 post-report.

- **Clean Energy Materials Accelerator**
  The Clean Energy Materials Accelerator PPP concept, expanded from the previous Advanced Materials Characterization, Experimentation, and Standardization PPP concept, focuses on increasing access to shared innovation infrastructure, and reducing pre-production costs and technical risk/uncertainty associated with deploying newly developed materials in commercial products and processes. This PPP concept creates a platform to identify and address common challenges; increasing access to existing materials qualification and characterization tools; and creating standards for advanced materials with leaders in industry, academic, government, and other organizations.

Mr. Michael R. Splinter, Executive Chairman of the Board, Applied Materials, Inc.

AEMC Partnership Dialogue 4 Participants.

- **Facilitating the Transition from Prototypes to Commercially Deployable Products**
  This PPP concept focuses on reducing capital requirements, pre-production costs, and technical risk/uncertainty while increasing access to shared infrastructure and access to capital. This PPP concept builds a new physical and virtual collaborative resource platform to connect the nation's world-class innovation institutions—SMEs, large multinational companies, universities, national laboratories, etc.—for the purpose of facilitating the transition of cutting edge clean energy technologies into products, processes, or services that are produced in the United States.

Dialogue 4 participants evaluated and critiqued both concepts to strengthen and increase their relevance to their organization. For example, recommending that both PPP concepts incorporate a workforce development program to increase STEM education and middle-skill jobs. They also surveyed the national landscape and revealed gaps in the U.S. innovation system that demonstrate a clear need for these PPP concepts.

These PPP concepts were further developed and presented to the Department of Energy at the Inaugural AEMC Summit on December 12, 2013 in Washington, D.C. in the Council publication *Amplify* as the Clean Energy Materials Accelerator and the Manufacturing and Energy Technology Accelerator, elaborated from the PPP concepts presented in Dialogue 4.

PART 2
Findings from AEMC Partnership Dialogue 5

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 5

Introduction

Through the AEMC Partnership, the Council and EERE convene dialogues in strategic locations across the country with leaders from nearly every sector of the economy who understand the importance of and are committed to enhancing U.S. competitiveness in the clean energy and manufacturing sectors. To increase U.S. competitiveness in these sectors, the Council and EERE examined next generation public-private partnerships (PPPs) designed by and comprised of national leaders from organizations across the innovation ecosystem through the AEMC Partnership dialogue series.

AEMC Partnership Dialogue 5 was co-hosted by Ms. Wince-Smith; Dr. Danielson; and Dr. Nicholas Dirks, Chancellor of the University of California, Berkeley (UC Berkeley).

Dr. Danielson shared his interests in supporting clean energy manufacturing for the benefit of the American people. At this unique time in U.S. energy history, a wide variety of clean energy and energy efficiency technologies are right on the cusp of direct cost competitiveness, even without subsidies. As these technologies approach direct cost competitiveness, the clean energy economy may grow from the $250 billion in 2013 into trillions of dollars. The nation has the opportunity to position itself with its intrinsic competitive strengths, to capitalize on this growing clean energy economy and create manufacturing jobs and innovative products and retain the manufacturing value competitively.

This important opportunity is further supported by globally changing trends. Labor costs are increasing overseas, especially in Asia. American companies are experiencing complications with foreign business environments and intellectual property. Additionally, American companies like GE have made it clear that co-locating manufacturing facilities with their innovation centers here in the United States facilitates interactions between the lab bench and the manufacturing floor.

Dr. Nicholas Dirks, Chancellor, University of California, Berkeley.

The President's Advanced Manufacturing Partnership initiative brings together America's great leaders to lay out the path forward. The Clean Energy Manufacturing Initiative can be considered the clean energy branch of this national manufacturing initiative, investing more than $325 million dollars directly into manufacturing-related innovation, research and development in thrusts such as materials with a large potential impact on multiple clean energy sectors and industrial efficiency innovation.

EERE continues to work toward the launch of significant branded PPPs that align with five EERE Core Statements. Through this AEMC Partnership dialogue series, leaders have identified a number of gaps and problems that could be solved with a partnership: providing early stage financing and lowering capital requirements or creating innovation commons, the innovation infrastructure as it relates to manufacturing. These PPPs could tie together capabilities and assets from national laboratories and universities with needs in industry to expand the number of companies—big and small—locating, manufacturing, and expanding in the United States.

During this dialogue, participants were asked to consider how industry can better utilize the unique, globally distinctive capabilities of our national laboratories and universities. One capability consistently recognized as a competitive advantage is advanced computing modeling and simulation. Placing the power of modeling and simulation through advanced computing into the hands of American producers, innovators, and entrepreneurs, can tremendously turbo-charge innovation—lowering costs, increasing speed to market, enabling the development of products and services never before imagined, and optimizing existing industrial operations, according to Ms. Wince-Smith. To spark conversation, Ms. Wince-Smith asked participants, “Can a tool such as advanced computing act as the connective tissue that binds together the challenges and opportunities to reinvigorate the manufacturing sector?”

Top: *Dr. Nicholas Dirks, Chancellor, University of California, Berkeley, the Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy, and Dr. Jon Schaeffer, Senior Engineering Manager, GE Power & Water.*

Bottom: *The Honorable Jennifer M. Granholm, Former Governor and Distinguished Practitioner of Law and Public Policy, University of California, Berkeley and the Honorable Deborah L. Wince-Smith, President and CEO, Council on Competitiveness.*

EERE Core Statements for Creating a Public-Private Partnership

1. This PPP concept addresses a high impact problem.
2. EERE funding for this PPP concept will make a large difference relative to current private sector efforts.
3. This PPP concept focuses on a broad problem that EERE is trying to solve and is open to new ideas, new approaches, and new performers.
4. EERE funding and participation will result in an enduring economic benefit to the United States.
5. EERE funding and participation represent a high-impact role of government rather than a role the private sector should lead itself.

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 5

The Goals and Objectives of the Clean Energy Manufacturing Initiative

Ms. Elizabeth Wayman, Director of the Clean Energy Manufacturing Initiative at the U.S. Department of Energy, briefed Dialogue 5 participants on CEMI goals: to create a strategy across the Department of Energy in manufacturing: to seek extensive external input to drive efforts with the needs of industry and to put forward a cross cutting budget proposal.

With the extended collaboration throughout the Department of Energy, CEMI has added several resources to this portfolio—including extensive commercialization and engagement efforts with the 17 U.S. national laboratories. In addition, CEMI is working with the Loan Program Office to bring an additional high impact resource into this portfolio.

In addition to the five core statements previously outlined, four characteristics are particularly salient in turning ideas into feasible efforts to unleash the potential of DOE focus areas. These ideas must be need-driven, actionable, opportunistic—taking advantage of existing resources and unique capabilities within DOE, and collaborative.

Through the group of leaders convened throughout the AEMC Partnership several ideas have already begun to develop into actions, including the creation of a Technologist-in-Residence program. The Technologist-in-Residence program supports the collaboration between national laboratory scientists and industry work to strengthen communication and understanding across these disparate organizations. The CEMI and EERE teams are also developing public-private partnership ideas around materials discovery, scaling materials to manufacturing, as well as scaling innovation to manufacturing and financing models.

The Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy; and Ms. Elizabeth Wayman, Director, Clean Energy Manufacturing Initiative, U.S. Department of Energy.

Through further discussions, including Dialogue 5, the CEMI and EERE teams will continue to evaluate ideas and hone the development of PPPs to be launched in the future.

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 5

Presenting a PPP Case-Study for the AEMC Partnership

As Dr. Danielson and Ms. Wince-Smith noted in their opening comments, the AEMC Partnership has two very specific goals: to increase U.S. competitiveness in the production of clean energy technologies and energy products and to increase overall U.S. manufacturing with activities that will increase energy productivity.

The Council, along with the Department, undertook a major effort over the past year through a literature review and the AEMC Partnership dialogue series to better understand barriers to manufacturing competitiveness and create PPPs that might address the two major goals of the AEMC Partnership. Through this process, AEMC Partnership participants have helped home in on three significant barriers to increasing clean energy manufacturing competitiveness:

- Insufficient access to innovation infrastructure
- High technical risk for uncertainty
- Insufficient access to capital

At Dialogue 5, participants were asked to consider a tool-based PPP focused on increasing industry access to advanced computing with the potential to lower these three barriers as a case-study. This advanced computing PPP places cutting edge assets and capabilities at the national laboratories and universities at the heart of an innovation ecosystem to facilitate innovation and optimization of products and processes, shorten time to market, quickly develop advanced materials, and transform R&D within large and small companies.

> "In the absence of access to high performance computing (HPC), small companies have no choice but to innovate through trial and error. On a small scale, this works. But accessing HPC assets and experts innovating in a cutting edge allowed JECO Plastic Products to cost-competitively innovate and displace foreign competitors."
>
> **Mr. Craig Carson**
> CEO
> Jeco Plastic Products

The PPP case-study is presented as an initiative that facilitates and possibly funds individual projects through a Request for Proposals process. An Executive Committee to provide oversight for the PPP and is advised by a Technical Advisory Board. The Executive Committee may include:

- Department of Energy representation providing insight and tying into other federal or state level initiatives and industry founding partners to decide our focus;
- University representatives with an understanding of legal agreements, available resources, and incorporating students and faculty;
- National laboratory representatives with an understanding of legal agreements, access and availability of resources, and personnel to engage on projects; and
- A secretariat organization to oversee and organize PPP functions.

Mr. Rob Guthrie, Business Initiative Specialist, Office of Renewable Energy & Environmental Exports, The Export-Import Bank of the United States and Dr. Eric Pomraning, Vice President, Convergent Science.

Mr. David Kenney, President, Oregon BEST and Dr. Costas Georghiades, Associate Dean for Research, Texas A&M University.

In opening the session for discussion, Ms. Wayman noted that advanced computing modeling and simulation has a major impact on furthering innovation, and requested participants consider how advanced computing could encourage industry to manufacture those innovations here in the United States. In response, Dr. Cynthia McIntyre, Senior Vice President, Council on Competitiveness shared successes from the National Digital Engineering and Manufacturing Consortium (NDEMC) public-private partnership, where funds from OEMs and the federal government facilitated access to HPC to increase the innovation capacity and competitiveness of small and medium sized manufacturing enterprises.

One of the successful projects within NDEMC was the modeling and simulation of plastic pallets from Jeco Plastic Products. Mr. Craig Carson, Chief Executive Officer of JECO Plastic Products, shared with Dialogue 5 participants his experience working with HPC assets and experts which resulted in increased products manufactured by JECO in the United States, increased wealth, and increased competitiveness. Mr. Rob Guthrie, Business Initiative Specialist in the Office of Renewable Energy & Environmental Exports at the Export-Import Bank of the United States, enthusiastically supported the idea of a PPP to accelerate exports and help create American jobs by tying in assets at the Export-Import Bank.

Accessing and implementing advanced computing into industry business is not a simple task. According to Dr. Costas Georghiades, Associate Dean for Research, Texas A&M University, computing is a confluence of many separate assets: hardware, software, computer experts, and domain scientists. To truly harness the power of advanced computing, industry needs to join a full ecosystem of advanced computing where they can find all the necessary facets in one location and train employees to apply these resources to a company's problems. A PPP facilitating access to the full gamut of advanced computing provides this benefit and increases the speed of adoption by industry.

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Aligning Clean Energy Manufacturing Forces through PPP Facilitating Access to Extraordinary Resources and Capabilities

Throughout the 2013 AEMC Partnership dialogue series, three barriers have been highlighted as important to unleashing the potential for clean energy manufacturing, specifically in the areas of deploying advanced materials faster and facilitating scale up of clean energy technology manufacturing in the United States: insufficient access to capital, insufficient access to shared infrastructure, and high technical risks.

Discussants provided suggestions on how to overcome these barriers through participation in a tool-based PPP, for example, around advanced computing. According to Dr. Peter Littlewood, Director of Argonne National Laboratory, there are technical obstacles to overcome in advancing manufacturing—for example training the workforce, high costs to entry, and determining how best to implement these tools into existing processes. To implement advanced computing, we need to evolve our software to run on larger systems, train people to use the software and hardware, and help them access these tools—create an entire ecosystem for the full chain of businesses involved in manufacturing. Dr. Sethuraman Panchanathan, Senior Vice President, Office of Knowledge Enterprise Development, Arizona State University further supported this ecosystem-based approach, encouraging a PPP built around advanced computing to create a physical center where people without specialized computer expertise can translate their problems and quickly access tools through an easily understandable human interface. An additional benefit would also connect ideas and new products to sources of start-up capital, like the venture capital community, Dr. Panchanathan added.

Top: *Mr. Frank Wolak, Vice President, FuelCell Energy and Dr. Peter Littlewood, Director, Argonne National Laboratory.*

Bottom: *Dr. Sethuraman Panchanathan, Senior Vice President, Office of Knowledge Enterprise Development, Arizona State University, and Mr. Chad Evans, Executive Vice President, Council on Competitiveness.*

Mr. William Sobel, Chief Executive Officer, System Insight, Inc.

The Honorable Jennifer M. Granholm, Former Governor and Distinguished Practitioner of Law and Public Policy, University of California, Berkeley.

Companies in the aerospace and automotive industries have begun to use computer modeling in their work processes, and finding a method to include small businesses and supply chain companies in this work could cut costs and increase productivity, supported Mr. Brad Markell, Executive Director of the Industrial Union Council, AFL-CIO. By collecting data from manufacturing companies, Mr. William Sobel, Chief Executive Officer, System Insight, Inc. has found many manufacturing enterprises operating at 25 percent utilization of equipment or efficiency. When implementing computer based data analytics and optimization methods, this efficiency can be raised to 50 percent, or even 80 percent—reducing labor costs and increasing manufacturing productivity. Further productivity gains could continue by connecting machines for direct communication.

According to the Honorable Jennifer M. Granholm, Former Governor and Distinguished Practitioner of Law and Public Policy, University of California, Berkeley, another way to unlock the potential for increased manufacturing competitiveness is to empower states to provide capital (potentially in partnership with the Export-Import Bank). States could support regional hubs—not to compete with each other for the same business, but by respecting incumbent industries and resources in different regions, build a national strategy from the bottom up. Mr. Frank Wolak, Vice President of FuelCell Energy supported this regional approach by stating that FuelCell Energy, as a medium-sized enterprise, works mainly with local and regional networks and encouraged any national initiative to trickle down to regional academic institutions. These partnerships would be particularly useful to SMEs if they have a way to participate when necessary and disassociate once the specific problem has been solved.

Dr. Dawn Manley, Deputy Director of Chemical Sciences, Sandia National Laboratories and Mr. Brad Markell, Executive Director, Industrial Union Council, AFL-CIO.

Dr. Mark Cotteleer, Director, Deloitte Services LP and Mr. Frank Wolak, Vice President, FuelCell Energy.

Ms. Granholm also mentioned the opportunity presented in response to new regulations like the Clean Air Act Section 111(d). Mr. Markell agreed that the Clean Air Act Section 111(d) provides a great opportunity, similar to that created by the CAFÉ standards that induced innovation, investment and job creation around in the automobile industry.

Participants at the dialogue discussed the difficulty in completing contracts to begin work and finding funding. Finding the perfect funding mechanism for companies of all sizes to access tools like advanced computing remains a challenge. Models exist, including the Advanced Technology Support Program with the Department of Defense Microelectronics Activity, the agreements when partnering through CalCharge with the Lawrence Berkeley National Laboratory, and the New Mexico Small Business Assistant Program—where small business partnerships between Sandia National Laboratories and Los Alamos National Laboratory are funded by a state tax program. However, in all of these situations, companies are required to provide funds, which in comparison to foreign programs such as the Hartree Center in the United Kingdom where resources and project work are funded by the central government, creates a large barrier to begin.

As summarized by Dr. Danielson, when it comes to a tool with the potential to increase productivity and competitiveness in manufacturing like advanced computing, many resources exist but once interested, the identification, accessibility, and mechanism to apply these tools in our current system is difficult.

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How Advanced Computing Can Transform Business

Dr. Dawn Manley
Deputy Director of Chemical Sciences
Sandia National Laboratories

Collaborations between national laboratories and industry through advanced computing benefits both players in many areas including materials science, vehicle technologies, and computing.

Some challenges can prevent these relationships from lasting or even forming. Companies can be hesitant to work with outside partners, not knowing the work product they will receive or for fear their innovations and trade secrets may become public when working with national laboratories tied directly to the federal government. Once trust has been built between collaborators, expectations must still be managed and coordinated. While industry wants "the solution yesterday, for the problem rising tomorrow," national laboratories typically think in longer time-frames, looking to solve problems arising in the next 10 to 15 years. Another challenge is differences in invested infrastructure –industry and national laboratories often use different software or hardware, for example using different computing operating systems, adding an extra layer of work before collaboration can begin.

Even in the face of these challenges, several successes exemplify the benefits of collaborations between national laboratories and industry. Two of these successes are Sandia's successful relationship with Goodyear Tire & Rubber Company (Goodyear) and the Engine Combustion Research Facility. As described in the primer of this report, Goodyear found itself in a slump and unable to compete with

Dr. Dawn Manley, Deputy Director for Chemical Sciences, Sandia National Laboratories.

companies such as Michelin and Bridgestone in 2003 and 2004. In an effort to improve its competitiveness, Goodyear funded Sandia to integrate modeling and simulation into the design of its products. In gaining access to advanced technology at Sandia, Goodyear's released several product successes—as well as benefitting Sandia scientists by forcing scientists to better "understand the dynamics of a different set of materials than we had already characterized for other national security purposes." This collaboration in turn, better prepared scientists for national security challenges in the future.

The federally funded Engine Combustion Research Program is another successful collaboration. In this research program, Sandia leads a consortium of multiple national laboratories and universities working with industry partners to advance vehicle technologies for the nation. From work undertaken during this research program, Cummins, Inc. was able to "develop the very first engine designed entirely by modeling, simulation and advanced computing." Following the design process, the engine was built and physically tested to verify the accuracy of the simulations and Cummins found development time and costs reduced by 10-15 percent.

Several characteristics were common through these successful engagements, important to consider when creating a new PPP. Work in these collaborations targeted high-priority problems for industry partners, keeping industry scientists and leaders engaged throughout the process. Success was achieved through deep collaboration between national laboratories and industry—industry approached Sandia in these cases because of existing capabilities that could directly be applied to problems. National laboratory scientists also learned from industry partners during these collaborations, providing preparation when tackling future challenges. By building momentum over several projects over years, these relationships engaged employees at several levels—from leaders to bench scientists at both organizations—and paved the way for further collaborations and successes.

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Differentiate: Understanding Existing PPPs and Opportunities to Further Support Clean Energy Manufacturing

Dr. Mark Johnson
Director
Advanced Manufacturing Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Mr. Steven Betza, Director, Hardware Engineering & Advanced Manufacturing, Lockheed Martin and Dr. Mark Johnson, Director, Advanced Manufacturing Office, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy.

The United States has the best technology and the most productive workforce in the world. We have an opportunity to channel this technology and productivity into issues that really matter, like clean energy manufacturing. The market has never looked better for clean energy technologies and clean energy manufacturing. The question to answer is how do we develop great business models that work for both the public and private sectors in developing clean energy technologies and efficiently scaling them to reach the global market?

The United States government has a long history of funding research, development, and demonstration through public-private partnerships. Our goal in the Advanced Manufacturing Office is to translate past successes into PPPs with the potential to increase U.S. manufacturing competitiveness. We fund cooperative agreements, which are PPPs with substantial public involvement, in addition to actively managing the project. To be accountable for our use of the taxpayer's money we work to ensure that the United States is considered as a location for manufacturing of the product or processes we support with funding—and if the United States is not the best place for manufacturing, we want to understand why.

We consider tools to increase U.S. clean energy manufacturing competitiveness by reducing technical uncertainties and risks. Our Better Plants Program is a great program that elevates the conversation around energy efficiency and energy productivity to the executive boardroom. Sector-specific tools are also under consideration, especially for a dozen traditionally energy-intense industries—which consume two-thirds of the energy of the whole industrial sector. One way to reduce this energy consumption and increase competitiveness is to apply tools such as high performance computing and massive sensor based control to regulate energy use. To move forward in this aspect, we ask ourselves: how can inexpensive sensors be developed that withstand the conditions of manufacturing plants so operators can better understand and control energy use in our manufacturing and production processes? Beyond specific sectors, the Advanced Manufacturing Office is also examining broad cross-cutting clean energy manufacturing materials and technologies and focusing on scaling these laboratory discoveries from the bench-scale into the marketplace cost-effectively and for wide applicability.

A public-private partnership that addresses energy productivity in manufacturing has the potential to generate a substantial increase of economic activity over the next 20 years. We have a window of opportunity right now—energy prices are low and we have a productive and educated workforce poised to meet the demand—to make investments that will benefit our economy and our country for years to come.

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Stakeholder Leadership Presentations

During, the Stakeholder Leadership Presentations session, six leaders at Dialogue 5 discussed the advanced computing PPP case-study presented, shared the benefits their organization would enjoy if participating, and the beneficial effects of the PPP case-study on the whole innovation ecosystem.

Strengthening the Innovation Ecosystem

Dr. David Dornfeld
Will C. Hall Family Chair in Engineering
and Professor of Mechanical Engineering
University of California, Berkeley

Dr. Dornfeld opened this session, presenting the views of Dr. Horst Simon, Deputy Director at Lawrence Berkeley National Laboratory (LBNL), who could not be present.

LBNL is involved in several public-private partnerships, including CalCharge—a consortium of 40 battery companies in the California Bay Area working to streamline new battery technology development; and the Flex Lab—a configurable test bed facility for evaluating technologies for low energy innovative building systems under realistic operating systems. Partnering with a national laboratory like LBNL provides access to collaborative research and great facilities, including the Flex Lab and the Advanced Light source at LBNL and advanced computing capabilities. Access to these capabilities can catapult a company's technology or manufacturing ahead of the competition, but industry is absolutely necessary to build the infrastructure, raise money, reduce the risk, and scale-up the technology.

Dr. David Dornfeld, Will C. Hall Family Chair in Engineering and Professor of Mechanical Engineering, University of California, Berkeley.

Through interactions in a PPP like the advanced computing PPP case-study, the entire innovation ecosystem is strengthened. As Mr. Carson mentioned, working together across companies and different organizations awakens people to potential answers and opportunities in other fields.

Deploying Advanced Materials into the Marketplace Faster, Collapsing the Research, Development, and Deployment Cycle

Dr. John Schaeffer
Senior Engineering Manager
General Electric (GE) Power and Water

Dr. Schaeffer shared with Dialogue 5 participants his perspective on the advanced computing PPP case-study, based on his work deploying advanced materials into the marketplace faster and collapsing

Dr. Jon Schaeffer, Senior Engineering Manager, GE Power & Water.

Mr. Craig Carson, President and Chief Executive Officer, JECO Plastic Products and Dr. Mark Cotteleer, Director, Deloitte Services LP.

the research and development cycle. GE has made the effort over the last 15 years to become more vertically integrated, building more test facilities, more manufacturing lines, and supporting stronger manufacturing-based education throughout South Carolina.

In the field of combustion, GE is working to increase the efficiency of gas turbines by increasing the firing temperatures and the size of the turbines. Increasing the firing temperature requires advanced materials such as ceramic matrix composites (CMCs) and thermal barrier coatings while increasing the size requires high-strength materials such as titanium. Beyond the benefit of using advanced computing to better understand the behavior of materials under varying conditions, computing could also be used to compile, organize and make use of the 50 years of compiled data.

GE, as a large company, has access to and integrates tools such as advanced computing into manufacturing and material development; however, the supply base does not. Companies in GE's supply base also resist working with GE to integrate their tools, likely fearing loss of intellectual property. Instead of integrating advanced computing into their design processes, they feel they can produce results faster using existing methods—for example running experiments rather than creating a new model and running simulations. Creating a PPP like the advanced computing PPP case-study provides a neutral ground for suppliers to learn about, access, and begin to integrate useful tools into their manufacturing processes. Through this neutral ground, GE would also see the benefit of being able to compare the parts created by different suppliers and better understand and compensate for variations.

Promoting Access, Understanding, and Investment to Drive Competitiveness

Dr. Mark Cotteleer
Director
Deloitte Services LP

Dr. Cotteleer shared his perspective on the PPP case-study from his work in linking organizations and bringing ideas to clients by "understanding technologies, understanding the research literature, synthesizing it, then presenting it in a way managers can understand."

Through his work at Deloitte, Dr. Cotteleer reaches out to managers in an organization, people who may not have deep technical backgrounds, yet make decisions that affect technology investments. In this vein, Dr. Cotteleer and the Deloitte team are building a "massive open online course" project to connect managers to technologies that are emerging from national laboratories like additive manufacturing and high performance computing so that they can better understand the intricacies and build a roadmap for implementation or adaptation for their companies.

PPPs, such as those discussed during AEMC Partnership Dialogue 5, play an important role in raising awareness and facilitating "a connection between national laboratories and interested companies." Through these connections, organizations can increase their communication and work together to tackle challenges both in the present and in the future. By creating this work stream through a public-private partnership, more organizations will learn about others working in the same field, and find the best path to working together without creating redundancies.

Mr. Sanket Amberkar, Senior Director, Strategic Marketing – Innovation, New Ventures and Energy, Flextronics and Dr. Jeff Nichols, Associate Laboratory Director for Computing and Computational Sciences, Oak Ridge National Laboratory.

Transforming U.S. Manufacturing Competitiveness

Mr. Sanket Amberkar
Senior Director, Innovation, New Venture, and Energy
Flextronics

Mr. Amberkar presented three factors with the potential to transform U.S. manufacturing competitiveness: minimizing total cost through the supply chain, monetizing the innovation process, and applying tools such as advanced computing.

A company that manufactures must minimize the total cost in supply chain by selecting the optimal place to manufacture—not just the locations with the lowest labor costs. With products becoming more complicated, intertwining research and development with product development, manufacturing, and deployment in the field becomes a desirable feature for a company. Building regional hubs for manufacturing brings disparate players together and minimizes costs for the end customer. An advanced computing PPP could be an integral part of a regional manufacturing hub—completing testing and simulations for manufactured products prior to deployment—and bring real value to people throughout the supply chain.

Mr. Craig Carson, CEO of JECO Plastic Products.

A PPP can help quantify the value of innovation along with the value of each partner and strengthen a region's manufacturing competitiveness. By picking a subject matter for partners to collaborate around—for example materials, sensors, or smart software—the PPP can induce breakthroughs, attract leaders in the area and act as a repository of knowledge for all partners. A common problem with PPPs can be the cost of participation. Instead of requiring high up-front costs to engage in the PPP which limits the number of interested initial partners, the application of knowledge from the PPP into a production environment or application should be monetized—so that the PPP receives a percentage of the revenue generated.

Advanced computing itself can be a great tool to increase manufacturing competitiveness—creating high visibility and control throughout the manufacturing process. Advanced computing is required to track, control, and minimize risk in complex and intricate manufacturing such as the progress of product manufacturingand logistics. Through this tool, rerouting materials and reducing costs or time becomes easier. These benefits can then translate into the ability to achieve mass-customization in manufacturing—further increasing the value of a manufacturing process.

Accessing Capital and Scaling Manufacturing

Mr. Craig Carson
CEO
JECO Plastic Products

Mr. Carson shared his experience accessing capital and scaling manufacturing by implementing advanced computing into his research and design cycle. While his company traditionally created low-tolerance, high volume products with low margin profits, he worked to enter markets with higher margins, smaller volumes, and higher-tolerance products. To create a better product for lower costs than his competitors in other countries with benefits such as indirect subsidies for freight charges or dissimilar duties levied on products from different countries, Mr. Carson designed and tested products through advanced computing. With this capability, he was able to demonstrate a deep understanding of product performance, with which he won a large contract for products, increasing his working capital to scale production.

Through his involvement in a PPP, Mr. Carson was able to access the tools necessary to implement advanced computing to increase his company's competitiveness. At this time, he can pay ten dollars per simulation at a computing center—removing the barrier of high up-front costs to purchase software licenses or computer hardware. Additionally Mr. Carson increased his interaction within the innovation ecosystem by working with a PPP—in advanced computing and in materials science—which enabled him to learn about opportunities for his company to meet needs in different fields. For these reasons, Carson continues to invest in equipment, software, and personnel that will integrate simulation technologies into his business.

These advanced computing capabilities and expertise make JECO an attractive company to other nations. Germany has offered JECO an interest-free equity loan to match any investments made to manufacture these products in Germany. The country will provide JECO with trained personnel to interface

Mr. Rodney Heiple, Director, EPS Business Technology, Alcoa, Inc.

"A skilled operator or technician adjusting a control on a machine is not making a process decision—they are making a business decision. With advanced computing, we could provide data feedback to that technician—that their adjustment just increased or decreased the cost of that product."

Mr. Rodney Heiple
Director EPS Business Technologies
Alcoa, Inc.

with customers and guarantee minimum contracts to ensure a JECO in Germany stays in business. High technology manufacturing is no longer driven offshore to low-cost countries. Instead, countries work to attract companies with high technology manufacturing to their shores.

Building Confidence to Invest in Manufacturing

Mr. Rodney Heiple
Director, EPS Business Technology
Alcoa, Inc.

Mr. Heiple provided his perspective on building confidence to invest in manufacturing by incorporating advanced computing, identifying two significant aspects: reinforcing the value proposition of a process or product technology and assessing the risk in deployment of that technology.

Alcoa assesses value proposition and risk early and often through the product and process development phases. Twenty years ago, products required six or seven manufacturing guide trials prior to making the first good part. At this time, Alcoa is moving to achieve zero guide trials for new products—this is accomplished by incorporating advanced computing into design and testing. These capabilities required finite element codes and days of computing time. At this time, these capabilities have been translated into desktop computers and will soon be available in tablets in use on the manufacturing floor. Through the use of computers, Alcoa has cut their lead times in half—critical from an innovation standpoint and from a competitive threat standpoint as well. The end result is tens of millions of dollars every year in savings—from reduced energy, material, and tooling needs, reduced waste and faster speed to market.

Advanced computing can reduce risk at the customer level as well. Alcoa can predict residual stress in large forging and the machining needed from customers. These predictions reduce set-up costs in the creation of these products and reduce the amount of scrap created. Alcoa can also estimate how customers use the products, without requesting proprietary knowledge. Using computers to communicate new ideas opens up a pathway for collaboration in creative thinking which parties can share with one another respectively. Pulling together advanced computing capabilities in a PPP propagates knowledge and best practices across partnering institutions, provides a location to share competition-insensitive data and models, and provides a place for industry to bring high-priority foundational problems and opportunities.

Open discussion

Connecting the private and public sectors to facilitate the development of innovative manufacturing strategies is a non-trivial task. According to Dr. Cotteleer, there is a challenge to beginning and sustaining relationships. As a person who does not work on the technical aspects of engineering or manufacturing, he sees the need to build a common ground for non-technical people to communicate with technical people. Dr. Nichols added to this the need for the community to better understand the requirements to begin applying advanced computing modeling and simulation to a manufacturing or development problem, in addition to better understanding how to create a flow of work: being easily able to move from the definition of the problem to the collection of data to the applications of models to find solutions.

Advanced computing can be used to connect these pieces together. Dr. Goldstein shared that experts at Lawrence Livermore National Laboratory use advanced computing to better understand the underlying physics and meet stringent specifications at each step of the creation process, while continuously validating with physical experiments—from design through certification and qualification. Dr. Cynthia Powell agreed with these capabilities and emphasized the knowledge specifically around materials developed at many of the national laboratories. While a PPP can be built around a broad topic or a strategically defined focus, there are some topics, such as materials where national laboratories have a strong foundation and the capability to build generic tools for use by any company. Dr. Adam Powell supported this idea of using broad knowledge of materials and computers to solve industry problems, and favored the support of the public sector along the complete spectrum of computing. For example, helping produce more elementary models and calculations to assist companies without the need of extremely advanced computing.

Beyond the discovery and design, advanced computing also has the potential to facilitate manufacturing through the interconnection of front and back end needs—what Mr. Steven Betza, Lockheed Martin, calls the digital tapestry. The manufacturing process can be designed and then observed and optimized through the maintenance of the digital tapestry. While scientists, architects, and design engineers may be very comfortable with the use of advanced computing, many manufacturers and second tier manufacturing suppliers will need a great deal of customer service to implement advanced computing into their work processes. Mr. Amberkar also pointed out many companies are generating large amounts of data, and pulling insights from multiple sources of data to improve logistics and respond to changes or concerns in real-time requires advanced computing.

Dr. Danielson pulled together threads from the conversation and supported the creation of a real or virtual capability around advanced computing to better understand materials in synthesizing new compounds or composites through the certification processes that increases U.S. industry access to the national laboratory and university capabilities.

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 5

AEMC Partnership PPP Next Steps

Mr. Steven Betza, Director of Hardware Engineering and Advanced Manufacturing at Lockheed Martin, highlighted concepts and thoughts from both the public and private sector in this "AEMC Partnership PPP Next Steps" session. To bring back manufacturing from abroad, according to Dr. Nag Patibandla, Managing Director at Applied Materials, Inc., the United States should work to reduce the resources needed to create products like raw materials and energy. The nation needs people who can operate these manufacturing plants and help think through accomplishing these feats affordably and intelligently, likely with the use of advanced computing to create more intelligent devices more efficiently to compete with foreign lower-cost labor.

Dr. Adam Powell, CTO and Co-Founder, INFINIUM.

Dr. Adam Powell, CTO and Co-Founder at INFINIUM, suggested that an emphasis be placed on rethinking products and manufacturing processes. Lighter and more energy efficient metals could be incorporated into products, displacing steel and aluminum. But, it is hard to unseat steel, and therefore hard to access capital to demonstrate the benefits of switching to alternative metals. The problem with applying advanced computing to these lighter metals is that there are no models available to describe their behavior and performance—some lighter metals have little experimental data available while the properties of others are based on chemical metallurgy correlations drawn from experimental data. While advanced computing has a potential to add insight on these new metals, INFINIUM requires more basic computing to answer the immediate questions.

While the advanced computing PPP case-study presented for the dialogue is strong and beneficial to the community, Dr. Goldstein suggested that national laboratories and industry draw academia further into these collaborations. Dr. Dornfeld commented that sustainability is the single most important element moving forward in manufacturing—including sustainably connecting universities and laboratories to industry.

Funding to support the activities and creation of a PPP was of interest to Dialogue 5 participants. Dr. Goldstein explains that the Department of Energy funds early research and application activities of interest. A PPP accomplishes a very important function—operating in the middle ground between government and the private sector—closing the gap and increasing the types of investments that lead to success. One potential method to structure a PPP with the national laboratories is to create a user-facility—a familiar and comfortable model for the national laboratories. National laboratories are working together now more than they have in decades—cooperating

Dr. William Goldstein, Director, Lawrence Livermore National Laboratory and Dr. Mark Cotteleer, Director, Deloitte Services LP.

Mr. Nolan Browne, Co-Founder and Chief Business Officer, Plotly, Dr. Nag Patibandla, Managing Director, Applied Materials, Inc. and Mr. John Grosh, Head for the Computing Applications and Reseasrch Department and Deputy Associate Director for Programs, Computation Directorate, Lawrence Livermore National Laboratory.

and competing, sharing strengths when appropriate to get things done. Dr. Cynthia Powell, Director of the Office of Research and Development, National Energy Technology Laboratory shared another model for a PPP, the Carbon Capture Simulation Initiative (CCSI). This PPP between national laboratories, academia and industry works to develop and deploy computational modeling and simulation tools to advance and accelerate the development of carbon capture technologies. Through this five-year effort, the Department of Energy, Office of Fossil Energy funds national laboratory and university researchers at $10 million per year to create advanced computing tools for problems informed by the industrial partners. A third model is the NNMI institutes. Mr. Betza shared his appreciation for the Departments of Defense and Energy supporting the existing institutes—additive manufacturing, power electronics, lightweight metals, and the forthcoming institutes.

Mr. Betza continued by emphasizing that the important factors in partnerships and collaborations are the people, process, technology, and the customer. The challenge in these conversations is to identify the problem set and the customer targets to apply the appropriate people, process, and technology. A PPP that offers a concierge service—bringing the appropriate skills, applying the proper processes and the right technologies to attach the desired problems—could connect the players and provide great value.

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 5

The Path Forward

Through different discussions, momentum and direction are gathering around advanced modeling and simulation, materials, and advanced manufacturing processes throughout several offices in the Department of Energy and the White House, shared Dr. Danielson. Continual feedback from industry is helpful in creating public-private initiatives, some of these ideas shared during the dialogue included creating a database of industry relevant capabilities at the national laboratories and supporting a concierge service to match lab capabilities to industry problems. To further the latter, the Department of Energy could potentially fund a large number of small grants for small businesses to define a problem and path forward that deploys advanced modeling and simulation. Another PPP effort could create a national network for advanced modeling and simulation for advanced manufacturing to facilitate small company access to modeling and simulation tools.

Advanced computing is a capability that many use on a daily basis. It has the potential to allow manufacturers and the private sector to leapfrog over competitors and create innovative products and processes that will improve the everyday lives of Americans, contributed Ms. Wince-Smith. By working together to create ideas for a PPP, we find ways to knit together our small and medium sized innovators with large scale global enterprises to strengthen our innovation ecosystem and ensure we remain competitive in the global marketplace.

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