American Energy & Manufacturing Competitiveness Partnership

Focus.

Dialogue 4

Compete.

Council on Competitiveness

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Dialogue 4
Table of Contents

AEMC PARTNERSHIP DIALOGUE 4

Letter from the President

On behalf of the Council on Competitiveness (Council), I am pleased to release *Focus*, a report on the American Energy & Manufacturing Competitiveness (AEMC) Partnership Dialogue 4 held on October 17, 2013, at Applied Materials, Inc. in Santa Clara, California. The AEMC Partnership, a three-year effort between the Council 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 three AEMC Partnership dialogues, the Council and EERE developed two public-private partnership (PPP) concepts 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 Dialogue 4 to further evaluate and refine these PPP concepts in preparation for the Council to make a formal recommendation to the Department of Energy.

I extend a special thanks to my partner, the Honorable 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 Mr. Michael Splinter, Executive Chairman of the Board of Directors of Applied Materials, Inc., and Industry Vice Chair of the Council for his many contributions, as well as Dr. Omkaram Nalamasu, Chief Technology Officer of Applied Materials, Inc., and the entire Applied Materials team engaged in this dialogue.

Focus is divided into two sections. The first is a primer developed in advance of AEMC Partnership Dialogue 4 to provide participants a summary of the activities undertaken in the preceding three dialogues and present two PPP concepts for discussion. Section two provides a summary, synthesis and distillation of the proceedings of the October 17, 2013 dialogue.

As envisioned in the design of the AEMC Partnership dialogue series, the outcomes of these progressive dialogues drive the creation of public-private partnership structures the Council will present to EERE at the upcoming inaugural American Energy & Manufacturing Competitiveness Summit in Washington, D.C. on December 12, 2013. This first-of-its-kind summit will gather pre-eminent leaders from industry, academia, labor, the national laboratories, government and media to:

- Discuss the most critical energy and manufacturing challenges and opportunities facing U.S. prosperity, sustainability and security;
- Accelerate a movement to increase U.S. competitiveness in the production of clean energy products, and increase U.S. manufacturing competitiveness across the board through greater energy productivity; and,

- Commit to concrete actions to spark continued innovation and industrial transformation needed for economic growth and job creation.

Our energy and manufacturing sectors are national concerns with the potential to unleash opportunities across the innovation ecosystem. Through the AEMC Partnership, we work to create concrete actions to support and grow stakeholders in the ecosystem. None of this can happen, however, without the input and support of energy and manufacturing stakeholders throughout the country. I look forward to continuing to engage national and regional leaders in industry, academia, national laboratories, and government as the Council 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 4

Participants

CO-HOSTS

The Honorable David T. Danielson
Assistant Secretary for Energy Efficiency and Renewable Energy
United States Department of Energy

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

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

DIALOGUE PARTICIPANTS

Dr. Penrose "Parney" Albright
Director
Lawrence Livermore National Laboratory

Mr. Neil Z. Auerbach
Founder and Managing Partner
Hudson Clean Energy Partners

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

Mr. Brenor Brophy
CTO, VP Business Development & Founder
Enki Technology

Mr. Nolan Browne
Managing Director
Fraunhofer CSE

Dr. Elizabeth Cantwell
Senior Advisor for Mission and Economic Development
Lawrence Livermore National Laboratory

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U.S. Department of Energy

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Applied Materials, Inc.

Mr. David Kenney
President
Oregon BEST

Mr. John Lagrandeur
Director of Programs
Gentherm

Mr. Eric Lanke
Chief Executive Officer
National Fluid Power Association

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GE Global Research

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Distinguished Professor and
Special Advisor to the Chancellor
University of California, Davis

Dr. Ajay Malshe
Founder, Executive Vice President, and
Chief Technology Officer
NanoMech, Inc.

Mr. Jerry Mix
Chief Executive Officer
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AEMC PARTNERSHIP DIALOGUE 4

Agenda
October 17, 2013

MORNING

8:00 Registration and Light Breakfast

8:30 Welcome and Opening Remarks

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

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

The Honorable David T. Danielson
(pre-recorded remarks)
Assistant Secretary
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

9:00 Briefing on AEMC Partnership Goals and Objectives

This session will describe the progress made over AEMC Partnership Dialogues 1, 2 and 3, and provide a description of the two concepts selected for evaluation and discussion in the following sessions.

Mr. Chad Evans
Executive Vice President
Council on Competitiveness

9:30 Concept Presentation: Facilitating the Transition of Prototypes to Deployable Products

Dr. Clara Smith
Senior Policy Director
Council on Competitiveness

9:40 State-of-Play: Facilitating the Transition of Prototypes to Deployable Products

This session will tap expertise in the area of scale-up to better understand the initiatives that already exist and work that is currently being done in this space. The speakers will describe the gap that exists in scale-up and how the proposed model fills the gap and complements existing initiatives and efforts.

Speakers

Mr. Neil Auerbach
Founder and Managing Partner
Hudson Clean Energy Partners

Mr. Nolan Browne
Managing Director
Fraunhofer CSE

10:30 Coffee Break

10:50 Stakeholder Perspectives: Facilitating the Transition of Prototypes to Deployable Products

In this panel we will hear the perspectives of a representative cross-section of target stakeholders on this PPP.

Moderator

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

Kick-off Discussants

Dr. Omkaram Nalamasu
Chief Technology Officer
Applied Materials, Inc.

Dr. Gregory Raupp
Director, Macro Technology Works
Arizona State University

Ms. Jean Redfield
President and CEO
NextEnergy

Mr. Steven Visco
Chief Executive Officer and
Chief Technology Officer
Polyplus Battery Company

Key Questions

1. Do the barriers enumerated in this model accurately reflect the challenges facing your organization? Please make suggested additions or subtractions as you see fit.
2. How would the activities proposed in this PPP help your organization overcome the barriers listed? If the activities do not, how would you change these activities?
3. What level of resources is needed to ensure the success of these activities as presented?
4. What is the value proposition to your organization? Does the list of value propositions provided reflect your perspective?
5. How would you change, if at all, the organization structure of the proposed model?

AFTERNOON

12:15 Lunch

1:15 Concept Presentation: Clean Energy Materials Accelerator

Mr. Michael Bush
Policy Director
Council on Competitiveness

1:25 State-of-Play: Clean Energy Materials Accelerator

This session will tap technical expertise in the area of advanced material characterization and standardization to better understand the work that is currently being done in this space and how the proposed concept complements this work.

Speakers

Mr. Pat A. Picariello, J.D., CStd
Director, Developmental Operations
ASTM International

Dr. Mehdi Vaez-Iranvani
Corporate Vice President
Applied Materials, Inc.

2:15 Coffee Break

2:30 Stakeholder Perspectives: Clean Energy Materials Accelerator

In this panel we will hear the perspectives of a representative cross-section of target stakeholders on this PPP.

Moderator

Mr. Arthur "Chip" Cotton
Program Manager
GE Global Research

Kick-off Discussants

Dr. Penrose Albright
Director
Lawrence Livermore National Laboratory

Mr. David Kenney
President
Oregon BEST

Dr. Amy L. Linsebigler
Technology Leader, Materials Characterization & Chemical Sensing, Chemistry & Chemical Engineering Domain, and Business Program Manager for Morpho Detection, Inc.
GE Global Research

Dr. Ajay Malshe
Founder, Executive Vice President, and Chief Technology Officer
NanoMech, Inc.

Key Questions

1. Do the barriers enumerated in this model accurately reflect the challenges facing your organization? Please make suggested additions or substations as you see fit.
2. How would the activities proposed in this PPP help your organization overcome these barriers? If not, how would you change these activities?
3. What level of resources is need to come to bear ensure the success of these activities as presented?
4. What is the value proposition to your organization? Does the supplied list reflect your views?
5. How would you change, if at all, the organization structure of the proposed model?
6. What are some specific materials or materials applications that need accelerating, and what are the specific challenges in those topics?

4:00 Next Steps

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

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

4:30 Conclude

PART 1
AEMC Partnership Dialogue 4 Primer

PART 1: AEMC PARTNERSHIP DIALOGUE 4 PRIMER

Executive Summary

On October 17, 2013, the Council and EERE are holding the fourth in a series of progressive dialogues 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.

AEMC Partnership Dialogue 4 will be held in the heart of Silicon Valley at the world headquarters of Applied Materials, Inc., a global leader in providing equipment, services and software to enable the manufacturing of advanced semiconductors and flat panel displays. Applied Materials is home to the Maydan Technology Center, a state-of-the-art 39,000 square foot "clean room" and innovation laboratory, employing 200 researches and technologists developing the most advanced semiconductor manufacturing tools, which can be found in every semiconductor factory in the world. The headquarters of Applied Materials—an icon of American manufacturing innovation and competitiveness—is an ideal platform to explore opportunities to build a stronger, more resilient, and more dynamic U.S. manufacturing sector.

Throughout the AEMC Partnership, the Council and EERE have collaborated with leaders from industry, academia, national laboratories, non-profit organizations and the government to define key barriers, challenges and problems in the production of clean energy products and in the manufacturing sector's efforts as a whole to increase energy productivity. The Council and EERE are strategically marshaling the wealth of knowledge generated and collected throughout the AEMC Partnership to craft scalable, deployable, high-impact PPP. From these conversations, the Council and EERE have converged on two PPP concepts aimed at bridging specific gaps in the innovation ecosystem.

Participants at the fourth AEMC Partnership Dialogue will explore and evaluate two PPP concepts.

1. **Facilitating the Transition from Prototypes to Commercially Deployable Products:** This PPP aims to lower the risk of developing new technologies, accelerate domestic innovation, and expand clean energy manufacturing by connecting U.S. manufacturers to companies with pilot-scale technologies that need both new and existing technical, management, and financial resources.
2. **Clean Energy Materials Accelerator:** This PPP reduces the risks associated with deploying newly developed materials in commercial markets by bringing together industry, state, academic and other organizations to co-create a platform to identify and address common challenges; increase access to existing materials qualification and characterization tools; and create standards for advanced materials.

"These two PPP concepts lay the groundwork to strategically place people and resources on both sides of the 'valley of death' to help our nation's entrepreneurs reach their potential," said the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness.

The four AEMC Partnership dialogues held in 2013 will culminate in the Inaugural American Energy and Manufacturing Competitiveness Summit in Washington, D.C. on December 12 at the Ronald Reagan Building and International Trade Center. The Summit convenes pre-eminent leaders to discuss the potential of a U.S. manufacturing renaissance, and the conditions in this country needed to promote energy efficiency, renewable technologies adoption and deeper investment in energy technology manufacturing.

PART 1: AEMC PARTNERSHIP DIALOGUE 4 PRIMER

The American Energy and Manufacturing Competitiveness (AEMC) Partnership

The AEMC Partnership is a 3-year effort by the Council EERE to bring together national leaders to address a rapidly shifting national and global energy and manufacturing landscape. In a series of progressive dialogues during 2013, participants uncovered actions that can be taken now to enable America to bolster dramatically its energy, manufacturing and economic competitiveness for the coming decades and beyond. This is a new partnership formed under EERE's Clean Energy Manufacturing Initiative (CEMI),[1] 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.
- **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 purpose of the AEMC Partnership dialogue series is to generate ideas, collect insights and serve as a platform for the creation and potential deployment of PPPs to advance the AEMC Partnership goals.

The AEMC Partnership is broadly divided into two phases, the first of which has been completed as described below.

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 energy efficiency efforts of manufacturers, renewable energy efforts;
- Energy-related barriers to manufacturing competitiveness; and
- Models for PPPs for fostering competitive industries.

This work also identified links, barriers and public-private partnership models that have not been studied or on which studies are out of date.

1 More information available at: http://www1.eere.energy.gov/energymanufacturing/index.html.

The literature review is documented in the Council publication, *The Power of Partnerships*, and its companion piece, *A Summary of Public-Private Partnerships*.[2] These reports provide the foundation for the AEMC Partnership and the 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?
  - 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 will discuss and expand on the findings in these reports.

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

Foundation of AEMC Partnership

REPORTS

184 reviewed

↓

28 selected for in-depth analysis

↓

180 **recommendations**

26 **policy categories analyzed**

PUBLIC-PRIVATE PARTNERSHIPS

30+ reviewed

↓

19 selected for in-depth analysis

↓

4 **PPP models developed**

Phase Two: AEMC Partnership Dialogue Series

The second phase of the AEMC Partnership includes a total of four progressive dialogues generating new insights pertaining to the overall goals of the Partnership—as well as informing the creation of a public-private partnership concept to further advance the initiative's goals. 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. The second dialogue hosted by President Lloyd Jacobs of the University of Toledo on June 20th continued the discussions sparked during the inaugural dialogue. This dialogue used Toledo as a case study to examine how both informal and formal partnerships, leveraging materials science and engineering, can drive regional manufacturing transformation.

The third dialogue, hosted by 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 homing in on potential PPPs. Discussions during the third dialogue continued to determine specific technology areas and barriers/opportunities for the five presented PPP concepts capable of increasing the competitiveness of clean energy manufacturing in the United States.

The fourth dialogue, hosted by Michael Splinter, Chairman of the Board of Applied Materials, and Omkaram Nalamasu, Chief Technology Officer of Applied Materials, will focus squarely on evaluating two PPP concepts and honing the attributes of a clean energy manufacturing public-private partnership that may be presented and announced at the inaugural American Energy and Manufacturing Summit on December 12, 2013, in Washington, D.C. Future dialogues to evaluate proposed PPP concepts and to elaborate upon success metrics will continue this conversation in 2014 and 2015—along with future, annual summits.

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; Jason Miller, National Economic Council; Libby Wayman, U.S. Department of Energy Office of Energy Efficiency and Renewable Energy; and Chad Evans, Council on Competitiveness.

Reviewing Previous AEMC Partnership Dialogues

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 of EERE, 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."

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

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

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.

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, , hosted by Dr. Lloyd Jacobs, President of the University of Toledo, 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, Ohio. The content development for 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. This dialogue also marked the first opportunity for a stakeholder discussion targeted at the "platonic" PPP models uncovered in the Power of Partnerships report that underpinned the AEMC Partnership's launch.

Though the fundamental tasks of this regional conversation remained similar to the inaugural dialogue—identify nascent areas of innovation-driven strength for national investment in clean energy manufacturing and recommend PPP concepts to accelerate these strengths—this dialogue moved beyond the high-level exploration and ideation of the foundational inaugural dialogue and into determining actionable outcomes in preparation for the third dialogue. 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.

The Honorable David T. Danielson, Assistant Secretary of Energy Efficiency and Renewable Energy, U.S. Department of Energy; Dr. Lloyd A. Jacobs, President of the University of Toledo; and the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness.

Participants suggested 17 distinct PPP concepts during AEMC Partnership Dialogue 2. Five of the 17 ideas received strong support.

1. Fellowship program promoting personnel exchange between innovation institutions;
2. Advanced materials design, qualification, and certification;

3. Rapid prototyping and demonstration of new technologies utilizing modeling & simulation tools and Big Data;
4. Building a virtual platform where companies can submit industrial innovations and seek crowd-source funding; and
5. Building a virtual portal that allows industry and research institutions to match real-world problems and challenges to solutions.

Regarding the suggested PPPs, there is an important distinction to be drawn between the concepts. Slightly more than half of the suggested PPPs were technology horizontal, the others being technology vertical.

The selection of a horizontal or a vertical PPP will have significant implications for a clean energy manufacturing public-private partnership. While both types of PPPs have the ability to drive the goals of the AEMC Partnership, the PPPs themselves will be different in terms of scale, scope, and sustainability. As such, the benefits and shortcomings of each type of PPP, as related to the twin goals of the AEMC Partnership, should be an important consideration as this initiative moves into the future.

This dialogue also moved the conversation beyond the PPP models articulated to facilitate this dialogue series. While these PPP models were tremendously valuable as a platform to launch a national discourse, dialogue participants quickly molded and honed these PPP models into concepts that drive the goals of the AEMC Partnership while being inclusive to all clean energy manufacturing stakeholders. During the second AEMC Partnership dialogue, participants:

- Identified the essential inputs to the development of the successful Toledo solar energy cluster: industry leadership from an established manufacturing base; shared infrastructure; patient, diverse, and consistent funding; complementary policy tools; in-kind equipment contributions; talent spillover; and a focus on first-to-market differentiated technologies;
- Quantified 4 barriers to increasing the use of advanced materials in mass manufacturing: cost of raw materials, processing speed, joining dissimilar materials, and qualification and characterization;

Types of Public-Private Partnership Concepts

Technology Horizontal

A technology-agnostic PPP designed to lower barriers to clean energy innovation and manufacturing

Technology Vertical

A PPP focusing on a strategically chosen clean energy product or process that vertically integrates some or all stages of technology development

- Identified institutional, practical, and administrative barriers to bridging the gap between businesses and external sources of innovation (e.g. university or national laboratories);
- Developed a set of principles intended to guide the process of selecting a target area for a clean energy manufacturing public-private partnership; and
- Proposed moving beyond conventional funding models, potentially leveraging the philanthropic community and crowd-sourcing to broaden the base of available risk capital.

Figure 1. Summary of PPP Concepts Gathered at AEMC Partnership Dialogue 2

Technology Horizontal		
Fellowship program promoting personnel exchange between innovation institutions Database of Department of Energy Solar Decathlon best practices with a tie to Property Accessed Clean Energy (PACE) Districts Multi-stakeholder partnership to pilot an electricity free building High Performance Computing Applications Store	Virtual portal that allows industry and research institutions to match real-world problems and challenges to solutions Rapid prototyping and demonstration of new technologies through modeling & simulation tools/big data A virtual platform where companies can submit industrial innovations and seek crowd-source funding	Research, development, and demonstration facility: Information Technology Enables Smart Manufacturing Increase interaction between business and national laboratories by having each side commit to more engagement and enabling reforms, respectively Test bed/demonstration facility on a city-scale
Technology Vertical		
Photovoltaic certification institute to address quality and standardization issues as well as drive lending from commercial banks Technology target area: advanced materials design, qualification, and certification	Technology target area: leveraging photovoltaic-enabled electric vehicles to create distributed energy generation (vehicle-to-grid) Technology target area: tools to support mass-customization manufacturing	Technology target area: flexible electronics Technology target area: next generation wind turbine Technology target area: fuel cells

AEMC Partnership Dialogue 2 generated a large pool of ideas and recommendations for leadership teams at the Council and EERE to evaluate and formulate—in concert with private and public innovation leaders—into PPP concepts to be presented at AEMC Partnership Dialogue 3.

Summary of AEMC Partnership Dialogue 3

AEMC Partnership Dialogue 3 engaged more than 60 leaders from industry, academia, non-profit organizations and the national laboratory system at the GE Global Research Center in Niskayuna, NY on August 12-13, 2013. Co-hosted by Ms. Wince-Smith, President and CEO of the Council; Dr. Danielson, Assistant Secretary of the U.S. Department of EERE; and Dr. Mark Little, Senior Vice President and Chief Technology Officer of General Electric, and Director of GE Global Research Center; this dialogue strategically evaluated five public-private partnership concepts capable of driving the overarching goals of the AEMC Partnership molded from several key themes strategically culled from the inaugural and second dialogues.

The New York Capital Region is exemplary of regional clusters that the AEMC Partnership aims to foster with its proximity to all major markets in the northeast, a highly skilled workforce, and many world renowned academic and research institutions. Additionally, General Electric has a more than 130 year tradition of innovation including public and private collaborations to address challenges in clean energy and advanced manufacturing—valuable expertise desired by the AEMC Partnership when formulating PPP concepts.

Dr. Mark Little, Senior Vice President and Chief Technology Officer, General Electric; the Honorable Paul Tonko, U.S. House of Representatives; the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; and the Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, Department of Energy.

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

- **Innovation Exchange Fellowship Program:** developing manufacturing leadership and enhancing knowledge spillover in the innovation ecosystem 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:** increasing accessibility to key national laboratory and university resources and providing manufacturers competitive user grants to reduce fees and lower barriers to use existing facilities and equipment;

Mr. Michael Newell, Chief Executive Officer, Ener-G-Rotors; Mr. John Mizroch, Senior Fellow, Council on Competitiveness; Dr. William Banholzer, former Chief Technology Officer, The Dow Chemical Company; Dr. Phillip Yu, Director for Corporate Science & Technology, PPG Industries, Inc.; and Mr. Steven Derezinski, Chief Executive Officer, INFINIUM, Inc.

- **Advanced Materials Characterization, Experimentation, and Standardization:** accelerating the time to, and increasing the rate of, adoption and commercialization of existing advanced materials by coordinating existing parts of the materials ecosystem, lowering barriers to access equipment, and creating standards to ensure new materials function reliably and predictably before integration into new technologies and systems;
- **Facilitating the Transition of Prototypes to Deployable Products:** increasing the rate of graduation of prototypes into commercial markets by improving communication and transparency within the private sector, and increasing access to resources to facilitate the smooth transition across the scale-up "valley of death"; and
- **Industrial Kickstarter and Manufacturing Marketplace:** increasing access to risk-tolerant investment capital by convening investors, entrepreneurs, and manufacturers to front-fund and crowd-fund promising new technologies through a web-based advanced manufacturing portal and clearinghouse.

While all five public-private partnership 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 ripe for engagement by the public and private sectors through a PPP, the AEMC Partnership has identified two gaps affecting the manufacturing and energy sectors. Collaborating to address one or both of these gaps in the near term will bolster dramatically U.S. energy, manufacturing, and economic competitiveness into the future.

> *"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."*
>
> **The Honorable Deborah L. Wince-Smith**
> President and Chief Executive Officer
> Council on Competitiveness

Setting the Stage for AEMC Partnership Dialogue 4

Using the data generated in AEMC Partnership Dialogue 3, the Council and EERE have further developed two PPP concepts with support from a large community in the innovation ecosystem:

- Facilitating the Transition from Prototypes to Commercially Deployable Products, and
- Clean Energy Materials Accelerator

The goal of AEMC Partnership Dialogue 4 is for each participant to evaluate both expanded PPP concepts and provide his or her feedback as to which PPP is the optimal choice to drive the goals of the AEMC Partnership. To achieve this goal, participants must evaluate each PPP objectively—as it relates to increasing U.S. competitiveness in clean energy manufacturing—as well as subjectively to determine which PPP concept is most relevant and/or beneficial to their respective organization. This input will be used to further hone the PPP concepts into engaging and relevant PPPs and to determine which PPP has strong support from energy and manufacturing stakeholders.

The agenda for the day includes presentations and moderated panel discussions for each PPP concept. Panelists and audience members will be asked questions about each concept to elucidate support for the PPP, its relevance, and its value. These questions are listed in the respective sections for each concept as well as the dialogue agenda.

Proposed PPP Concept: Facilitating the Transition from Prototypes to Commercially Deployable Products

The Challenge

Feedback from the participants at the first three AEMC Partnership dialogues—coupled with an extensive literature review performed by the Council and EERE—defined a resource gap that inhibits promising new technologies in the pilot-line phase from reaching manufacturing at scale. This gap marks the second valley of death in the technology innovation cycle, often referred to as the scale-up valley of death. Without manufacturing innovation infrastructure—including human capital—and funding to scale production of a new technology, prototypes often fail to make the transition to a commercially deployable product. Two barriers that affect this phase of the technology development cycle are capital requirements and 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 when capital requirements reach $30 million to $100 million as innovators attempt to scale-up production.

- **Industrial Innovation Infrastructure & Expertise:** This barrier refers to a lack of 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 skill.

The Response

To lower these barriers and allow for the increased introduction of commercially deployable products, this PPP will work toward two over-arching objectives:

1. Support the transition of prototypes at pilot-scale to commercially deployable products through an industry guided, high-profile, competitive process.

- The Executive Committee will identify broad technical areas where they have need for a commercial product or supplier, or where they would be interested in investing. The technical areas identified by the Executive Committee will be the categories for a "scale-up" competition. Technologies proven at the pilot production stage not yet transitioned into commercial-scale manufacturing will be eligible to compete.
- The Executive Committee will issue a Request for Proposals (RFP) for the solicitation of promising pilot-scale technologies ready for manufacturing scale-up that will benefit from access to product/process design expertise and funding. The winner(s) of the competition will be the organization(s) that have the technology that best meets the needs of the founding partners—as judged by the Executive Committee. The winner(s) will be awarded a commitment from the founding partners to provide a path to commercialization by providing funding and assistance from a "Tiger Team" comprised of experts who can assist the company's scale-up efforts with technical and business consultations. Full distribution of funds from the Executive Committee would be awarded contingent upon the winner securing the remaining funds required for completion of the proposed project. The funding will be cost-shared among federal agencies, founding partners, and a third party (such as a state partner).

2. Share up-to-date and relevant information on resources available for helping companies scale their technologies to commercial-scale manufacturing stages through a publicly accessible website.

- The Executive Committee will issue a Request for Information (RFI) to the engineering design and consulting community (for-profit, university, and national laboratories) to accumulate a database of capabilities that facilitate effective manufacturing scaling expertise.
- Information will be collected on existing technical, managerial, and financial resources for manufacturers and innovators, with an associated asset map and directory of qualified design, engineering and consulting resources with specific expertise to support scale-up from prototype to mass-manufactured product.

Examples

- "Design for X" capabilities (where X may represent manufacturability, assembly, maintenance, durability, automation, or logistics);
- Product life-cycle management (PLM);
- Manufacturing process design, including advanced manufacturing technologies, robotics, automation, flex manufacturing for mass customization;
- Equipment/ process specification at various production volumes;
- Materials evaluation at various production volumes as well as supply chain development;
- Feasibility and economic analysis to support manufacturing scale-up decisions, e.g., contract vs. dedicated manufacturing, distribution and logistics, site selection; and
- State and federal resources or incentives available to manufacturers

- Proposed projects that have been submitted to the PPP through the RFP process will be posted to an online "Industrial Marketplace" type of platform (similar to www.useed.org). Technologies not selected as winners have the potential to be crowd-funded by interested investors through the website. Potential investors wishing to access the Industrial Marketplace will be required to pay a small fee. For a fee, manufacturers and innovators can post their ideas to the Industrial Marketplace without applying through the competition. This fee will also purchase access to the resource database.
- Up-to-date information will be shared on the successes of the PPP.

Value Proposition

Founding Members

- Define the problems advertised 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 best and brightest entrepreneurs in the U.S. clean technology arena;
- Access to technologies ready for scale-up and deemed worthy to compete on a global scale—having built due diligence into the program;
- Significant risk reduction to mass-manufacture technologies of strategic interest to founding members;
- Ability to leverage federal dollars to evaluate exciting and potentially scalable technologies; and
- Early access to licensing, partnering, and/or acquisition deals.

General Members

- Technologists in start-up companies, SMEs, universities, and national laboratories can earn access to technical, management, and financial resources to develop prototypes into mass-manufactured products and be connected to buyers to provide the capital infusion needed to scale production; and
- Entrepreneurs, SMEs, universities, and other entities can identify early-on the needs of potential customers and potential strategic investors and orient their innovation and efforts toward industry-relevant needs.

U.S. Department of Energy

- Create high-quality enduring jobs for Americans in the clean technology industry;
- Drive the market entry of technologies fostered by DOE-funded programs;
- Create a network of American entrepreneurs, start-up companies and volume manufacturers to catalyze the birth of new industries; and
- Help America compete in the global race to develop large profitable clean energy technology companies by increasing the likelihood that technologies will be manufactured in the United States.

Organization

Establishment

The DOE will issue a Request for Information (RFI) and conduct appropriate internal surveys to understand and gauge interest in technology, applications, or sectors of interest.

Through a competitive bidding process, the Department of Energy will select one proposal from a group of partners to become the founding members of this PPP. Additional partners of the PPP could be added at a later stage.

Leadership

Executive Committee

The founding members will participate in the Executive Committee of the PPP together with representation from the Department of Energy and other organizations that make a significant initial financial contribution. This Executive Committee will direct and approve the vision and strategy of the PPP as well as dictate its organizational structure by managing the PPP directly or through a contracted organization.

Technical Advisory Board

The Technical Advisory Board is composed of relevant representatives from the founding partners and experts in relevant fields. The expertise of the Technical Advisory Board will be utilized in reviewing submissions to the competition based on the selected topic as identified by the Executive Committee. Members of the Technical Advisory Board may also be called upon to consult as needed.

Tiger Teams

Tiger Teams, the core mentorship resource of the PPP, will be comprised of experienced professionals in technical, business, and related fields. Possible teams could consist of national laboratory experts, regional and local non-profit organizations, universities and other stakeholders in the nation's innovation enterprise. All project award recipients are eligible to receive on-site visitation from the Tiger Team for consultation and advice.

Management

As referenced in the Executive Committee section above, the Executive Committee has the freedom to delegate the management of the activities performed by or through the PPP, so long as the objectives of the PPP are being met.

Participants

Founding Members

Industry Founding Members: These founding partners will support the PPP by providing high-level representatives to the Executive Committee and with substantial annual contributions of funds or in-kind donations of personnel, equipment, and expertise. Companies that match the contribution of the founding partners may become Industry Founding Members, with participation in the Executive Committee.

Department of Energy (and potentially other Federal Agencies): These founding members will support the PPP by providing high-level representatives to the Executive Committee and financially supporting the project. Funding can be allocated to PPP activities at the discretion of the Executive Committee.

General Members

Successful Applicants: All successful applicants to the Request for Proposal will become members of the PPP.

Applicants to the Website: Organizations (manufacturers, innovators, or investors) wishing to purchase access to the "Industrial Marketplace" website without participating in the competition will become members of the PPP.

Strategies for Sustainable Operation

This PPP could ultimately generate sufficient funds to become self-supporting. Sustained funding will be decided by the Executive Committee and may include dues or fees-for-service or access, or in-kind contributions.

Key Questions

1. Do the barriers enumerated in this model accurately reflect the challenges facing your organization? Please make suggested additions or subtractions as you see fit.
2. How would the activities proposed in this PPP help your organization overcome the barriers listed? If the activities do not, how would you change these activities?
3. What level of resources is needed to ensure the success of these activities as presented?
4. What is the value proposition to your organization? Does the list of value propositions provided reflect your perspective?
5. How would you change, if at all, the organization structure of the proposed model?

Proposed PPP Concept: Clean Energy Materials Accelerator

Accelerating the use of advanced materials into commercial products by U.S. manufacturers will enhance U.S. manufacturers' competitive advantage and drive the market for advanced materials. Early adoption of advanced materials by manufacturers can make a product higher performing, less expensive, more energy-efficient over its life-cycle, and differentiate it in the marketplace—i.e. more competitive.

The Challenge

Feedback from the participants at the first three AEMC Partnerships dialogues reveals that, while significant efforts to discover and develop advanced materials are already in place and carried out independently in public and private sectors, moving a new material into widespread adoption is larger in scope and more multi-faceted than the focus, jurisdiction, perspective, and capabilities of any one private or public entity. The scope often includes the definition of roadmaps and norms on which a range of entities across the supply chain can agree. As many of these steps require agreement and input across a wide range of stakeholders, a lack of multi-stakeholder collaboration can slow or even halt the transition of an otherwise high-impact material into widespread use.

While manufacturers face multiple challenges when attempting to increase the use of advanced materials in products and processes, there are three related barriers that are appropriate targets for public-private collaboration:

- **Technical Risk:** High technical risks for integrators of recently developed advanced materials dampen the incentives to the increased use of these new materials. The creators and suppliers of advanced materials that, for example, could result in significant weight savings per vehicle in the automotive industry need to prove that the new material is applicable and robust for a particular component. In the workplace, engineers can pull the specifications and properties of dual phase 600 steel from a database and be confident in their understanding if the material will work in the desired application. This same knowledge and confidence does not exist for new materials such as carbon fiber—the carbon fiber producer, the coating supplier, the resin supplier, the material supplier and the component manufacturer must produce the part for characterization and testing, prior to incorporation in the desired application. This process can take a number months or several years for a single company to complete.
- **Innovation Infrastructure:** A lack of shared infrastructure and expertise on which industry scientists and engineers can draw to increase speed and lower costs on the production and commercialization of advanced materials. Typically, innovation infrastructure refers not only to shared research and testing equipment, but also to university or national laboratory personnel with specialized knowledge and skill.
- **Imperfect Information:** The effects of variability in the properties of a raw material are not always understood throughout the component value chain. Distributed value chains make

communication between the necessary actors complex—there are cases in industry where the cumulative effects on the molecular structure of a material from each stage of manufacturing is not communicated through the 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.

The Response

A PPP will be created to identify high-priority materials and form focused teams to accelerate each identified material into widespread use in commercial products. This proposed PPP reduces the above-listed barriers associated with deploying newly developed materials into commercial markets by bringing together industry, academic, federal, state, and other organizations to co-invest in the following four objectives:

1. Create a platform to improve or generate the information feedback loop between the producers and users of advanced materials, and to address common needs.

- The PPP will create a platform where stakeholders across the industry and the value chain can come together to identify and address common needs, reducing the technical risk for all parties involved. Common needs will ultimately be determined by the members of the PPP, but could include:
  - Establishing a roadmap for accelerating the material into widespread use in commercial products;
  - Creating modeling and simulation tools to accurately predict the behavior and performance of materials in final products;
  - Establishing universally recognized standards for the material to make the material easier to use by product designers;
  - Establishing common development plans;
  - Verifying the performance of new materials through a range of characterization and qualification activities; and
  - Populating an industry database with material performance properties.

2. Support the implementation of advanced materials through an industry guided, high-profile, competitive process:

- The Executive Committee will select common needs to address through an RFP focused on a topic as identified through the first objective.
- Successful applicants will be provided with funding to carry out the proposed development or vouchers to utilize equipment within the national laboratory system or subsidize time on other equipment, such as equipment at a university or for-profit laboratory. Successful applicants will also be provided with the technical assistance provided by or through the PPP.

3. Create standards (test methods, specifications, etc.) and a database for the characterization and qualification of existing advanced materials.

- The characterization and qualification work between PPP members and the successful applications may be ripe for formal standardization. If this is the case, PPP leaders

will work with an accredited standard setting body in the United States to formally request the commencement of the standard setting process.

- Key material properties for each grade of material will be made publicly available in materials databases to ease the use of these materials by component designers.

4. Improve access to advanced material characterization and qualification resources:

- The PPP will bring together a pool of resources from national laboratories and other entities to address the needs identified by the membership of the PPP.
  - Existing characterization and testing equipment available for use and relevant to the PPP topic area will be identified and collected in a database.
    - The database could include equipment at the DOE and other federal laboratory systems, universities, private research laboratories, and corporations where equipment time can be purchased;
    - This database will be easily sortable and searchable as well as connected with the ongoing and related work of other organizations, federal agencies, and the Materials Genome Initiative.
    - Characterization experts within these different entities will be included so that interested companies can be directed to an expert for further discussion.
- In addition, a publicly available website will be established with searching and sorting functions within the database of existing equipment.
  - The website should will the creation of profiles for companies that visit, where they can self-identify their capabilities or needs.
  - If a non-member organization has equipment for use, they can choose to advertise themselves and the rates they charge, for a small fee.
  - Additional options for equipment use will be made available such as fee-for-service technical assistance to provide access to expertise or connect interested companies with relevant resources. The fee should be consistent with market rates or could be partially subsidized at the discretion of the Executive Committee.

Value Proposition

Founding Members

- Ability to identify and prioritize materials and leverage a broad array of partners to accelerate identified materials into commercial products;
- Allow manufacturers to better compare and contrast the performance of different materials;
- Improve the purchaser/suppliers relationship by enabling part requirements to be more accurately specified to commonly recognized standards;
- Enable researchers and process developers to provide repeatable results that can be independently verified;
- Leverage federal investments to drive individual organizational goals;
- Increase knowledge in national and university laboratories of private sector needs and priorities; and

- Generate income in exchange for access to equipment and expertise.

General Members

- Leverage federal dollars to evaluate exciting and potentially scalable advanced materials;
- Access intellectual and physical capital that a single company could not afford on its own; and
- Connect businesses with potential customers.

The Department of Energy

- Reduce the risk of advancing new materials into commercial products across a whole sector by sharing information, resources and enabling common standards;
- Create a network of American entrepreneurs, start-up companies and volume manufacturers that drive the deployment of advanced materials;
- Help America compete in the global race to develop large profitable clean energy technology companies; and
- Increase the speed of implementation of material science and engineering advances into the marketplace.

Organization

Establishment

The DOE will issue a RFI and conduct appropriate internal surveys to identify key areas of interest including technology, application, or sectors that may benefit from the Clean Energy Materials Accelerator. The RFI will inform DOE's understanding of the material needs of stakeholders in clean energy sectors. Through a competitive bidding process, the Department of Energy will select one proposal from a group of partners to become the founding members of this PPP.

Leadership

Executive Committee

The founding members will participate in the Executive Committee of the PPP together with representation from the Department of Energy and other organizations that make a significant initial financial contribution. This Executive Committee will direct and approve the vision and strategy of the PPP as well as dictate its organizational structure by managing the PPP directly or through a contracted organization. The Executive Committee will identify and prioritize materials or material applications on which the PPP will focus.

Technical Advisory Board

A Technical Advisory Board will be established for each material or application specified by the Executive Committee. The Technical Advisory Board will be composed of relevant representatives from the founding partners and experts in relevant fields. The expertise of the Technical Advisory Board will be utilized in executing the priorities established by the Executive Committee, and issuing and reviewing RFPs based on the selected topic as identified by the Executive Committee. Members of the Technical Advisory Board may also be called upon to consult as needed.

Management

As referenced in the Executive Committee section above, the Executive Committee has the freedom to delegate the management of the activities performed by or through the PPP, so long as the objectives of the PPP are being met.

Participants

Founding Members

Industry Founding Members: These founding members will support the PPP by providing high-level representatives to the Executive Committee and with substantial annual contributions of funds or in-kind donations of personnel, equipment, and expertise. Companies that later match the contribution of the founding members to the PPP may become Founding Members, with participation in the Executive Committee.

Department of Energy (and potentially other federal agencies): These founding members will support the PPP by providing high-level representatives to the Executive Committee and financially support the PPP by matching the sum of the industry contribution. Funding can be allocated for PPP activities at the discretion of the Executive Committee.

National Laboratory and University Founding Members: These founding members will support the PPP by providing high-level representatives to the Executive Committee and with substantial annual contributions of funds or in-kind donations of personnel, equipment, and expertise.

General Members

Successful applicants to the PPP: All successful applicants to RFPs who receive vouchers or support to access resources in the PPP will become members of the PPP.

Accessing PPP Resources: Organizations accessing the PPP resources for a small fee will become members of the PPP. This membership will allow participants to receive assistance in connecting with other member organizations or accessible tools across the PPP network.

Organizations Advertising on the Website: Organizations advertising resources including tools and expertise will become members of the PPP.

Strategies for Sustainable Operation

This PPP could ultimately generate sufficient funds to become self-supporting. Sustained funding will be decided by the Executive Committee and may include dues, fees-for-service or access, or in-kind contributions.

Key Questions

1. Do the barriers enumerated in this model accurately reflect the challenges facing your organization? Please make suggested additions or subtractions as you see fit.
2. How would the activities proposed in this PPP help your organization overcome the barriers listed? If the activities do not, how would you change these activities?
3. What level of resources is needed to ensure the success of these activities as presented?
4. What is the value proposition to your organization? Does the list of value propositions provided reflect your perspective?
5. How would you change, if at all, the organization structure of the proposed model?
6. What are some specific materials or materials applications that need accelerating, and what are the specific challenges in those topics?

PART 1: AEMC PARTNERSHIP DIALOGUE 4 PRIMER

Looking Forward

AEMC Partnership Dialogue 4 presents two PPP concepts for consideration by stakeholders across the innovation ecosystem—industry, academia, labor unions, government, non-profit organizations and national laboratories. These PPP concepts have been selected based on both the quantitative and qualitative feedback from participants at the first three AEMC Partnership dialogues and have been honed through a robust evaluation process drawing on input from subject-matter experts, business leaders and key decision-makers.

The dialogue held on October 17, 2013, at Applied Materials allows for EERE and the Council to solicit feedback from the AEMC Partnership community of stakeholders who have helped conceive and construct these two PPP concepts. At the conclusion of this dialogue, participants will have a clear vision of outcomes of the AEMC Partnership as it moves toward the announcement of a chosen public-private partnership concept at the Inaugural American Energy and Manufacturing Competitiveness Summit in Washington, D.C. on December 12, 2013.

PART 2
Findings from AEMC Partnership Dialogue 4

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 4

Overview of AEMC Partnership Dialogue 4

AEMC Partnership Dialogue 4 brought together more than 50 regional and national clean energy manufacturing stakeholders from industry, academia, the national laboratories and the public sector to explore and evaluate two PPP concepts:

1. **Facilitating the Transition from Prototypes to Commercially Deployable Products:** This PPP aims to lower the risk of developing new technologies, accelerate domestic innovation, and expand clean energy manufacturing by connecting U.S. manufacturers to companies with pilot-scale technologies that need both new and existing technical, management, and financial resources.
2. **Clean Energy Materials Accelerator:** This PPP reduces the risks associated with deploying newly developed materials in commercial markets by bringing together industry, state, academic and other organizations to co-create a platform to identify and address common challenges, increase access to existing materials qualification and characterization tools and create standards for advanced materials.

The plenary discussion covered the Facilitating the Transition from Prototypes to Commercially Deployable Products PPP concept in the morning sessions and the Clean Energy Materials Accelerator concept in the afternoon sessions. Each PPP concept was discussed in two approaches, presenting the State-of-Play and analysis through Stakeholder Perspectives. The State-of-Play sessions surveyed the national landscape to reveal gaps in the U.S. innovation system and demonstrate the need for these PPP concepts. The Stakeholder Perspectives sessions viewed the PPP concepts through an organizational lens where dialogue participants reflected on the ability of each PPP concept to meet the needs of their organization.

Facilitating the Transition of Prototypes to Commercially Deployable Products

Dialogue Participants:

- Validated the need for a multi-stakeholder solution to the scale-up valley of death;
- Supported the need to lower barriers to manufacturing scale-up in the United States;
- Recognized their respective organization's needs in the value propositions enumerated in the PPP concept;
- Offered four unique examples of strategic technologies for the PPP concept to target;
- Suggested that the PPP is operated independently of the executive committee;
- Proposed that the Tiger Teams be initially constructed, and then continuously draw from a network of subcontractors that reside in the nation's innovation institutions—i.e. national laboratories, universities, private laboratories, non-profits, etc.; and
- Recommended that the PPP concept expand to include explicit workforce development activities, such as a fellowship program built into the Tiger Team concept.

The two most debated topics during this session were the process by which the technology focus of the PPP will be chosen and what level of investment is needed to seed the partnership concept. Concrete recommendations on these topics proved elusive. Nonetheless, the insights generated during this robust discourse kept the AEMC Partnership dialogue series on a productive path forward.

Clean Energy Materials Accelerator

Dialogue Participants:

- Emphasized the need to balance, within the PPP, activities that target materials or prototypes with a strong and existing need in the marketplace that pulls technology development, "market-pull," with those without an established market;
- Highlighted the importance of the political design of the PPP to achieve sustainable support and funding for the model;
- Recommended that the PPP start small in scale to increase the likelihood of early success, which could pave the way for more impactful investment in the future;
- Suggested that the PPP concept leverages synergies with other initiatives and funding sources; and
- Expressed concern that this PPP concept favors large companies over SME's and start-ups.

While these constructive remarks are tremendously valuable, the discourse around this PPP concept remained somewhat abstract. The participants explained that without knowing the specific material focus, it is difficult for companies to gauge the value of participating in a Clean Energy Materials Accelerator and critique the key attributes of the model —which, in itself, is a useful lesson.

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

Bottom: *The Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness*

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 4

State-of-Play: Facilitating the Transition of Prototypes to Commercially Deployable Products

Session Summary

Participants from the three dialogues leading up to AEMC Partnership Dialogue 4, coupled with the collective research of the Council and EERE, identified several barriers to scaling manufacturing in the United States.[1] The Council designed the Facilitating the Transition of Prototypes to Commercially Deployable Products PPP concept to target two barriers: high capital requirements and lacking industrial innovation infrastructure. During this panel session, leaders professionally engaged in the transition of ideas to manufactured products reflected on and critiqued the ability of the proposed PPP concept to address these two barriers: Mr. Neil Auerbach, Founder and Managing Partner of Hudson Clean Energy Partners and Mr. Nolan Browne, Managing Director of Fraunhofer CSE.

Mr. Auerbach brought the perspective of a venture capitalist currently in the process of determining where to locate a manufacturing plant for a commercially viable technology. The case study of Silicor Materials presented by Mr. Auerbach validated the need for a key function of the PPP—facilitating access to capital—and provided an example of innovative, high-skill and energy-intensive manufacturing. The United States is distinctly qualified to lead the global marketplace in advanced manufacturing techniques such as this.

Mr. Browne reflected on the success factors of the Fraunhofer Institutes, a German—and now American—not-for-profit organization internationally recognized as a successful scale-up platform.[2] He provided success factors to measure the potential of the Facilitating the Transition of Prototypes to Commercially Deployable Products PPP concept. While some adjustments to the concept are needed, according to Mr. Browne, this PPP concept is viable and timely.

Mr. Neil Z. Auerbach
Founder and Managing Partner
Hudson Clean Energy Partners

Silicor Materials is one of approximately 20 companies around the world using metallurgical processes to produce solar-grade silicon to 6-7N (see call-out box for explanation)—rather than the traditional Siemens process which creates silicon at up to 9N purity levels.[3] Though Silicor Materials is one of several polysilicon manufacturers, it may be the first company ready for full-scale, profitable production. Silicor lowers the cost of polysilicon through its processing technique by at least 30 percent relative to low-cost polysilicon producers in China, and produces a valuable by-product, a high-strength alloy that is attractive to the automotive and other manufacturing industries. Considering that silicon accounts for 16 to 18 percent of the total materials cost for a solar module, this process innovation has the potential to transform the solar industry.

1 The Power of Partnerships, *Council on Competitiveness*, 2013.

2 Boosting Competitiveness by Connecting Science and Industry: Insights from Germany's Innovation Model, *Information Technology and Innovation Foundation*, Webcast, October 18, 2011.

3 Today, most solar and electronic grade silicon is manufactured using the Siemens Process—named after the company that invented the process. In the Siemens Process, high purity silicon rods are exposed to a chemical gas compound trichlorosilane (TCS) at high temperatures. The TCS gas decomposes due to high temperature and deposits highly pure silicon on the rods. The remaining chlorine byproducts are either disposed of or recycled.

Polysilicon is the fundamental material in photovoltaic cells. Silicon is one of the most abundant minerals on earth, found in the form of silicon dioxide, or sand. But refining it to the high purity required for use in semiconductors is an energy-intensive, highly specialized process.[i] The polysilicon industry is one part of the larger semiconductor industry built to serve the electronics industry. It focuses on manufacturing extraordinary pure silicon—at least 99.9999999 (9N) percent pure. However, the solar industry is different—the level of purity needed to create electrical current is much lower, from 6N to 7N level of purity, than the purity necessary to create semiconductors. Therefore, a process that can create silicon at a 6N to 7N level of purity that is also less energy-intensive and more cost-effective has the potential for a great impact.

i The Pew Charitable Trusts, "Advantage America: The U.S.-China Clean Energy Technology Trade Relationship in 2011", 2013.

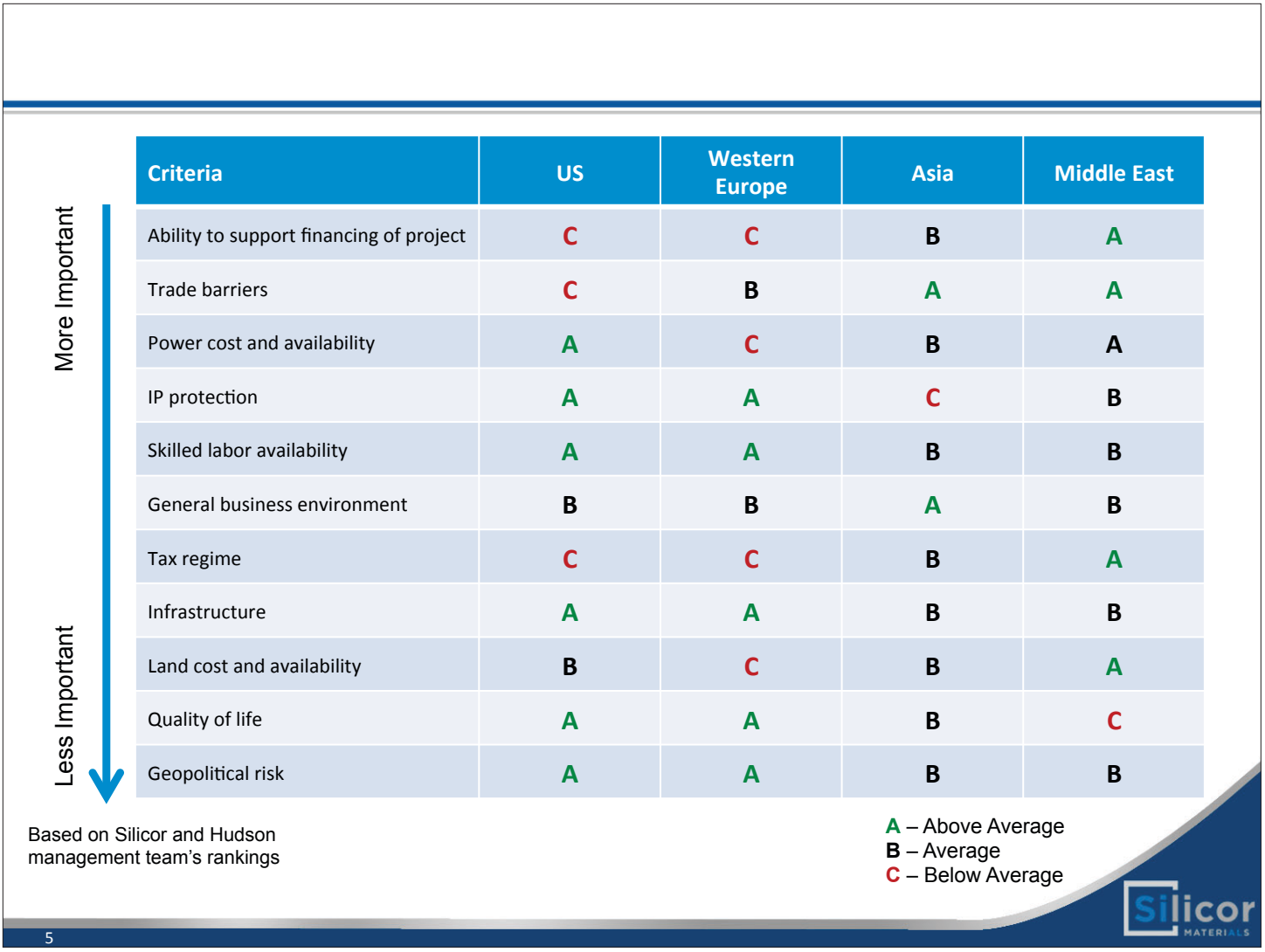
Mr. Chad Evans, Executive Vice President, Council on Competitiveness, and Mr. Neil Z. Auerbach, Founder and Managing Partner, Hudson Clean Energy Partners.

In developing and piloting this highly innovative process, Silicor Materials has effectively bridged the first technology valley of death—the resource gap between the development, prototyping, and demonstration phases of technology commercialization. This required $250 million in investment from the venture capital firm. The company now stands at the precipice of the second valley of death; it is searching for the financing to move from the pilot phase by building its first full-scale production plant. Constructing this manufacturing plant is estimated to cost $670 million. Though access to capital is the most important factor in this particular case, Mr. Auerbach presented numerous criteria Silicor Materials uses to select its manufacturing site among numerous opportunities around the world (Figure 1) along with grades given to different locations.

Unfortunately, the United States scores low marks in two important site selection criteria—the ability to support financing of the project and (low) trade barriers. These factors represent two ongoing wars in America—one in Washington D.C. and the other a global trade war. The political stalemate in our nation's capital has a chilling effect on investors; uncertainly creates risk that is difficult for venture capitalists or private equity investors to manage. This divisive environment also deters developers

Figure 1: Silicor Materials—Site Selection Criteria

Source: Neil Auerbach, Hudson Clean Energy Partners



More Important

Less Important

Criteria	US	Western Europe	Asia	Middle East
Ability to support financing of project	C	C	B	A
Trade barriers	C	B	A	A
Power cost and availability	A	C	B	A
IP protection	A	A	C	B
Skilled labor availability	A	A	B	B
General business environment	B	B	A	B
Tax regime	C	C	B	A
Infrastructure	A	A	B	B
Land cost and availability	B	C	B	A
Quality of life	A	A	B	C
Geopolitical risk	A	A	B	B

Based on Silicor and Hudson management team's rankings

A – Above Average
B – Average
C – Below Average

Silicor MATERIALS

5

from taking money from government programs. When high technology ventures fail, which they frequently do, the entrepreneurs, technologists, and investors need to move on as quickly as possible, which can be difficult if these teams are pulled into a national policy debate.

The trade war with China also creates a hostile environment for investing. After the United States Trade Representative levied anti-dumping and countervailing duties on Chinese solar cells and modules, China imposed preliminary tariffs on U.S. solar-grade polysilicon. The United States, a net exporter of polysilicon to China, fell into a trap.[4] The U.S. tariffs on Chinese solar panels will have little impact on China's overall solar exports. China, however, is a primary importer of U.S. polysilicon. America is on the losing side of this trade war, which makes the decision for Silicor Materials to locate a manufacturing plant in the United States even less likely.

4 The Pew Charitable Trusts, "Advantage America: The U.S.-China Clean Energy Technology Trade Relationship in 2011", 2013.

It should also be mentioned that China is the leading producer of raw materials Silicor Materials requires. Considering this—as well as the better grades in trade barriers and access to capital—China would be a natural location for the Silicor Materials plant. However, a main concern for Silicor Materials and Hudson Clean Energy Partners is intellectual property (IP) protection, for which China receives a Below Average grade. In addition to weak IP protection, there are other factors that make Asia unattractive for investment, particularly the average cost for power compared to the lower costs in the United States and the Middle East.

The PPP concept—Facilitating the Transition of Prototypes to Commercially Deployable Products—works to increase scaled production in the United States, and the Silicor Materials case study offers a lens to better understand the value of this proposed PPP. Clearly, the decision on locations to site manufacturing plants is complex. However, access to capital is the top priority for Silicor Materials, as presented by Mr. Auerbach, when considering where to locate production. Thus, this PPP provides a viable solution and comes at a time when risk capital is scarce.

Mr. Nolan Browne, Managing Director, Fraunhofer CSE.

Mr. Nolan Browne
Managing Director
Fraunhofer CSE

When considering the process of transitioning from prototype to deployable products, it is beneficial to reflect on the factors that have led national scale-up platforms, such as the Fraunhofer-Gesellschaft Institutes, to success. Listed below are six key elements that have contributed to the success and sustainability of the Fraunhofer-Gesellschaft Institutes.

Experience with the Fraunhofer Institutes suggests that a successful PPP targeting scale-up manufacturing will:

- ***Match industry-pull with technology-push.*** *The needs of the local manufacturing industry typically determine the technology areas at Fraunhofer Institutes. Every principal in the organization meets with their industrial supporters to understand what problems they need to solve, and then reaches into the appropriate community for solutions.*
- ***Stay relevant to entire industries because a consortium of industry partners, not just one company, influences the strategy for each institute.*** *Fraunhofer Institutes have the independence to drive projects in directions that meet the needs of an entire industry as opposed to the needs of individual companies.*
- ***Create research and development economies of scale.*** *Industrial partners derive benefit from Fraunhofer because the institutes' value to partners exceeds their investment. The German Fraunhofer Institutes have created a national research and development (R&D) platform that individual companies can access. With the research infrastructure already in place—including both equipment and experienced scientists—the Fraunhofer Institutes enable firms to complete a project at reduced R&D cost, creating a relative competitive advantage in the global market.*
- ***Lower the risk associated with bringing new innovations to market.*** *Because it is a national center, Fraunhofer Institutes distribute the risks faced by an individual company especially when working in pre-competitive technology areas.*

- ***Provide trained industrial scientists and engineers to the workforce, lowering corporate investment and limiting headhunting efforts.*** *Building workforce development into an industry-driven applied R&D and scale-up effort ensures tomorrow's technical leaders will serve the needs of the growing advanced manufacturing sector in the United States.*

It is important to note that what works in Germany may not necessarily work in the United States; the two countries have cultural differences when it comes industry-government relations. Moreover, there are other successful public-private partnerships available for guidance—which the Council detailed in Power of Partnerships. Nonetheless, given its internationally recognized success as a scale-up platform, it is valuable to measure the Facilitating the Transition of Prototypes to Commercially Deployable Products PPP concept using six Fraunhofer success factors (Figure 2). To consider how the Fraunhofer Institutes might be adapted for the U.S. business culture, an additional metric has been added to the scorecard: engagement of the vibrant start-up and small and medium-sized enterprise (SME) community. There is nothing like the U.S. start-up community anywhere in the world and any PPP that is developed through the AEMC Partnership must tap into this world-class national resource.

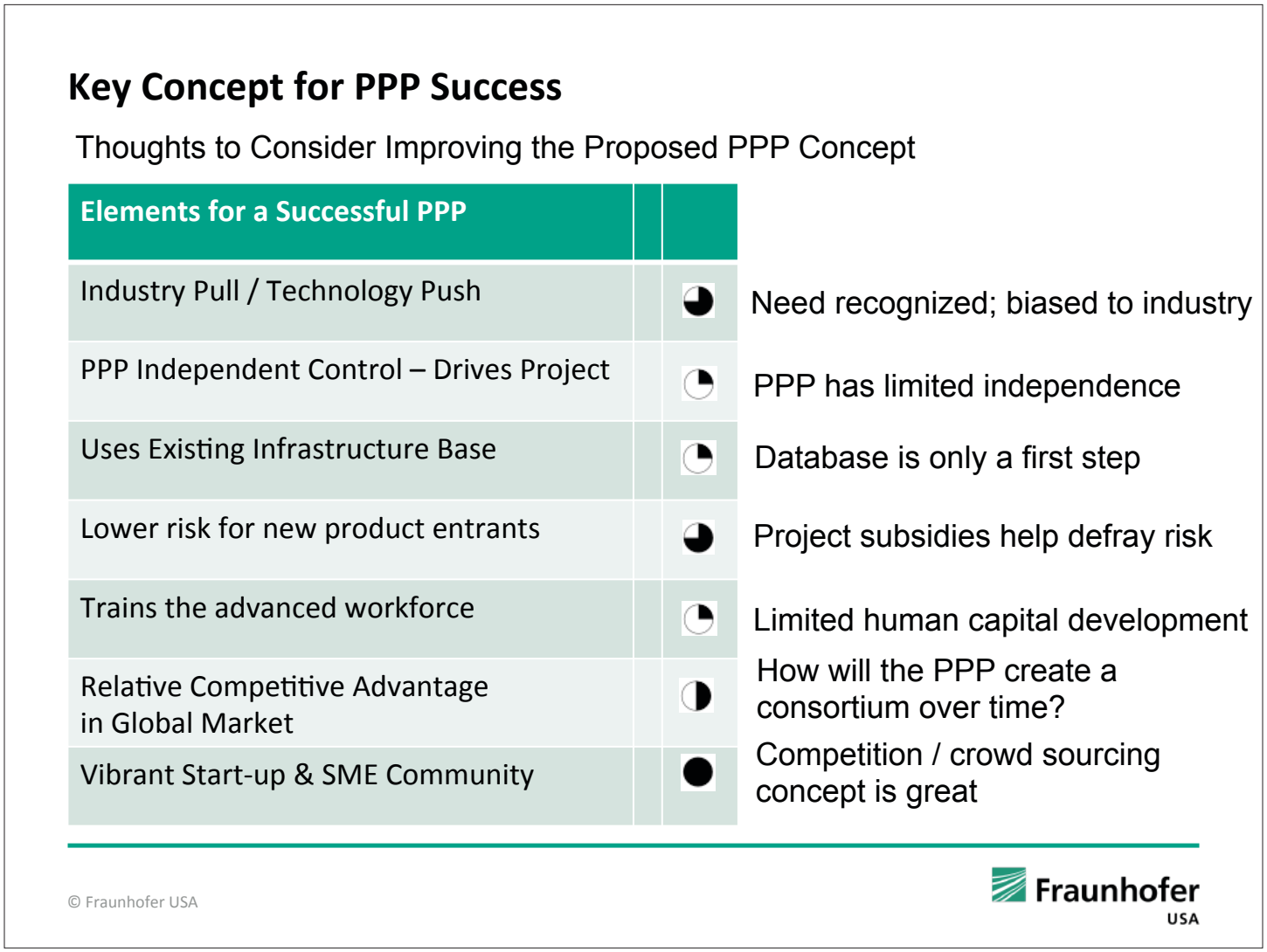
This PPP concept is strong with useful components generated during previous AEMC Partnership dialogues. Determining how these pieces function together in an operational PPP, however, is the difficult—and yet the most important work. To this point, improvements can be made to the concept—namely in the areas of PPP management and leadership; leveraging the U.S. science, technology, and manufacturing community; and workforce development. The current structure of the PPP, particularly with leadership from an Executive Committee, limits organizational independence. The PPP should be governed by an industry-led executive committee that is also responsible for setting the strategic vision—including the technology focus areas of national strategic importance. However, there should be an individual PPP director with the autonomy to execute this vision as he or she sees fit.

Another suggestion for this PPP concept is to limit the size of Tiger Teams to small groups of technology and business experts led by a veteran in the technology focus area. These teams will develop a national manufacturing R&D network comprised of scientists and engineers from national laboratories, universities, for-profit companies, non-profits research laboratories, etc. This network will then be used as a sub-contracting pool for the Tiger Teams to link technologies and companies in need of scale-up expertise with the people who can solve scale-up problems.

Lastly, there should be a workforce development mandate for the PPP concept. This could include a fellowship program that brings early-career scientists, engineers, and technologists into Tiger Teams for predetermined periods of time.

Figure 2: Facilitating the Transition of Prototypes to Commercially Deployable Products—Score Card

Source: Mr. Nolan Browne, Fraunhofer CSE



PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 4

Stakeholder Perspectives: Facilitating the Transition of Prototypes to Deployable Products

Panel Summary

The Facilitating the Transition of Prototypes to Commercially Deployable Products PPP concept is designed to link together the often disparate stakeholders in the nation's innovation ecosystem in a way that leverages the strengths of each partner, overcomes systemic failures in technology development, ensures the partnership is greater than the sum of its parts, and—ultimately—drives U.S. competitiveness in advanced manufacturing. This panel brings together representatives of the stakeholders groups that would potentially constitute this PPP concept for the purpose of measuring it against this bold vision.

This session, moderated by Mr. Steven Betza, Director of Hardware Engineering & Advanced Manufacturing at Lockheed Martin, begins with opening remarks from each panelist:

1. Do the barriers enumerated in this model accurately reflect the challenges facing your organization? Please make suggested additions or subtractions as you see fit.
2. How would the activities proposed in this PPP help your organization overcome the barriers listed? If the activities do not, how would you change these activities?
3. What level of resources is needed to ensure the success of these activities as presented?
4. What is the value proposition to your organization? Does the list of value propositions provided reflect your perspective?
5. How would you change, if at all, the organizational structure of the proposed model?

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

The PPP concept was well received by dialogue participants. The panelists' opening remarks validated the needed for a multi-stakeholder solution to the scale-up valley of death, offered examples of strategic technologies this PPP could accelerate, and highlighted how a public investment in the second valley of death complements investments the federal government already makes to pull technologies through the first valley of death. While participants did not suggest the removal of any activities in the proposed PPP concept, the most obvious missing element was an explicit workforce development element. The two most debated topics during this session were the technology-focus selection process and the level of investment needed to seed the partnership concept. While dialogue participants engaged in a rich conversation on these issues, a consensus did not emerge around a path forward. Nonetheless, the insights generated during this robust discourse kept the AEMC Partnership dialogue series on a productive pathway.

"Make no mistake out about it; manufacturing is a national team sport. If we don't recognize that, we are going to get crushed."

Mr. Nolan Browne
Managing Director, Fraunhofer CSE

Panelist Remarks

This subsection of the report provides the key insights from each panelist's opening remarks during the moderated discussion—Stakeholder Perspectives: Facilitating the Transition of Prototypes to Deployable Products.

Dr. Omkaram Nalamasu, Chief Technology Officer, Applied Materials, Inc.

Dr. Omkaram Nalamasu
Chief Technology Officer
Applied Materials, Inc.

It is important to think about scale-up in terms of innovation. Imagine an engineer that has prototyped a nanotube-based device. Scaling this technology is more than just a multiplication of the same processes used to create the prototype. At Applied Materials, we think scale-up is innovation. Scale-up is building manufacturing technology that is robust, reliable, and controllable to transition the prototype into a value-added product or value-added service. Thus, being able to bridge the scale-up valley of death is not only a financial challenge but also a technical challenge.

From Applied Materials' perspective, there are two opportunities where this PPP concept could be utilized. The first is epitaxial growth[5] of silicon wafers for solar photovoltaics. Current polysilicon production methods are very wasteful. Between the creation of polysilicon and the finished wafer, 85 percent of the silicon is wasted in the cutting and sizing of silicon wafers (i.e. kerf loss). Applied Materials and others in the United States are leaders in epitaxial silicon technology that can be used to create monocrystalline silicon wafers directly from trichlorosilane (TCS). This process will eliminate the kerf loss and may bring the cost of solar modules down to 50 cents/watt-peak and below. Furthermore, many suppliers of TCS and companies with expertise in epitaxy are currently in the United States. This PPP could be used as a vehicle to bring the supply chain together, firmly anchor kerf less fabrication of silicon wafers in the United States, and—ultimately—drive down the cost of solar beyond grid parity.

5 The growth of the crystals of one mineral on the crystal face of another mineral, such that the crystalline substrates of both materials have the same structural orientation.

The other potential target area of this PPP concept is superconductivity-based fault current limiters SCFCLs. The economic loss to the U.S. economy from brownouts and blackouts is $40 billion per year and estimated to be more than $100 billion globally. The increasing demand on the power grid and the large-scale integration of renewable energy sources are increasing the risk of large fault currents. SCFCLs increase stability to the power grid and save power by bypassing the impedances needed to keep fault currents under control during normal operation. Power quality and voltage stability are also enhanced, making the power grid stronger, smarter and more secure. This new fault current technology has been demonstrated with Keuring van Elektrotechnische Materialen te Arnhem (KEMA), a high-power electrical testing laboratory, and is a new market for Applied Materials and its supply chain partners, with the State of New York as its first utility customer. This PPP concept could be a vehicle to bring together utilities, the private sector and the government to scale and deploy this technology in the United States, and build a vibrant industry around creating a secure power grid.

Dr. Gregory B. Raupp
Director, Macro Technology Works
Arizona State University

The Facilitating the Transition of Prototypes to Commercially Deployable Products PPP concept is of great interest to the group at MacroTechnology Works, a public-private partnership at Arizona State University (ASU), as there are numerous prototypes in MacroTechnology Works' laboratories that reside on the wrong side of the scale-up valley of death. MacroTechnology Works was created ten years ago by the U.S. Army as the Flexible Display Center—since renamed the Flexible Electronics and Display Center. The objective of the Flexible Electronics and Display Center is to take flexible displays across the first and second valleys of death to provide soldiers with lightweight, wearable, rugged, and comfortable situational awareness display technologies. Today, several companies ready to commercialize flexible displays use technologies developed at ASU in collaboration with industry partners. Unfortunately, this discussion is overdue for flexible displays because the manufacturing base already exists overseas.

Dr. Gregory B. Raupp, Director, Macro Technology Works, Arizona State University.

Building on its expertise in flexible displays, ASU also works with Palo Alto Research Center Incorporated (PARC), an independent research laboratory, and General Electric to develop a flexible digital X-ray imager. This device has a wide range of applications, replacing very delicate and expensive glass plates in digital hospital X-ray machines to mobile applications for disaster triage or monitoring the structural health of oil pipelines. This is just one example of a group of prototypes called flexi-electronics that the MacroTecholgy Works' laboratories develop, which are well positioned to benefit from a scale-up focused PPP.

Ms. Jean Redfield, President and Chief Executive Officer, NextEnergy and Mr. Steven Visco, Chief Executive Officer and Chief Technology Officer, Polyplus Battery Company

Ms. Jean Redfield
President and Chief Executive Officer
NextEnergy

NextEnergy is a public-private partnership that works with individual technologies, businesses, and industry sectors to identify innovation white space and make the necessary connections with laboratories, universities, federal funding, and private investment funds to accelerate innovation and commercialization timelines. In 11 years of business, NextEnergy helped 44 companies leverage resources to create new investment a factor of 75 greater—totalling more than $1.6 billion into the State of Michigan in the last two years. This is evidence that these kinds of partnerships really work.

The idea of investing in a PPP concept that links the resources of the inventor to manufacturing expertise is very exciting. NextEnergy recognizes that even the very best technologies cannot penetrate the market without a manufacturing review early in the technology development process. This includes analyses and decisions on hard tooling, soft tooling, automation, design for flexible manufacturing, etc. The Facilitating the Transition of Prototypes to Commercially Deployable Products PPP concept can provide a manufacturing review, which also reduces risk for investment from the venture capital community. When SMEs can be matched with world-class design for manufacturability talent, the risk of scaling production is reduced. This PPP could also strengthen the supply chains of downstream integrators. If a supplier to GE Health Care or General Motors, for example, can get its product to market sooner and at a lower cost with the help of this PPP, then it has the potential to de-risk the integrator's supply chain.

Mr. Steven Visco
Chief Executive Officer and Chief Technology Officer
Polyplus Battery Company

The electrification of transportation may be today's only prospect for a trillion-dollar market and the United States is not on the list of global competitors. East Asia continues to outpace the United States in battery technologies and companies like BASF, based in Germany, are investing billions of dollars to be a material supplier for advanced batteries. If America wants to compete in next generation batteries, the nation needs to invest in the Facilitating the Transition of Prototypes to Commercially Deployable Products PPP concept.

To enable electrical vehicle technologies, lighter-weight batteries are needed; lithium ion technology is not likely to reach the necessary energy density. Lower-cost raw materials and advanced manufacturing process are also required. Fortu-

nately, companies like Polyplus Battery Company are developing promising technologies such as the water-stable lithium metal electrode, the basis for lithium air, lithium water, and advanced lithium sulfur batteries. Polyplus Battery Company is working with Corning and Johnson Controls to take this technology to the next step, which is exciting. However, we are now facing live or die decisions as the next steps are extremely capital intensive and risky. This PPP concept could go a long way toward reducing risk during this process—both financially and technically.

Open Discussion

Following the opening remarks, Mr. Betza moderated an open discussion around the presented PPP concept addressing the questions and collecting feedback from dialogue participants.

Do the barriers enumerated in this model accurately reflect the challenges facing your organization? Please make suggested additions or subtractions as you see fit.

There was broad agreement among participants that this PPP targets barriers that, in their experience, present challenges to scaling manufacturing in the United States. The lack of risk-tolerant capital to scale manufacturing resonated with the group—particularly entrepreneurs and technologists who have personally experienced this barrier.

> *"Clearly, capital requirements are important [and] the clean energy technology industry is not very well-aligned with the venture capital model. So I think absolutely, the government has to do this."*
>
> **Mr. Steven Visco**
> Chief Executive Officer and Chief Technology Officer, Polyplus Battery Company

Moreover, as the participants explained, large well-established U.S. manufacturing firms have been reluctant to acquire new, disruptive technologies (i.e. technologies outside of their strategic plans). As an example, Polyplus Battery Company began thinking about scale-up very early in their development of next generation lithium-based batteries. They approached the three largest U.S. battery manufacturers and were turned away because Polyplus Battery Company's manufacturing processes drastically differ from the established alkaline cell technology. A better known example of a strategic technology failing to bridge the scale-up valley of death in the United States is that of flat panel displays. The technology for these displays was invented in America but ultimately manufactured in Asia because U.S. companies were not willing to make the substantial and risky investments needed to scale manufacturing in the United States.

Difficulty accessing manufacturing talent (i.e. manufacturing innovation infrastructure) also received considerable attention from dialogue participants.

> *"First you have to figure out how to invent the stuff, but then somebody has to invent the best way to make it. And that is the talent that we have not been producing to the degree that we had in previous generations."*
>
> **Ms. Jean Redfield**
> President and Chief Executive Officer, NextEnergy

Ms. Redfield's statement was explored in detail by the group—particularly the causes of the current deficit of manufacturing expertise. Factors contributing to this situation include the loss of a U.S. culture of "making things" and a wage gap between manufacturing jobs and other occupations, which is larger in the United States than in other industrialized nations and discourages U.S. workers from investing in manufacturing skills. Participants also highlighted the changing structure of U.S. corporations as a contributing factor to the reduction of manufacturing expertise in the United States. As vertically-integrated firms released business units unrelated to their core competencies, large swaths of middle managers were released as well. Middle managers, according to the dialogue participants, were responsible for talent development and mentorship. Lastly, a mismatch between the workforce needs of industry and

academic curriculum was mentioned by participants as contributing to the deficit in workers with marketable manufacturing skills.

How would the activities proposed in this PPP help your organization overcome the barriers listed? If the activities do not, how would you change these activities?

Most participants called for the PPP concept to include a greater focus on talent development. While there was an acknowledgement that this PPP concept could not possibly address all the nation's manufacturing skills needs, it could create a cadre of people who become scientists, engineers, and advanced manufacturing pioneers. Functionally, this could occur by integrating a fellowship program into the Tiger Team concept currently built into the PPP concept. Fellows could come from academia or the for-profit world and work on the Tiger Team on a scale-up process for two years, for example. Fellows in a program such as this would learn valuable skills that U.S. manufacturing firms seek.

What is the value proposition to your organization? Does the list of value propositions provided reflect your perspective?

The moderator, Mr. Betza, garnered positive responses from both the large global manufacturing firm and the start-up company on the panel. Both companies felt that their needs were reflected in the PPP concept and each highlighted the value proposition that resonated most. Well-established manufacturing firms with a global outlook have well-defined markets, customers, technologies, and intellectual property. However, moving to adjacent or new markets is expensive and risky for any company. Having the opportunity to defray financial and capital risk as they enter new markets, according to the group, is a key value this PPP concept brings to large multinationals. While these are also values to the SMEs—particularly the concept of lowering risk—the value proposition most interesting from the perspective of SMEs was the access to top talent in engineering, namely manufacturing and scale-up engineering.

How would you change, if at all, the organizational structure of the proposed model?

There was considerable discussion around how the topic or technology focus areas should be selected. Specifically, should the PPP be established and then have the executive committee select the focus areas or should another organization, such as EERE, select the focus areas itself and competitively award the opportunity to a consortium around a specific topic?

A consensus did not emerge. Several participants felt that the National Network of Manufacturing Institutes (NNMI) model of pre-selecting a focus area has facilitated that particular PPP establishment process. However, this method of pre-selection—according to others—was implemented out of necessity, as the funding for the institutes came from existing federal agency budgets. Pre-selection of technology focus areas may not be the long-term model for selecting NNMI Institutes in the future, as surveys and working groups organized by the Advanced Manufacturing National Program Office (AMNPO) revealed that industry representatives did not want the focus areas pre-selected:

There was broad consensus among the workshop participants and RFI respondents that the emergent focus areas should be defined by the proposing teams. The proposing teams will be driven by the needs of industry, the opportunities created by new technologies, and the programmatic needs of the AMNPO partners. Many respondents cautioned against the tendency to pre-select trendy topics that don't serve this essential balance. This concept, strongly supported from public input, is to allow open solicitations with clear selection criteria rather than government-selected topics. Good ideas come from unexpected places. The government view is included as the agencies will make the selections.[6]

Independent of the specific technology areas selected, participants also focused on a distinction that was detailed in the *Power of Partnerships*—PPPs that target early market verses mature market.[7]

"[We] need to identify an area where we want to be a world leader, where we want to have a robust manufacturing economy, and bring the world leaders together and create a manufacturing economy."

Dr.Omkaram Nalamasu
Chief Technology Officer, Applied Materials, Inc.

According to participants, the PPP should not be targeting sectors or technology focus areas if a supply chain already exists in another country or region outside the United States (i.e. mature markets). The Executive Committee of the PPP should target new markets where supply chains are not well established. This PPP could be a center of gravity acting to pull together supplier networks for next-generation products and processes. The presence of robust supply chains, as was noted in Mr. Auerbach's presentation, is instrumental in anchoring a manufacturing base in a region. Several participants also noted that the PPP should aim to affect more than the supply side of the technology focus area.

"Identifying the adopter who will have their catcher's mitt ready for a new technology on the other side of the valley before you begin the journey of a transition to production is very important."

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

Many participants reiterated an idea that has been pervasive throughout the AEMC Partnership dialogue series—the protection of sensitive information and well-defined ownership rights. These important interests, according to the group, need to be built directly into the organizational structure of the PPP concept.

6 National Network for Manufacturing Innovation: A Preliminary Design, Executive Office of the President, National Science and Technology Council, Advanced Manufacturing National Program Office, January 2013.

7 *The Power of Partnerships,* the Council on Competitiveness, 2013.

> *"The idea of Tiger Teams is great. However, with teams working with multiple entities, diffusion of knowledge is going to be a very sensitive issue...companies are going to be very sensitive about the problems that are being addressed by people who are going to other companies."*
>
> **Mr. Steven Visco**
> Chief Executive Officer and Chief Technology Officer, Polyplus Battery Company

According to participants, the importance of intellectual property rights and ownership structure ties back to incentives. Start-up companies and entrepreneurs may be deterred from participation if they are beholden to a large company when their technology is ready to launch. As such, to attract the best and brightest to the PPP, the incentive structure needs to be right for all parties involved.

What level of resources is needed to ensure the success of these activities as presented?

This question was not targeted at one particular panelist, and the group was not asked to select a dollar value range from a list of options. It was an opportunity for stakeholders in the room to reflect on the level of investment that their company would need to bridge the scale-up valley of death in the clean energy technology sector. Moreover, the group reflected on the data that currently exists on the funding levels of similar organizations. The dollar values expressed for an individual company ranged from $10 million per year to hundreds of millions of dollars. This wide range reflects the difficulty of bracketing the start and end activities of the scale-up phase, as well as the varying lengths of time needed to complete scale-up processes. Moreover, technologies may have widely different capital needs. Participants also noted that the NNMI Institutes are funded at $150-300 million over five years. This funding supports early-stage technology development, which tends to be less expensive than manufacturing scale-up.

The Facilitating the Transition of Prototypes to Commercially Deployable Products PPP concept is also a novel concept, according to participants. Coupled with the large capital investments likely needed to be successful, participants suggested the PPP may have more success by starting with small pilots, perhaps two simultaneous projects along different technological foci to refine and pilot the concept. This recognizes that honing the concept itself is a process independent of selecting the technology focus area that must be refined before the PPP concept scales nationally.

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 4

State-of-Play: Clean Energy Materials Accelerator

Session Summary

The Clean Energy Materials Accelerator is designed to target and overcome the barriers to increasing the use of advanced materials in products and processes. The lack of standards for next generation materials is an issue that cuts across each of the three barriers targeted by this PPP concept: technical risk, innovation infrastructure, and imperfect information. During this panel session, leaders who are professionally engaged in creating and deploying advanced materials reflected on and critiqued the ability of the proposed PPP concept to address these three barriers: Mr. Pat Picariello, Director, Developmental Operations, ASTM International and Dr. Mehdi Vaez-Iravani, Corporate Vice President at Applied Materials, Inc.

Mr. Pat Picariello, Director, Developmental Operations, ASTM International.

As a representative of the standards community, Mr. Picariello, Director for Developmental Operations, ASTM International, provided an expert's perspective on how the standards component of the Clean Energy Materials Accelerator strengthens the innovation ecosystem for advanced materials.

Dr. Vaez-Iravani, Corporate Vice President at Applied Materials, thoughtfully explained the realities of today's semiconductor industry and the importance of standards to this sector. Moreover, Dr. Vaez-Iranvani discussed a key challenge faced by Applied Materials: decreasing the time from invention to high volume manufacturing.

Mr. Pat Picariello
Director, Developmental Operations
ASTM International

ASTM International has been in continuous operation since 1889, when it was created to serve the railroad industry. As railroad track was being laid, it quicky became apparent that one manufacturer's track did not match a manufacturer's track in another region—a big problem when attempting to connect the country by rail. Thus, the producers of railroad track needed a common agreement on specifications. To this problem, ASTM International was the solution. The national benefits of deploying railways throughout the country is an example of how standards can be an economic enabler. Today ASTM International has 32,000 members from 135 countries, 144 technical committees, and has developed over 12,000 standards.

The Clean Energy Materials Accelerator public-private partnership concept is the bedrock principle upon which ASTM International derives their authority—ASTM standards developing committees represent a microcosm of the industry that they serve. Like the PPP concepts presented here today, a goal of ASTM International is to facilitate the process of getting an idea out to the marketplace.

What is an ASTM Standard?

Standard (noun)—as used by ASTM International, a document that has been developed and established within the consensus principles of the Society and that meets the approval requirements of ASTM International procedures and regulations.

Types of ASTM Standards:

- **Specification:** an explicit set of requirements to be satisfied by a material, product, system or service
- **Test Method:** a definitive procedure that produces a test result
- **Practice:** a set of instructions for performing one or more specific operations that does not produce a test result.
- **Guide:** an organized collection of information or series of options that does not recommend a specific course of action.
- **Classification:** a systematic arrangement or division of materials, products, systems, or services into groups based on similar characteristics such as origin, composition, properties, or use.
- **Terminology:** a systematic arrangement or division of materials, products, systems, or services into groups based on similar characteristics such as origin, composition, properties, or use.

Source: ASTM International

ASTM International's vehicle to achieve this goal is the creation of a standard. The process is completely neutral—the ideas are driven by membership and the standards developing process itself is voluntary and consesus-based.

There are solid synergies between ASTM International and the types of PPPs that the Council and EERE are investigating. In fact, ASTM International recently agreed upon memorandums of understanding with the National Additive Manufacturing Innovation Insitute and the Critical Materials Institute at Ames National Laboratory to be the standards development organization for the standards needs in funded projects.

The Clean Energy Materials Accelerator can fill two current gaps in the standards setting process. One of the largest impediments to efficient and effective standards development is the initial takeoff period. It can be very difficult to transition enthusiasm and good ideas into the actual work of developing standards. The voucher and funding mechanisms in the PPP concept could dramatically shorten this process by bringing materials characterization data (instead of only ideas) that can immediately be dropped into the standards development process. The other gap addressed is participation. There is currently a dearth of participation from the user community. The more evolved the concept (i.e. a concept with user input) that is brought to the standards community, the more likely it is developed quickly and retains its initial concept. The fact that the Clean Energy Materials Accelator engages the user community is tremendously valuable.

Dr. Mehdi Vaez-Iravani, Corporate Vice President, Applied Materials, Inc.

Dr. Mehdi Vaez-Iravani
Corporate Vice President
Applied Materials

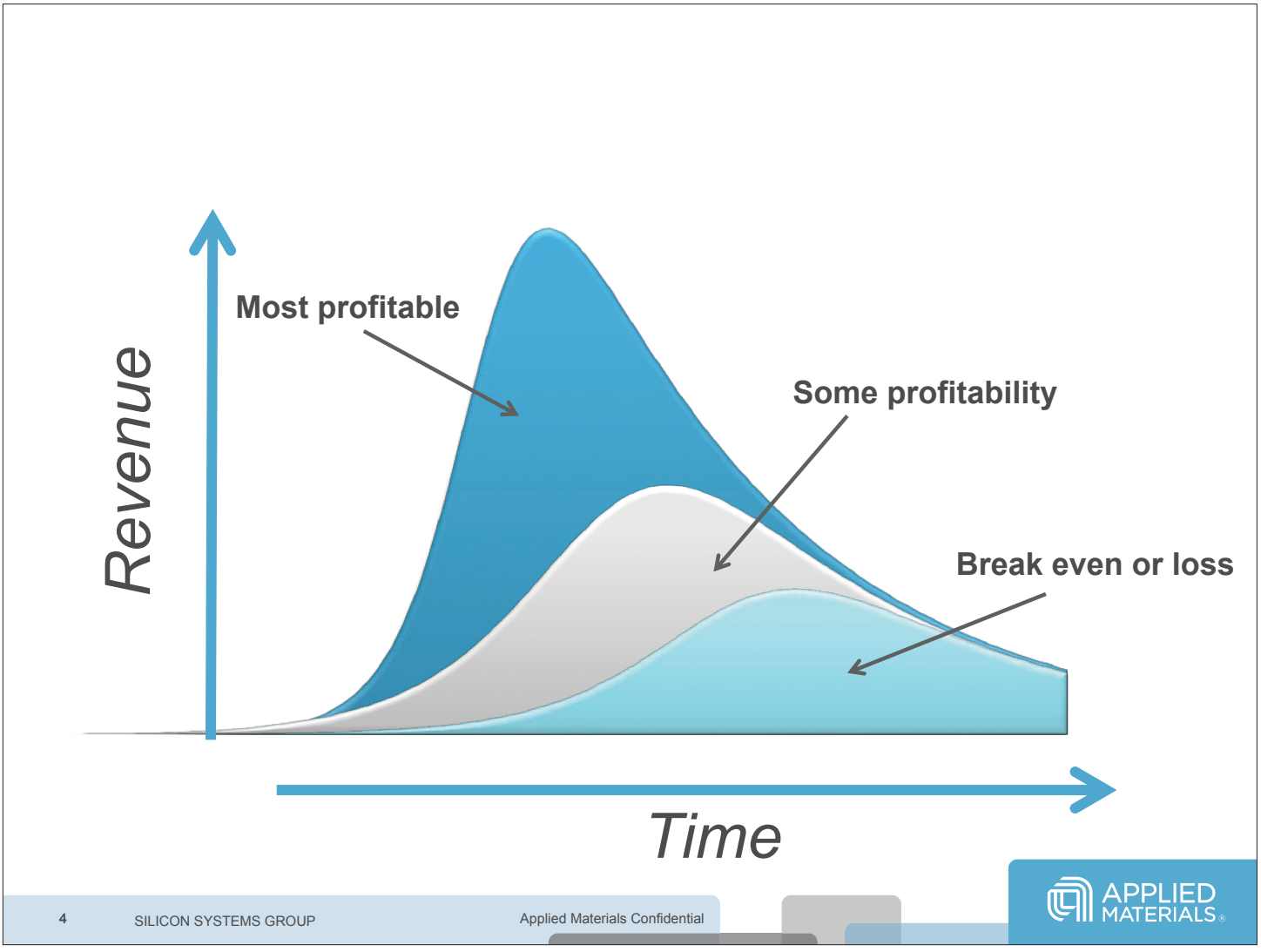
Two things have transformed the entire semiconductor industry—standards and the International Technology Roadmap for Semiconductors (ITRS). Together, these have created a vector comprised of goals and milestones for the semiconductor industry. These milestones are more than just numbers; they are a state of mind. They are a commitment to do everything humanly possible to push the frontier of technology. This is a higher-level goal than meeting numerical targets or turning a profit—it is an ideal to which each of us aspire. This is the national state of mind necessary to move the needle on today's energy challenges. To the extent that the Clean Energy Material Accelerator can set standards and create roadmaps to achieve this state of mind—it is a good thing.

In the case of the ITRS—and true for any roadmap—the nature of the problem is not whether companies like Applied Materials can demonstrate ultra-fast transistors, or enable ultra-narrow critical dimensions, or detect ultra-small defects. There are many different ways that scientists and engineers can demonstrate progress along the ITRS in a laboratory. This is invention, which is wonderful—but, nobody gets paid for invention. In order to transform invention into a real industry there needs to be innovation. For our work at Applied Materials, we transform the basic knowledge generated in a laboratory, guided by the ITRS, into something which is ultra-reliable, ultra-fast, and repeatable.

To complicate matters, there is the issue of time. The economics of the semiconductor enterprise become clear when revenue is plotted against time (Figure 3). Making money in this industry is all about yield; the higher the yield, the greater the revenue. The yield curve begins once researchers start work on a new tool in the laboratory. As the process continues to improve and advance, whatever it may be, high volume manufacturing will begin to achieve the highest yield possible, Applied Materials must also work with customers to increase their learning rates—shifting the curve to the left and increasing revenue (represented as the dark blue curve). The difference between the most profitable and least profitable parts of the curve is a function of time, which can be as little as 12 months.

Figure 3. Prosperity Curves: Profits are Highly Skewed in Time

Source: Mehdi Vaez-Iravani, Corporate Vice President, Applied Materials



PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 4

Stakeholder Perspectives: Clean Energy Materials Accelerator

Panel Summary

The Clean Energy Materials Accelerator PPP concept is designed to link together the often disparate stakeholders that produce and use advanced amterials in the U.S. innovation ecosystem in a way that leverages the strengths of each partner, overcomes systemic failures in technology development, ensures the partnership is greater than the sum of its parts, and—ultimately—drives U.S. competitiveness in advanced manufacturing. This panel brings together representatives of the stakeholders groups that would potentially constitute this PPP concept for the purpose of measuring it against this bold vision.

This session, moderated by Mr. Arthur "Chip" Cotton, Program Manager, Energy R&D, GE Global Research and National Operations Co-Lead, GE Veterans Network, began with opening remarks from each panelist before opening the conversation up to the group for a conversation structured around six questions:

1. Do the barriers enumerated in this model accurately reflect the challenges facing your organization? Please make suggested additions or subtractions as you see fit.
2. How would the activities proposed in this PPP help your organization overcome the barriers listed? If the activities do not, how would you change these activities?
3. What level of resources is needed to ensure the success of these activities as presented?
4. What is the value proposition to your organization? Does the list of value propositions provided reflect your perspective?
5. How would you change, if at all, the organization structure of the proposed model?
6. What are some specific materials or materials applications that need accelerating, and what are the specific challenges in those topic.

The discussants initiated an insightful conversation exploring both the political and economic realities that the Clean Energy Materials Accelerator will inevitably confront. The structure and organization of the PPP, according to participants, must have a strong political design that recognizes the current era of fiscal austerity and the factions within Congress that want less federal government involvement in the economy, not more. This panel also continued on the theme of decreased time-to-market with participants highlighting the need for the PPP to operate at the speed of business. Regarding the model structure itself, critiquing the components and their interactions proved elusive. Based on this panel session, the function and organization of a materials-focused PPP concept appears to be tightly linked to the material selected. Thus, the PPP concept should be designed further once desired materials are selected.

Panelist Remarks

This subsection of the report provides the key insights from each panelist's opening remarks during the moderated discussion—Stakeholder Perspectives: Clean Energy Materials Accelerator.

Dr. Penrose Albright
Director
Lawrence Livermore National Laboratory

There are two important considerations that the leadership team designing this PPP concept should make–political design and the linkage of advanced materials and manufacturing. In order to attract sustainable funding, the focus of the part-

nership needs to be in the purview of the government agency providing the funding. If the PPP activities are linked to the agency's activities and mission, the likelihood it will survive administration changes will increase. Moreover, as the PPP concept requires substantial public funding, EERE needs to make the justification to Congress that this is the best use of the public funding. This gets at an important issue in the current public policy debate—the perception, right or wrong, that these types of partnerships are picking economic winners and losers. Policy support for PPPs in the last couple of years has been mixed. If the political design of the PPP is correct from the beginning, the chances of getting Congressional support increases.

As I mentioned, the second consideration is understanding that materials cannot be separated from manufacturing. Manipulating the properties of a material—either electrical or mechanical—occurs at the grain boundary or microscopic level. The manufacturing process can change the creation of grain boundaries and conversely, changing grain boundaries can affect the manufacturing process. Thus, how this partnership will link with other manufacturing focused initiatives—even the other PPP concept, Facilitating the Transition of Prototypes to Commercially Deployable Products—is something that should be considered by this AEMC Partnership.

Mr. David Kenney
President
Oregon BEST

Many truly disruptive technologies and innovations come from SMEs and the start-up community. Small companies and start-up companies tend to be local—at least in the beginning. They are able to access the local university, local Angel investor networks and the local entrepreneur services such as mentorship and business support. Companies need to grow to a certain size before being able to engage networks and resources at the national level. In comparison, corporations like General Electric can engage in activities on a national scale. It is not clear in the proposed PPP concept how this national scale concept allows for—or encourages—geographically distributed companies to access and benefit from the Clean Energy Materials Accelerator.

Dr. Penrose Albright, Director, Lawrence Livermore National Laboratory.

A core challenge of any PPP concept targeting early markets is finding common areas of interest where—in this case—there can be shared standards development and shared research. There is a natural evolution where issues become more common in an industry, and finding technology platforms or challenges of shared interest becomes easier, and the discussion of standards for materials could be part of that discussion. The semiconductor industry is a perfect example of this. In a developing industry or sector, however, each technological advancement has the potential to be competitively differentiating—making it difficult to know what is strategically acceptable to share. I can see a role for an organization founded on this PPP concept, especially if these two issues are addressed.

Dr. Penrose Albright, Director, Lawrence Livermore National Laboratory; Mr. David Kenney, President, Oregon BEST; and Dr. Amy Linsebigler, Technology Leader, Materials Characterization & Chemical Sensing, Chemistry & Chemical Engineering Domain, and Business Program Manager for Morpho Detection, Inc., GE Global Research.

Dr. Ajay Malshe, Founder, Executive Vice President and Chief Technology Officer, NanoMech, Inc.

Dr. Amy L. Linsebigler
Technology Leader
Materials Characterization & Chemical Sensing, Chemistry & Chemical Engineering Domain, and Business Program Manager for Morpho Detection, Inc.
GE Global Research

Materials characterization is the key. It is the piece that relates the material, the micro-and macro-structures, to the properties of that material—the behavior, the performance, and the manufacturing properties. Once a material has been characterized, this information can be loaded into modeling and simulation tools that can predict the behavior of that material for future projects.

GE Global Research has tens of millions of dollars invested in capital equipment to perform materials characterization. In addition, GE Global Research also works in more than 30 one-on-one collaborations with academia and national laboratories to gain access to tools that our researchers need, but are not able to bring in-house. Furthermore, the test procedures and tools to better understand many promising new materials do not yet exist. Thus, we also form partnerships with outside laboratories to help discover new characterization methods.

Another topic I would like to address that other dialogue participants have mentioned is concerns around IP protection. One way that GE minimizes IP issues is to have the outside researchers working on GE projects develop new characterization methods on materials that are similar to, but not the same proprietary materials on which that new technique will eventually be applied. While it may not be the best solution for every instance, there are methods to work with these outside organizations without fear of losing IP rights.

Dr. Ajay Malshe
Founder, Executive Vice President, and Chief Technology Officer
NanoMech, Inc.

The PPP concepts presented today should embody "value engineering." Value is created through people, processes, and products. Innovative thinking occurs when people's minds and hands work synchronously. In manufacturing, people work

using both their minds and hands—this is how truly innovative individuals apply the best processes and products. Once you have these types of people together, they must have incredible infrastructure to work with. Lastly, people should work in an environment that encourages out-of-the-box thinking to bring out the best in their work.

It is also important for the PPP concept to balance curiosity driven ideas with a pull from the marketplace for specific technologies or materials. The former is very important, but an idea must also deliver value. The PPP that includes the right balance of big ideas and a market-pull will be successful and increase U.S. competitiveness.

This PPP should be designed to act quickly. As a small company, NanoMech does not have time to spare when working in the space of disruptive innovations. In nanomanufacturing, a technology must make it from a laboratory table to factory floor in a few months. One of the ways this could be achieved is by using a components-off-the-shelf (COTS) strategy, where existing units are repurposed for a new activity. For example, NanoMech's patented lubrication technology is built using a platform that once manufactured chocolate products. Performing manufacturing scale-up is not always about inventing a $1 billion machine for every new technology that is developed. Using a COTS strategy, when possible, is critical to accelerate ideas to market.

Open Discussion

Following the opening remarks, Mr. Cotton moderated an open discussion around the presented PPP concept addressing the questions and collecting feedback from dialogue participants.

Do the barriers enumerated in this model accurately reflect the challenges facing your organization? Please make suggested additions or subtractions as you see fit.

The group acknowledged the three listed barriers—technical risk, innovation infrastructure, and imperfect information—as a foundational justification for a materials-focused PPP. However, there was a sense among the participants that it is difficult to discuss in detail the barriers to the deployment of a particular material without first identifying that material.

> *"The question that keeps coming up is what role [is large industry] going to play in this. I really think it depends on what the focus area ends up being—each focus area is going to have a unique risk-reward calculation."*
>
> **AEMC Partnership Dialogue Participant**

Without knowing which specific material, the quote suggests, it is difficult for companies to gauge the value of participating in the Clean Energy Materials Accelerator.

How would the activities proposed in this PPP help your organization overcome the barriers listed? If the activities do not, how would you change these activities?

The PPP concept is designed to be a flexible and open platform that accommodates a wide range of activities capable of driving the development and deployment of advanced materials. With this in mind, participants emphasized the importance of two particular activities. This first links back to Dr. Albright's opening remarks regarding the connection between manufacturing and materials. In practice, materials innovation includes both characterization tools as well as manufacturing tools. The PPP concept, according to the group, should recognize this relationship.

The other recommendation—something that has been discussed in detail at the second AEMC Partnership dialogue in Toledo, OH and the third AEMC Partnership dialogue in Niskayuna, NY—is using the PPP to create streamlined processes and procedures for companies to access tools in national or university laboratories. For example, to avoid re-litigating IP agreements for each and every industry-laboratory partnership, the PPP could focus on creating standard agreements and contracts that only need minor modification for subsequent projects.

What level of resources is needed to ensure the success of these activities as presented?

Throughout the day, dialogue participants referenced—directly or indirectly—the current federal budget environment of fiscal austerity and a Congress that is wary of government influence in the marketplace. Within this context, participants discussed the value of starting small—a PPP that fits within EERE's existing authority, uses relatively low levels of capital, and fills critical gaps in both the innovation pipeline and DOE's project portfolio.

> *"We live in a constrained environment and we need to align [the PPP] with those funding constraints so we have a reasonable opportunity to be successful, because this is the only thing that will bring continued efforts and expenditures."*
>
> **Mr. Arthur L. "Chip" Cotton**
> Program Manager, Energy R&D, GE Global Research and National Operations Co-Lead, GE Veterans Network

Having early success—enabled by a small scale launch—would lay the groundwork for bigger investments and greater impact in the future.

Considerable attention was also given to aligning the Clean Energy Materials Accelerator with complementary federal initiatives. The scope in a number of existing PPPs such as the Next Generation Power Electronics National Manufacturing Innovation Institute could be targeted with a Small Business Innovation Research (SBIR) proposal, the group explained. Another recommendation from participants was to create focused SBIR solicitations to complement the funding and work of the PPP.

Participants also suggested that the PPP concept should be designed to leverage third party capital, including state and local funding sources as well as venture capital. There have been examples of PPPs explored in the 2013 AEMC Partnership dialogue series that require an applicant to the PPP (or an applicant to an RFP issued within the PPP) to obtain third party funding as a prerequisite to receive an award. Not only does this method increase the resource pool, participants suggested, it builds due diligence into the structure of the PPP by requiring other investors to evaluate and support the proposal.

What is the value proposition to your organization? Does the list of value propositions provided reflect your perspective?

The dialogue participants validated the value propositions presented in the PPP concept with particular attention paid to its potential to reduce risk. Risk is both a barrier and a motivation to participating in technology development consortia. Pursuing market opportunities or new products and processes independently allows a company to maintain control of the outcomes, as much as this is possible, and does not expose their intellectual property. When working in a consortium, a certain amount of control is given up and IP becomes less secure. However, financial and technical risks in investing one company's resources into a project that may not reach fruition drives cooperation.

> *"Despite being a large corporation with a lot of revenue, high levels of risk will often require [GE] to seek additional tools and resources that we can leverage—whether it's experts, other laboratories, or hard dollars—to reduce risk for a project to low enough levels to justify pursuing this path. Our level of risk tolerance may be different than other companies, but the same kind of discussion occurs in all businesses."*
>
> **Mr. Arthur L. "Chip" Cotton**
> Program Manager, Energy R&D, GE Global Research, and National Operations Co-Lead, GE Veterans Network

How would you change, if at all, the organization structure of the proposed model?

The PPP concept was proposed in a way that members of the PPP would be able to identify the high-priority materials and actionable development challenges associated. While this design stemmed from recommendations generated in previous AEMC Partnership dialogues to ensure the PPP is industry-driven, it proved difficult to critique the inner workings of a PPP concept without first understanding the material or challenges around which stakeholders would gather.

> *"The key thing is to get people excited about a challenge and working on that—taking it out of the abstract into a very specific thing to focus on."*
>
> **Mr. David Kenney**
> President, Oregon BEST

Regardless of the selected materials, participants focused on two additional modifications to the PPP concept. The first was speed—a common thread throughout the afternoon session. A dialogue participant shared that six months may pass from the time an SBIR grant RFP is released until the time the resources are awarded. This is much longer than most small companies can tolerate.

> *"Speed absolutely kills. It will kill your competitors if you're on the right side of it, and you are in deep dark danger if you're on the wrong side of it."*
>
> **Mr. Arthur L. "Chip" Cotton**
> Program Manager, Energy R&D, GE Global Research and National Operations Co-Lead, GE Veterans Network

Mr. Arthur L. "Chip" Cotton, Program Manager, Energy R&D, GE Global Research and National Operations Co-Lead, GE Veterans Network.

The desigers of the PPP should recongize this latency, according to participants, and strive for an organizational structure—like the structure of DARPA or ARPA-E—that can significantly increase the speed in which resources reach awardees.

The discussion around decreasing the time to award resources to organizations led some dialogue participants—typically SMEs or representatives of SMEs—to suggest the PPP concept as presented may favor large companies. Though certainly an important consideration for all businesses, a lack of speed is more tolerable for companies with more resources. Furthermore, there may be little incentive for the large companies producing incumbent materials, likely to participate as PPP founding partners, to include small companies in this PPP as they could be potential competitors. One suggestion to reduce this possibility made by the group is to incentivize the

inclusion of smaller companies and request Original Equipment Manufacturers (OEMs) bring companies in their supply chains into the partnership.

What are some specific materials or materials applications that need accelerating, and what are the specific challenges in those topic?

While there was limited discussion on specific material classes or applications for this PPP concept to target, there was a robust dialogue on the importance of working on issues with a strong market-pull.

Broadly stating that the PPP needs to target material classes with a market-pull is clumsy language, according to some participants. More market-pull is not always better when designing PPPs. If there is a strong market-pull, companies would accomplish the work themselves, and there is no proper role for public funding. Thus, it is a question of balance—balancing the evolutionary with revolutionary innovations within the PPP concept. One suggestion to provide this balance is to segment the activities of the PPP.

> *"Some prototypes are component parts that go into larger materials that already have a demand in place. On the other hand, there are prototypes that are freestanding technologies with little or no market-pull."*
>
> **Ms. Alecia Ward**
> Leader, Program and Business Development, Environmental Energy Technology Division, Lawrence Berkeley National Laboratory

The PPP could include activities that are close to market and clearly address the needs of industry and provide a quantifiable value proposition to industry. Simultaneously, the PPP could focus on revolutionary technologies without clear markets where government support can clearly be justified. In both cases, risk for loss of intellectual property and eventually manufacturing ecosystem to regions with lower manufacturing costs, the participants stressed, would need to be addressed.

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 4

The Path Forward

Clean energy companies face growing challenges in commercializing their technologies. From raising the vast capital needed to scale-up their technologies to facing a lack of access to expertise, bridging the scale-up valley of death is becoming increasingly difficult in the United States. Similarly, significant barriers exist in this country to deploying newly developed materials in commercial markets. Recognizing the need to overcome these barriers, the Council, EERE and dialogue participants have converged on two PPP concepts that have the potential to make a significant impact on U.S. clean energy and manufacturing competitiveness.

At the upcoming inaugural American Energy & Manufacturing Competitiveness Summit in Washington, D.C. on December 12, 2013, the Council will formally recommend—based on the input received from AEMC Partnership Dialogue 4—one or more PPP concepts to the Department of Energy that will drive the twin goals of the AEMC Partnership.

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Council on Competitiveness

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HOW WE OPERATE

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

The Council achieves its mission by:

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

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