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Council on
Competitiveness

American Energy & Manufacturing
Competitiveness Partnership

Dialogue 5 Primer

April 16, 2014

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 American Energy and Manufacturing Competitiveness (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 – 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 also increases the domestic talent pipeline, both in 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.

The American Energy and Manufacturing Competitiveness (AEMC) 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 are considering 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 - 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:

- 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 A-1.

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 Nalamsu, 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 other 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

- **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 U.S. 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—are the 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 small and medium-sized enterprises [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

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

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.

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

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.

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

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

Figure 2: Complex layering of material used in a Goodyear tire



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/>.

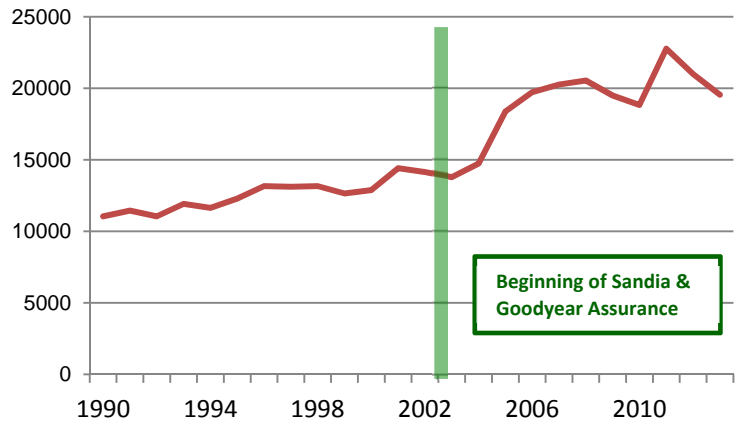
⁶ Albuquerque Business First. "Los Alamos honors team for work with P&G." August 2013. Available at: <http://www.bizjournals.com/albuquerque/blog/morning-edition/2013/08/los-alamos-honors-team-for-work.html>.

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>.

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.

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 continue on to access sufficient capital to launch new product lines that resulted in record profits (Figure 3: Goodyear Tire & Rubber Company Annual Revenue, 1990-2013).

Figure 3: Goodyear Tire & Rubber Co Annual Revenue, 1990-2013 in millions USD

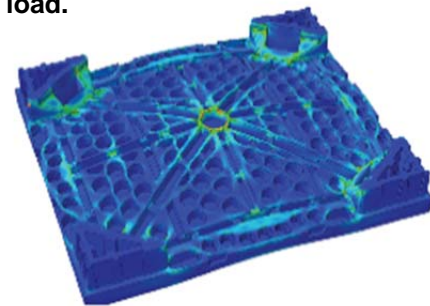


HPC for Supply Chain Efficiency

JECO Plastic Products, LLCs

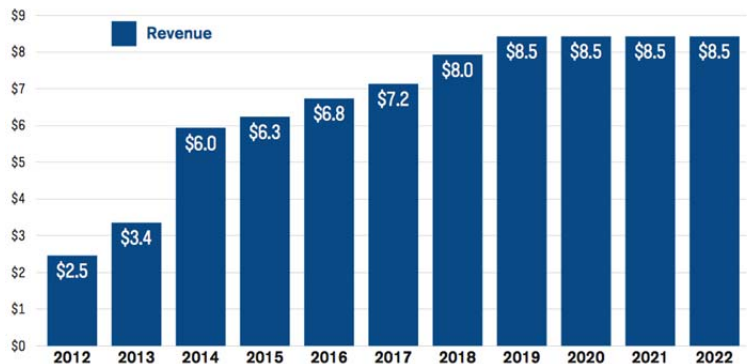
To secure a prospective automotive client, JECO Plastic Products needed to ensure that a requested design change did not undermine the strength and performance of their plastic pallet. Tedious trial-and-error physical design and testing was deemed inefficient and too time-consuming to meet the expectations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

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



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

Figure 5: Projected Annual Revenue (millions \$USD)



technical uncertainty.

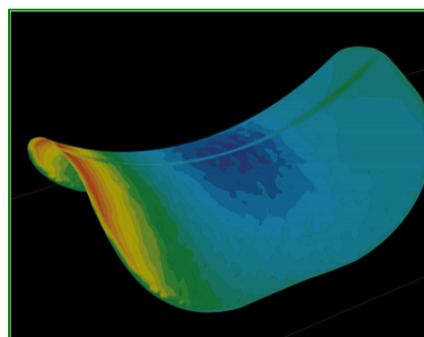
Improvements to the JECO pallet product increased sales revenue (Projected Revenue shown in Figure 5), increased payroll by 35 percent at their plant, and placed the company in contention for additional high-margin, domestic and export business projects. While JECO still searches for capital to invest 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

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



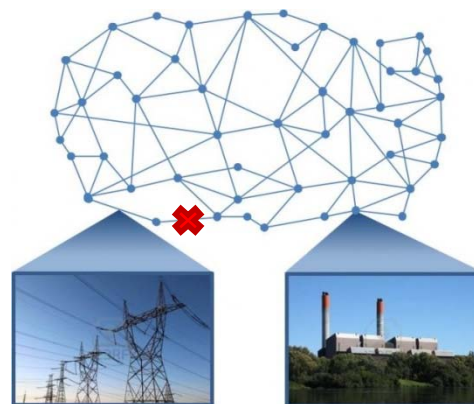
HPC to Optimize Products

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 (depicted in Figure 7) and inform planners and system operators how to operate under

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



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

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.

abnormal system conditions. For 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 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

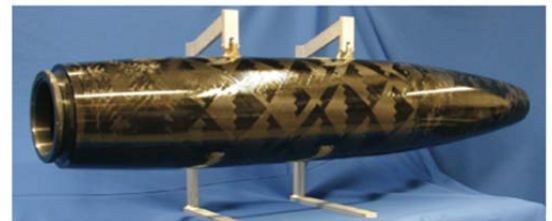
HPC Decreases Both Development Costs and Time to Market

Lawrence Livermore National Laboratory

In a traditional and risk-averse sector such as national defense, Lawrence Livermore National Laboratory (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 a highly effective, low-collateral-damage munitions known as BLU-129/B to the U.S. Air Force. The prototype munitions was 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>.

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 review, 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.

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 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).

Figure 9: AEMC Partnership PPP Process

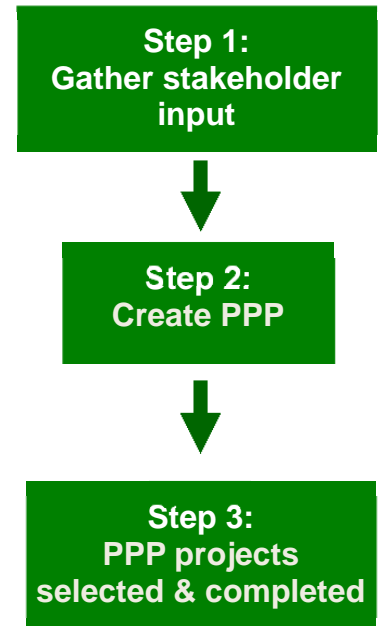
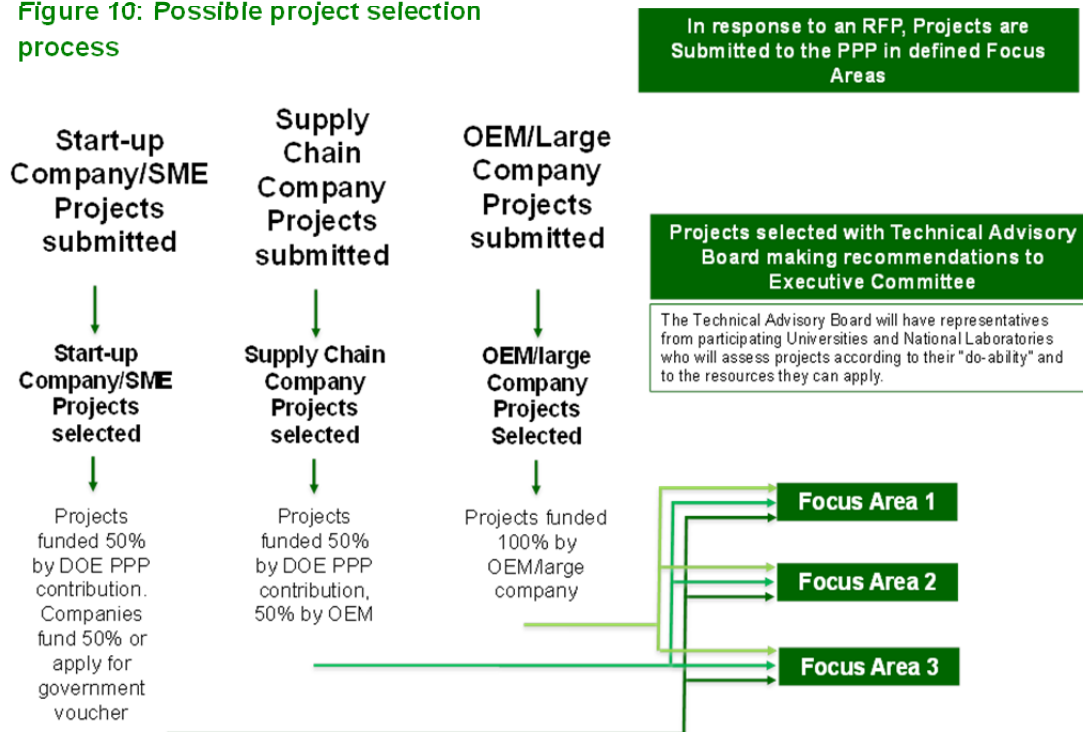


Figure 10: Possible project selection process



OEM and large company projects 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.

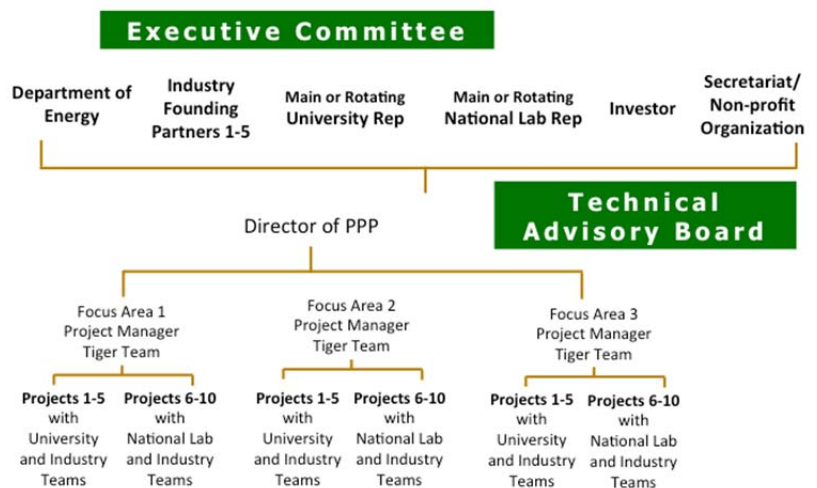
Selected projects begin work with partners in the universities and/or national laboratories. Project Managers and Tiger Teams will work with project teams to ensure completion in a 1-2 year timeframe. Final results for each project will be presented to the Executive Committee.

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.

Figure 11: Possible PPP Organization



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 Team, constituted from the nation’s innovation institutions such as universities, national laboratories, independent laboratories, and the Manufacturing Extension Program, assigned to solve technical problems through onsite collaboration and consultation. Tiger teams may guide projects through analyses and manufacturability and designing projects to ask optimal questions that can be answered using high performance 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.

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 contributing 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.

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.

APPENDIX: The American Energy & Manufacturing Competitiveness (AEMC) Partnership

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 2.

Figure A-1: Barriers to the Manufacturing of Innovative and Advanced

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.

Securing the Talent Pipeline

Talent: STEM

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

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.

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



The Honorable David T. Danielson, U.S. Department of Energy Office of Energy Efficiency and Renewable Energy; the Honorable Deborah L. Wince-Smith, Council on Competitiveness; Mr. Jason Miller, National Economic Council; Ms. Elizabeth Wayman, U.S. Department of Energy Office of Energy Efficiency and Renewable Energy; and Mr. Chad Evans, Council on Competitiveness

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 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
- Diffusing tools including modeling and simulation, robotics, automation, sensor technologies, and additive manufacturing into the manufacturing sector.



The Honorable Deborah L. Wince-Smith, Council on Competitiveness; Dr. Pradeep Khosla, University of California, San Diego; and Dr. J. Michael McQuade, United Technologies Corporation

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 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;



Dr. Jay Kim, Director, School of Dynamic Systems, University of Cincinnati; Mr. Lorry Wagner, President, Lake Erie Energy Development Corporation; the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; Dr. Lloyd A. Jacobs, President, 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

- 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 2: 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.

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



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

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 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.

“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 and CEO, Council on Competitiveness

While all five PPP concepts were supported for the benefits they could unleash in the innovation ecosystem, two PPP concepts received widespread



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.

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 has 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. Splinter, Executive Chairman of the Board, Applied Materials, Inc.; and Dr. 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.

- ***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



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

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.



AEMC Partnership Dialogue 4 Participants

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 Facilitating the Transition from Prototypes to Commercially Deployable Products PPP concept presented in Dialogue 4.