American Energy & Manufacturing Competitiveness Partnership

Bridge.

Dialogue 2

Compete.

Council on Competitiveness

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Dialogue 2
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AEMC PARTNERSHIP DIALOGUE 2

Letter from the President

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

The April 11-12, 2013, inaugural dialogue in Washington, D.C. set the trajectory for Dialogue 2 at The University of Toledo—an institution at the center of a materials-enabled, regional, clean-energy manufacturing transformation driven by public-private collaboration. The Council, EERE and The University of Toledo designed Dialogue 2 to tap into the experiences of the leaders at the center of this transformation. These leaders, along with other key stakeholders from industry, academia and the national laboratory system, began to develop and hone ideas from the inaugural dialogue into potential public-private partnership concepts capable of driving the goals of the AEMC Partnership.

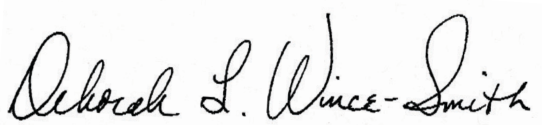
I extend a special thanks to my partner, the Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, as well as the entire EERE team for all their hard work and significant, thoughtful contributions to this dialogue and the larger AEMC Partnership. Also, this event would not have been possible without the thought leadership and hospitality of Dr. Lloyd A. Jacobs, President of The University of Toledo and member of the Council.

Bridge is divided into two sections. The first is a primer developed in advance of the AEMC Partnership Dialogue 2 to prepare participants with a review of the AEMC Partnership goals and objectives, a summary of the inaugural dialogue, and a technical and strategic explanation of the topics chosen for the Toledo dialogue. Section two provides a summary, synthesis and distillation of the proceedings of the June 20, 2013, dialogue held at the Driscoll Alumni Center on the campus of The University of Toledo.

As envisioned in the design of the AEMC Partnership dialogue series, the outcomes of this conversation will drive the structure and content of the upcoming third and fourth AEMC Partnership dialogues in Niskayuna, New York on August 13, 2013 and Santa Clara, California on October 17, 2013. These dialogues will culminate in the inaugural American Energy & Manufacturing Competitiveness Summit in Washington, D.C. on December 12, 2013. This first-of-its-kind summit will highlight the barriers and challenges to a more competitive U.S. clean energy manufacturing sector uncovered during the 2013 dialogue series as well as the opportunities—or leverage points—around which public-private collaboration can have the greatest impact on national prosperity.

Solutions to clean energy manufacturing challenges cannot be effectively developed or put in place 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 2

Participants

CO-HOSTS

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

Dr. Lloyd A. Jacobs
President
The University of Toledo

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

PARTICIPANTS

Dr. Sam Anand
Co-Director, Center for Global Design and Manufacturing
University of Cincinnati

Mr. Jeffrey M. Brancato
Vice President of Strategic Initiatives
NorTech

Dr. Frank Calzonetti
Vice President -Government Relations
The University of Toledo

Mr. Norm Chagnon
Staff Director
Third Frontier Commission

Mr. Michael J. Cicak
Chief Executive Officer
Willard & Kelsey Solar Group

Dr. Alvin Compaan
President and CTO
Lucintech, Inc.

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

Ms. Judith M. Cowan
President
Ohio Energy & Advanced Manufacturing Center, Inc.

Mr. Chad Evans
Executive Vice President
Council on Competitiveness

Mr. Peter Finamore
Manager of Product Sustainability and Energy Technology
John Deere

Mr. Craig Giffi
Vice Chairman
Deloitte LLP

Mr. Stephen Hatkevich
Director—Research and Development
American Trim LLC

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

Dr. Rob Ivester
Director, Advanced Manufacturing Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Dr. Jay Kim
Director, School of Dynamic SystemsUniversity of Cincinnati

Dr. Sridhar Kota
Former Assistant Director for Advanced Manufacturing at the White House Office of Science and Technology Policy
-and-
Professor
University of Michigan

Dr. Jih-Fen Lei
Director
Research and Technology Directorate
NASA John H. Glenn Research Center

Dr. Peter B. Littlewood
Associate Director for Physical Sciences and Engineering
Argonne National Laboratory

Mr. John Mizroch
Senior Fellow
Council on Competitiveness

Mr. Joe Needham
Director, Corporate Business Development and Public Policy
The Andersons, Inc.

Mr. Michael Peck
Chairman
Isofoton North America

Ms. Jean Redfield
President & CEO
NextEnergy

Mr. Ralph Resnick
Founding Director
NAMII
-and-
President and Executive Director
NCDMM

Mr. Patrick Valente
Executive Director
Ohio Fuel Cell Coalition

Dr. David Wagner
Vehicle Engineer Technical Leader
Ford Motor Company

Dr. Lorry Wagner
President
Lake Erie Energy Development
Corporation (LEEDCo)

Ms. Elizabeth “Libby” Wayman
Director
Clean Energy Manufacturing Initiative
Office of Energy Efficiency and
Renewable Energy
U.S. Department of Energy

Ms. Jetta Wong
Deputy Director
Clean Energy Manufacturing Initiative
Office of Energy Efficiency and
Renewable Energy
U.S. Department of Energy

Dr. Phillip C. Yu
Director, Corporate Science &
Technology
PPG Industries, Inc.

KEY PARTNERS

Ms. Diane M. Miller
Assistant Vice President - Federal
Relations
The University of Toledo

Ms. Margaret Anna Traband
Office of Government Relations Grant
Director, NSF-Partnership for Innovation

COUNCIL STAFF

Mr. Michael Bush
Policy Director
Council on Competitiveness

Mr. Zachary Schafer
Senior Policy Director
Council on Competitiveness

AEMC PARTNERSHIP DIALOGUE 2

Agenda
June 20, 2013

MORNING

8:30 Opening Remarks for the American Energy & Manufacturing Competitiveness Partnership Dialogue 2

Dr. Lloyd A. Jacobs
President, The University of Toledo

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

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

9:00 Briefing on AEMC Partnership Goals and Objectives

Ms. Jetta Wong
Deputy Director
Clean Energy Manufacturing Initiative
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Mr. Chad Evans
Executive Vice President
Council on Competitiveness

9:30 Evolution of an Industry: Glass in the Midwest

Building from a strong foundation in glass products, manufacturers and entrepreneurs in the Midwest glass industry—centered in Toledo, OH - have successfully reoriented their vision and capital assets to higher valued-added sectors such a solar power. This is an example from which stakeholders can learn as we develop strategies to transition the United States into a new era of clean energy manufacturing.

Moderator

Dr. Frank Calzonetti
Vice President—Government Relations
The University of Toledo

Kick-Off Discussants

Dr. Alvin Compaan
President and CTO
Lucintech, Inc.

Mr. Michael J. Cicak
CEO and Chairman of the Board
Willard & Kelsey Solar Group

Key Questions

1. What can we learn and replicate from the experience of Toledo's glass manufacturing sector to support the transition of existing national and regional assets into the next level of value-added, high-tech manufacturing?
2. How much did the existing materials (e.g. glass) manufacturing infrastructure in Toledo impact the changing manufacturing sector?
3. What past experience would guide you in creating a new PPP (success factors, pitfalls, etc.) intended to help achieve the goals of the AEMC Partnership? How do we integrate OEMs and SMEs into this process?
4. How important is it to manufacturers in your sector to locate near customers, suppliers, and/or innovators?

10:30 Break

11:00 Cross-cutting Materials: The Nexus of Renewable Energy Products and Energy Productivity

Advanced materials—such as intermetallic alloys, polymers, fiber-based materials, and composites—can at once be a high value-added product, a renewable material, and capable of increasing energy productivity. Moreover, the industrial applications of advanced materials are practically boundless, creating outsized benefits to the U.S. manufacturing sector from manageable resource inputs.

Moderator

Dr. Phillip C. Yu
Director, Corporate Science & Technology
PPG Industries, Inc.

Kick-Off Discussants

Dr. Peter Littlewood
Associate Laboratory Director for Physical Sciences and Engineering
Argonne National Laboratory

Dr. David Wagner
Vehicle Engineering Technical Leader
Ford Motor Company

Key Questions

1. How can advanced materials drive innovation across numerous manufacturing sectors?
2. What improvements or investments—particularly around materials—has your organization made that increased energy productivity and, in turn, provided competitive advantage?
3. Are there materials, technologies, or a mission (standards, demonstration, etc.) in which the nation should invest to create sustainable competitive advantage in clean energy manufacturing?
4. What focus of PPPs (standards development, demonstration, etc.) can best create this sustainable competitive advantage?

AFTERNOON

12:00 Setting the Stage: An Overview of Public-Private Partnership Models

Mr. Chad Evans
Executive Vice President
Council on Competitiveness

12:10 Working Lunch

In addition to defining the goals and objectives around the broader mission of clean energy manufacturing competitiveness, the lunch conversation aims to tap into the deep experiential knowledge of private and public sector leaders to inform the creation of a public-private partnership capable of achieving these goals. In particular, this session is intended to begin the process of narrowing the field of public-private partnership models that are optimal to promote the broader goals of the AEMC Partnership.

Three working groups have been developed around public-private partnership models the Council has suggested in the report titled *The Power of Partnerships*: Mature Market, Innovation Network, and Test Bed Demonstration.

Working Group 1: Innovation Networks
Location: The Board Room, Suite 2026

Moderator

Mr. Chad Evans
Executive Vice President
Council on Competitiveness

Kick-Off Discussant

Dr. Norm Chagnon
Staff Director
Third Frontier Commission

Working Group Participants

Mr. Peter Finamore
Manager, Product Sustainability & Energy Technology
Deere & Company

Mr. John Mizroch
Senior Fellow
Council on Competitiveness

Mr. Dan Radomski
Vice President, Industry & Venture Development
NextEnergy

Mr. Michael Peck
Chairman
Isofoton North America
Ohio Fuel Cell Coalition

Mr. Craig Giffi
Vice Chairman
Deloitte LLP

Mr. Jeffery M. Brancato
Vice President of Strategic Initiatives
NorTech

Dr. Jay Kim
Director, School of Dynamic Systems
University of Cincinnati

Innovation Networks Working Group Scribe
Ms. Rosa Zartman
Student
The University of Toledo

Working Group 1 Key Questions:

1. How can this partnership model facilitate the scaling of technologies from prototypes to mass-manufactured products in the United States?
2. What are some ways this model could catalyze information exchanges to promote knowledge spillover (e.g. a research personnel exchange program)?
3. What is the most effective way to stand up this type of partnership model? How can we take advantage of existing PPPs to bring them into the network? How can we identify new nodes for exchange?
4. How do decentralized stakeholders leverage the network as a whole to maximize its assets?
5. How should the financing model be organized? Does this change over time?

Working Group 2: Mature-Market PPPs
Location: The Conference Room, Suite 2024D

Moderator

Mr. Michael Bush
Policy Director
Council on Competitiveness

Kick-Off Discussant

Dr. Frank Calzonetti
Vice President-Government Relations
The University of Toledo

Working Group Participants

Mr. Ralph Resnick
NAMII
Founding Director

Dr. Alvin Compaan
President and CTO
Lucintech, Inc.

Mr. Stephen Hatkevich
Director—Research and Development
American Trim LLC

Ms. Judith M. Cowan
President
Ohio Energy & Advanced Manufacturing Center, Inc.

Mr. Rodney Heiple
Director of Business Solutions
Alcoa, Inc.

Dr. Phillip C. Yu
Director, Corporate Science & Technology
PPG Industries, Inc.

Mr. Michael J. Cicak
CEO and Chairman of the Board
Willard & Kelsey Solar Group

Mr. Rob Ivester
Acting Director, Advanced Manufacturing Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Mature Markets Working Group Scribe

Mr. Brad Guthrie
Student
The University of Toledo

Working Group 2 Key Questions

1. How can this PPP model overcome the barriers to the scaling of technologies from prototypes to mass-manufactured products in the United States?
2. How can this PPP model be organized to catalyze knowledge spillover (e.g. a research personnel exchange program)?
3. Using the PVIC model as an example, in what ways does this IP regime satisfy the needs and promote the inclusion of relevant stakeholders?
4. Given the lag time due to infrastructure and relationship building, what is the appropriate mix of income streams to provide short-term stability and long-term sustainability?
5. What leadership model best ensures long-term commitment to the goals of the AEMC Partnership?

Working Group 3: Test Bed/Demonstration Location: The Schmakel Room, Suite 2000

Moderator

Ms. Jetta Wong
Deputy Director
Clean Energy Manufacturing Initiative
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Kickoff Discussant

Ms. Jean Redfield
President & CEO
NextEnergy

Working Group Participants

Dr. Peter Littlewood
Associate Laboratory Director for Physical Sciences and Engineering
Argonne National Laboratory

Mr. Arthur “Chip” Cotton
Program Manager, Energy R&D
GE Global Research
-and-
National Operations Co-Lead
GE Veterans Network
General Electric

Dr. David Wagner
Vehicle Engineer Technical Leader
Ford Motor Company

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Dr. Lorry Wagner
President
Lake Erie Energy Development Corporation (LEEDCo)

Dr. Jih-Fen Lei
Director of Research and Technology Directorate
NASA

Dr. Sam Anand
Co-Director, Center for Global Design and Manufacturing
University of Cincinnati

Dr. Sridhar Kota
Former Assistant Director for Advanced Manufacturing at the White House Office of Science and Technology Policy
-and-
Professor
University of Michigan

Test Bed/Demonstration Working Group Scribe:

Ms. Kelly Marbaugh
Student
The University of Toledo

Working Group 3 Key Questions:

1. How can this partnership model facilitate the scaling of technologies from prototypes to mass-manufactured products in the United States?
2. What are some ways this model could catalyze information exchanges to promote knowledge spillover (e.g. a research personnel exchange program)?
3. Given that one of the greatest hurdles to this model is its significant up-front costs, what organizational and funding structures can best stand-up this approach?
4. In what ways can this model leverage its role as a nexus for regional OEMs and SMEs across industries and sectors to maximize its impact?

1:30 Highlights from Working Lunch Discussions

Moderator

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

1:45 R&D and Manufacturing Linkages: Attacking the Problem of Scaling

There are numerous challenges—both technical and financial—to overcome when translating new technologies into mass production. Industry leaders in the manufacturing-heavy Midwest have experience in successfully overcoming these obstacles. This panel will explore best-practices when linking R&D and manufacturing to drive innovation.

Moderator

Mr. Peter Finamore
Manager, Product Sustainability & Energy Technology
Deere & Company

Kick-Off Discussants

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

Mr. Michael Peck
Chairman
Isofoton North America

Key Questions

1. How does linking R&D teams and manufacturing teams accelerate innovation? Please provide examples.
2. Is there a difference if the link between manufacturing and R&D is physical (co-located) or remote, but in the same company?
3. How can technologists and researchers—in both private and public laboratories—be encouraged to include manufacturing design implications from the earliest stages of technology development?
4. What types of public-private partnership can support or create this dynamic?

2:45 Break

3:15 Measuring the Success of the AEMC Partnership

A key insight that came out of the research for *The Power of Partnerships*—the literature review in preparation for the AEMC Partnership—was the importance of success metrics and measurements systems for a public-private partnership. However, few PPPs actually have these systems in place, preventing a thorough and accurate understanding of what drives success in public-private partnerships.

Moderator

Mr. Ralph Resnick
Founding Director
NAMII
-and-
President and Executive Director
NCDMM

Kick-Off Discussants

Mr. Jeffery M. Brancato
Vice President of Strategic Initiatives
NorTech

Mr. Patrick Valente
Executive Director
Ohio Fuel Cell Coalition

Key Questions

1. How should success in PPPs that meet the goals of the AEMC Partnership be measured? What are the critical leading and lagging indicators of success (i.e. job creation, spinoffs, exports, tax revenue, productivity, etc.)?
2. Who should perform the evaluation?
3. Are there examples of successful measurement models that could be applied to the AEMC Partnership?

3:45 Stakeholder Perspectives on the Day

The session is intended to capture stakeholder insights in an effort to shape the AEMC Partnership's agenda on issues particular to developing clean energy and energy efficient products and/or energy productivity in the manufacturing process, and on the development of at least one PPP concept.

Moderator

Dr. Sridhar Kota
Former Assistant Director for Advanced Manufacturing at the White House Office of Science and Technology Policy
-and-
Professor, Mechanical Engineering
University of Michigan

Kick-Off Discussants

Mr. Craig Giffi
Vice Chairman
Deloitte LLP

Dr. Judith Cowan
President
Ohio Energy & Advanced Manufacturing Center

Key Questions

1. What technology, material, or mission is your organization willing to invest in to co-create?
2. What are the critical areas within the materials supply chain that—if targeted for investment—have the potential to create an outsized impact on U.S. manufacturing competitiveness?
3. What is the best level of involvement of federal/state/local governments, academia/national laboratories and industry?
4. What are the benefits of different leadership roles (industry, university/national laboratories, government, and non-profits)?

4:45 Closing Remarks for the American Energy & Manufacturing Competitiveness Partnership Dialogue 2

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

Dr. Lloyd A. Jacobs
President
The University of Toledo

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

5:15 Dialogue Concludes

PART 1
AEMC Partnership Dialogue 2 Primer
Driving Regional Transformation

PART 1: AEMC PARTNERSHIP DIALOGUE 2 PRIMER

Introduction

On June 20, 2013, the Council on Competitiveness (Council) and the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy (EERE) will hold the second in a series of important leadership dialogues on the campus of The University of Toledo (UT). The dialogues are being held across the country as part of the American Energy and Manufacturing Competitiveness (AEMC) Partnership—a three-year effort to bring together national leaders to address a rapidly shifting national and global energy landscape. The second dialogue continues the conversation started during the foundational Inaugural AEMC Partnership Dialogue in Washington, D.C., on April 11-12, 2013.

The Council and EERE have partnered with UT for the AEMC Dialogue 2 due to critical lessons being learned from the materials and silicon-based industries in Northwest Ohio, which have historically played an important role in the region's glass-making industry. Today, these lessons are informing the acceleration of Toledo's evolution from the "glass city" to a thriving cluster of solar energy research and manufacturing.

AEMC Partnership Dialogue 2 will bring together leaders from industry, academia, labor, the national laboratories, government and the non-profit community. The Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, will lead the discussion, alongside the Honorable Deborah L. Wince-Smith, Council President & CEO, and Dr. Lloyd Jacobs, UT President, Council member, and dialogue host.

The AEMC Partnership will convene two additional regional dialogues this year—the next of which will take place in August, 2013 at the GE Global Research Center in Niskayuna, NY, and a fourth dialogue in October, 2013 at Applied Materials, Inc. in Santa Clara, California. The four AEMC Partnership dialogues in 2013 with culminate in a major, annual, Washington D.C.-based, energy and manufacturing summit in December 2013.

PART 1: AEMC PARTNERSHIP DIALOGUE 2 PRIMER

The American Energy and Manufacturing Competitiveness (AEMC) Partnership

The AEMC Partnership is a three-year effort by the Council and EERE to bring together national leaders to address a rapidly shifting national and global energy landscape. In a series of progressive dialogues over Spring-Fall 2013, participants are uncovering 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 the EERE's Clean Energy Manufacturing Initiative (http://www1.eere.energy.gov/energymanufacturing/index.html), a strategic integration and commitment of manufacturing efforts focusing on American competitiveness in clean energy manufacturing. The goals of the AEMC Partnership are to:

Increase U.S. competitiveness in the production of clean energy products: Strategically investing in technologies that leverage American competitive advantages and overcome competitive disadvantages.

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 create a platform for the generation and potential deployment of public-private partnerships (PPP) to advance the AEMC Partnership goals.

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

AEMC Partnership: Phase One—Mapping the Landscape

To cultivate topics for the progressive dialogue series, and provide a foundation the larger goals of the AEMC Partnership, the Council performed an extensive literature review and "mapping" of 184 past and current research efforts across the United States and internationally on three topics:

- Linkages between energy efficiency (EE) efforts of manufacturers, renewable energy (RE) efforts and manufacturing competitiveness;
- Energy-related barriers to manufacturing competitiveness as they relate to energy; 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.

The literature review is documented in the Council publication *The Power of Partnerships*, and its companion piece, *A Summary of Public-Private Partnerships*. (Both of these documents are available at http://www.compete.org/about-us/initiatives/aemcp/). These reports provide the foundation for this effort and address the following questions.

- What prevents the United States from leading in the manufacturing of clean energy and energy efficient products, as well as 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.

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

AEMC Partnership: Phase Two—Inaugural Dialogue and Beyond

The Council and EERE initiated Phase Two of the AEMC Partnership with an inaugural dialogue in Washington, D.C. on April 11-12, 2013. This phase includes a total of four progressive dialogues in 2013 generating new insights pertaining to the overall goals of the AEMC Partnership—as well as informing the creation of a public-private partnership to further advance the initiative's goals. The inaugural dialogue laid out the objectives of the AEMC Partnership and began examining a range of PPPs. The second dialogue hosted continues the discussions sparked during the inaugural dialogue—including the examination of a regional experience in scaling expertise in materials science and technology into advanced manufacturing. At the third dialogue on August 13, 2013 hosted by Dr. Mark Little, Senior Vice President and Chief Technology Officer of General Electric and Director of GE Global Research at the GE Global Research Center in Niskayuna, NY, will continue the process of homing in on potential PPP concepts with a focus on specific technology areas and barriers/opportunities for their deployment and scaling in the United States. A fourth dialogue in Santa Clara, California hosted by Mr. Michael Splinter, Executive Chairman of the Board, Applied Materials, Inc. on October 17, 2013, focusing squarely on designing the attributes of a clean energy manufacturing public-private partnership that may be presented and announced at the first, annual American Energy and Manufacturing Competitiveness Summit on December 12, 2013 in Washington, D.C. Future dialogues to vet and evaluate proposed PPP models, and to elaborate upon success metrics will continue this conversation in 2014 and 2015—along with future, annual AEMC Summits.

PART 1: AEMC PARTNERSHIP DIALOGUE 2 PRIMER

Summary of the AEMC Partnership Inaugural Dialogue

The inaugural dialogue convened and engaged more than 100 senior leaders from industry, government, academia, labor and the national laboratory system. Co-hosted by Ms. Wince-Smith and Dr. Danielson, the dialogue laid the foundation for future discussions by gathering input on fields in the clean energy manufacturing sector that could enhance U.S. competitiveness by creating a public-private partnership and discussing the benefits and detriments of different methods in structuring a public-private partnership.

Participants in the inaugural dialogue included: Mr. Jason Miller, Special Assistant to the President for Manufacturing Policy, National Economic Council; Dr. Pradeep Khosla, Chancellor, University of California-San Diego; Dr. Dan Arvizu, Director, National Renewable Energy Laboratory, and Chairman, National Science Board; Dr. Thomas Mason, Director, Oak Ridge National Laboratory; Mr. Sean McGarvey, President, Building and Construction Trades Department of AFL-CIO; Dr. Om Nalamasu, Chief Technology Officer, Applied Materials, Inc.; Dr. J. Michael McQuade, Senior Vice President for Science and Technology, United Technologies Corporation; and, Dr. Montgomery Alger, Senior Vice President, Research and Development, Myriant Corporation.

An important function of the inaugural dialogue was to identify, understand and discuss the opportunities around clean energy manufacturing. Much of this exploration was intended to highlight the convergence of market forces, public interest and private sector strategies around clean energy manufacturing.

In her opening remarks, Ms. Wince-Smith noted:

> *"Half of the new electricity-generating capacity installed to meet the growing global energy demand during the next 25 years is expected to come from clean energy. Furthermore, businesses, governments, and communities are embracing energy saving behaviors and technologies. These market and political forces are converging to create the national will to invest in developing, manufacturing, and deploying clean energy technologies, as well as ensuring that all industrial sectors of our economy are using energy efficiently to, in turn, drive industrial productivity."*

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

Her quotation conveys the sense of urgency at the dialogue and around the country as to the importance of having a clean energy manufacturing strategy. 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 models that would best use these leverage points and launch the United States ahead of international competitors.

The exceptional cross-section of industry, academic, labor, national laboratory and public sector leaders in attendance produced a robust discourse. Some key insights regarding potential leverage points and public-private partnership models 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;
- Diffusing tools including modeling and simulation, robotics, automation, sensor technologies and additive manufacturing into the manufacturing sector; and
- Leveraging "big data."

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

Insights on Public-Private Partnership Models

- Designing the project with input from all stakeholders and with the outcome in mind greatly increases the likelihood of success;
- Shouldering the indirect cost of research facilities and equipment is a barrier to industry participation in a PPP;
- Facilitating the progress and success of a PPP is contingent on strong and singular leadership; and
- Creating a boundary of trust through intellectual property agreements is essential to create an environment attractive for broad stakeholder participation.

PART 1: AEMC PARTNERSHIP DIALOGUE 2 PRIMER

Materials: Foundations for the Clean Energy Economy

While participants presented several ideas during the inaugural dialogue, the technology platform of materials science and engineering surfaced as a strong field of interest across multiple stakeholders primarily because of the relevance of advanced materials to both, overarching goals of the AEMC Partnership. A recent report funded by the DOE's Advanced Manufacturing Office makes a similar case:

> *"…the nations that assume leadership in producing materials for this next era of human progress—the Clean Energy Age—will have access to unprecedented opportunities for economic development by unleashing manufacturing innovations and efficiencies that are limited by current materials capabilities."* [1]

The crosscutting nature of materials through all technologies is reflected in the research and development (R&D) portfolio of EERE. In fact, all EERE Technology Offices currently make investments in materials technologies. The Next Generation Materials program, an R&D portfolio within the Advanced Manufacturing Office, also contributes to the Materials Genome Initiative,[2] a federal interagency program supporting integrated materials computational engineering (a tool to speed the materials development cycle).

Advanced materials can drive significant enhancements in energy products including more efficient solar cells; larger, lighter and stronger wind turbines; and longer-range car batteries. Moreover, material technologies have the ability to increase the competitiveness of all manufacturing sectors, for example through broadly applicable advances in heat recovery processes, lubricants that reduce wear and tear on process equipment, and shaping processes that reduce material waste. As such, materials science and engineering have the potential to be a major vehicle for meeting the goals of the AEMC Partnership.

The AEMC Partnership is interested in exploring how to leverage investments in materials science and engineering being made at universities, national laboratories and businesses across the country. One of the common themes of the Inaugural AEMC Partnership Dialogue was the idea of "aligning vectors" to promote U.S. competitiveness. Each effort of organizations affecting materials science and engineering can be considered a "vector," and these could be aligned to increase U.S. competitiveness in the production of clean energy products and increase U.S. manufacturing competitiveness across the board by increasing energy productivity. Public-private partnerships can play important roles in this process for maximum market impact.

UT is a natural platform for the second dialogue of the AEMC Partnership given its role in the transformation of much of Ohio's industrial base into high-tech, high value-added manufacturing. This type of evolution is an example of what the AEMC Partnership hopes to achieve on a national scale. This follow-on dialogue will build off the momentum from the first, foundational conversation of the inaugural dialogue—to move decisively and strategically to create the conditions for a better, more competitive America.

PART 1: AEMC PARTNERSHIP DIALOGUE 2 PRIMER

Spotlight

Photo Source: General Electric

Composites for Wind Energy

Advanced composites have the potential to reduce the cost of wind power and drive down the production cost of wind turbines. According to a 2008 Department of Energy study, the potential energy captured by a wind turbine—rotor power—grows with the square of the diameter of the turbine blades.[3] However, increasing the size of the blades increases the production cost as well as imposing a weight penalty on energy efficiency. Layered composite materials offer significant performance increases for both blades and tower structures,[4] increasing efficiency and reducing costs—potentially providing a competitive advantage for manufacturers adopting this technology.

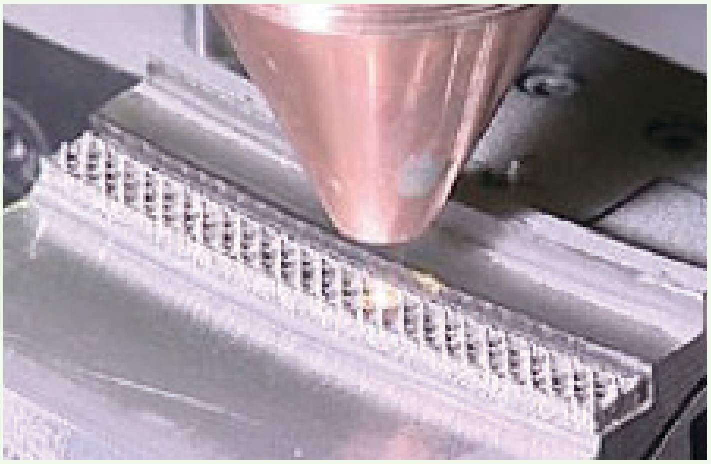

Photo Source: Rolls Royce

Net-Shape Processing

Producing a component as close as possible to its final shape—often combining energy-intensive processing steps—can reduce material waste and often eliminate the need for costly secondary processing and finish machining. Net-shape processing, any manufacturing method that applies this methodology, offers an avenue for tremendous energy savings across a wide swath of the industrial sector.[5]

Photo Source: Ford Motor Company

Thermoelectric Materials

Manufacturers can apply thermoelectric materials to multiple technology platforms and thereby convert waste heat into useful electricity to conserve energy—reducing the need for more power generation. According to research funded through the U.S. Department of Energy's Vehicle Technology Program, approximately 40 percent of an automobile's energy is lost to waste heat in the exhaust gas.[6] Thermoelectric materials can convert energy lost through exhaust gas into useful energy for such functions as lights, pumps, etc.—reducing overall energy use and improving vehicle fuel economy.

PART 1: AEMC PARTNERSHIP DIALOGUE 2 PRIMER

Toledo: Transforming the Glass City into a Solar Energy Cluster

A global leader in glass throughout the 20th century, with thriving industrial laboratories connected to university research capabilities in glass technology, Northwestern Ohio endured a period of time where it lost its manufacturing competitive advantage.[7] This is a familiar story in the industrial Midwest. However, by forming public-private partnerships in the late 1980s and mid-2000s, stakeholders from the private sector, Ohio's universities, and local government have successfully leveraged the region's deep manufacturing history and the technical expertise embodied in both The University of Toledo and local businesses to make the region a global competitor in the energy space. This Dialogue 2 primer highlights two public-private partnerships pivotal to the emergence of Toledo's solar energy cluster.

Observers can trace the vision of Toledo and the local region as a world-leader in solar energy back to Toledo entrepreneurs Mr. Harold A. McMaster and Mr. Norman Nitschke, along with their business partner, Mr. Frank Larimer. A business leader and inventor with more than 30 years of experience in automotive, architectural and other glass products, Mr. McMaster formed Glasstech Solar, Inc. in 1984. Glasstech Solar, Inc. was a spinoff from the parent company Glasstech Inc., a leader in the manufacturing of furnaces for tempered glass Mr. McMaster co-founded with Mr. Nitschke.[8] Glasstech Solar, Inc. initially worked on thin-film solar technology at its Wheatridge Colorado location. In 1987, however, Glasstech Solar, Inc. funded and built the $13.5 million solar cells production plant, Solar Cells, Inc., located on the UT campus in Toledo, Ohio.[9]

As Mr. McMaster and Mr. Nitschke advanced their technology, they sought the assistance of UT to address processing issues in thin film solar development. Driven by university researcher Dr. Alvin Compaan, UT secured two State of Ohio grants that brought sophisticated thin-film deposition systems to the region—systems that Solar Cells, Inc. leveraged. Due in part to this public-private collaboration, Solar Cells, Inc. became a global leader in thin film solar technology, winning additional grants with Dr. Compaan from the Department of Energy. In 1996, Mr. Michael Cicak took over the role of President of Solar Cells, Inc. The company was eventually acquired by True North Partners, LLC in 1999 and renamed First Solar, Inc.[10]

In the era of fierce global competition, accelerated product cycles and constantly shifting competitive advantage, looking for external sources of innovation can become a mandate for some firms and some industries. Mr. McMaster, Mr. Nitschke and Dr. Compaan understood this reality and engaged in a public-private partnership that began the evolution of Toledo's manufacturing base centered around glass to one focused on solar energy.

A more recent and formal public-private partnership is the university-driven Center for Photovoltaics, Innovation, and Commercialization (PVIC) created at UT in 2007. PVIC launched with a $18.6 million grant from Ohio Department of Development's Third Frontier Project, and $30 million in matching contributions from federal agencies, universities and industrial partners.[11] The PVIC has its origins in a strategic analysis performed in 2001 by UT that identified thin-film materials as a premier area of research with the university.[12] The PVIC, in a sense, is the codified and institutionalized version of the partnership between Mr. McMaster, Mr. Nitschke and Dr. Compaan that, today, is carrying on the work these three visionaries began. More broadly, PVIC's role in driving the regional transformation displayed

by Solar Cells, Inc. and UT suggests the value of public-private partnerships.

Side-by-side with industrial partners, PVIC addresses numerous aspects of thin-film photovoltaic research including improvements to materials and technologies, and ways to lower production costs and improve the efficiency of solar technologies.[13] Though the solar power sector is on shaky footing the United States, PVIC has achieved success in its mission of accelerating the photovoltaic industry. At the present time, PVIC has generated 130 new jobs statewide with an average salary of $71,473 and is directly responsible for the establishment of two new companies and the relocation of three other businesses into Northwestern Ohio. Moreover, six new patents are currently pending.[14]

The Council and EERE have partnered with UT for this second dialogue to tap into the experiences of the people at the center of this evolution and to capture insights that will inform the mission, goals and organization of the AEMC Partnership. The collaboration between Solar Cells, UT and PVIC is an example of the power of partnerships to drive regional transformation. These collaborations are also models that the AEMC Partnership was built to explore and, to some degree, emulate to realize a new era of sustainable and clean energy manufacturing. Lastly, the Toledo narrative highlights the ability of advanced materials to act as a technology platform to advance multiple industrial sectors—as glass has done across the automotive, architectural, and now solar sectors in Toledo.

Solar Cluster Success Factors[15, 16, 17, 18, 19, 20]

- Deep history in the research, development and production of glass.
- Active support of local congressional representative.
- Involvement of exceptional entrepreneurs (industry leadership).
- Local center of knowledge and talent creation (The University of Toledo).
- Solar Cluster is vertically integrated.
- Expertise gained through a long history of university-industry partnership related to automotive sectors eased the launch of PVIC.
- Commodities-based nature of Northwestern Ohio's automotive parts supply chain created an environment of collaboration.

TRANSFORMING THE GLASS CITY INTO THE SOLAR CITY
Toledo's Tradition of Innovation and Entrepreneurship Continues

1880

1887

✷ Edward Libbey visits Toledo and decides to move his glass company here. He is attracted to Toledo because of its:

- Major transportation hub and access to the west
- Aggressive local business community
- Available gas supplies
- High-quality sand

1903

✷ Michael J. Owens invents the automatic bottle-making machines. It proves to be the most significant development in glass making since the invention of the blowpipe around 50 B.C. The machine produces a phenomenal 13,000 bottles a day, compared to the 600 a day that could be produced by a skilled glassblower. Today's machines can produce more than 1 million bottles in a day.

1940s

✷ Harold A. McMaster and Norman Nitschke, both inventors and entrepreneurs, begin their careers in glass. At Libbey Owens Ford, McMaster is hired as the first research physicist in the company working with Nitschke. McMaster departs in 1948 to form a new company, Permaglass, to work on various molded and treated glass. He later forms Glasstech in 1971 and works on the glass tempering processes (80 percent of the world's automotive glass and 50 percent of its architectural glass is manufactured using machines developed by the work at Glasstech).

1984–1990

✷ Nitschke and McMaster form Glasstech Solar to start working on amorphous silicon thin-film solar cells. In 1987, they form Solar Cells Inc. and locate the plant on UT's campus. They stop work on amorphous silicon and focus on cadmium telluride thin films.

✷ Arizona investors, True North Partners, jointly venture with Solar Cells to form First Solar in 1999, and McMaster forms a new company, McMaster Energy Enterprises in 2001 (at age 84), using machines developed by the work at Glasstech.

1987

✷ Dr. Al Compaan, a scientist, is hired and helps McMaster and Nitschke develop thin-film PV technology.

2001

✷ UT identifies renewable energy as an area of strategic research focus and dedicates new faculty positions, including an endowed chair position (now occupied by Professor Robert Collins) in this area.

"Our plan is to develop Northwest Ohio into a nationally recognized center for alternative energy technologies in which the knowledge from our universities is transformed locally into innovations and wealth creation."

PFI proposal, May 2, 2002

2003

✷ UT receives PFI grant from the National Science Foundation, which formalizes northwest Ohio's solar energy cluster through the funding of the Northwest Ohio Partnership on Alternative Energy Systems with Dr. Frank Calzonetti as the PI, including a plan to establish the UT Clean and Alternative Energy Incubator.

Source: The University of Toledo, "Transforming the Glass City into the Solar City: Toledo's Tradition of Innovation and Entrepreneurship Continues," Poster. June 2013.

"This center will work to overcome barriers to the commercialization of solar energy technology, and includes support to advance public support and understanding of solar energy technology options."

Dr. Robert Collins, PI, NEG Endowed Chair and Professor, 2006

2006

✷ UT opens its Clean and Alternative Energy Incubator. Companies who will graduate from the incubator in following years include: Xunlight (MWOE), Calyxo (Solar Fields), Advanced Distributed Generation, and Innovative Thin Films.

✷ Founded at UT in 2006, Wright Center for Photovoltaics Innovation and Commercialization (PVIC) is supported by a $18.6 million Third Frontier Grant with The University of Toledo serving as lead institution and working with The Ohio State University and Bowling Green State University.

2007

✷ UT is involved in two of the 11 projects nationwide to receive U.S. Department of Energy Solar Energy America awards.

✷ UT is selected to host the University Clean Energy Alliance of Ohio at its Clean and Alternative Energy Incubator.

2008

✷ UT receives $8.5 million from the Ohio Research Scholars Program designated as endowed chairs. The Harold and Helen McMaster Foundation awards UT with $2 million for a new endowed chair as part of the match for this state award.

✷ With the assistance of Representative Marcy Kaptur, the NASA Solar Cell Testing Facility is established at UT in August. The facility provides testing and certification of solar cells and solar cell materials.

✷ The University of Toledo, following the invitation of the National Science Foundation, sponsors an NSF Partnership for Innovation Conference in Arlington, VA, to showcase best practices in creating innovation partnerships.

2009

✷ The Ohio Board of Regents announces that UT's Center of Excellence in Advanced Renewable Energy and the Environment is an OBOR Center of Excellence.

✷ UT's School of Solar and Advanced Renewable Energy is established. Building on UT's strengths in solar energy, fuel cells, biomass, electricity management energy storage and wind research, this new school provides national leadership in education and research in solar and other forms of advanced renewable energy.

✷ The UT Scott Park Campus of Energy and Innovation is dedicated in September, featuring an 8-acre solar field installed by a Clean and Alternative Energy Incubator client, ADG; a massive wind turbine installed by incubation client EPS; alternative and sustainable energy demonstration sites; and plans for an accelerator, which will assist companies that have graduated from the incubator.

2010

✷ UT begins accepting students for its new Professional Masters in Photovoltaics.

✷ UT Vice President of Research, Dr. Frank Calzonetti, testifies at the White House Clean Energy Manufacturing Forum.

2012

✷ ISOFOTON announces R&D and economic development partnership with The University of Toledo and the opening of a new factory in Northwest Ohio

✷ UT is awarded the NSF SEP: Earth-Abundant Solar Cells As A Sustainable Energy Pathway grant for nearly $2 million.

2020

PART 1: AEMC PARTNERSHIP DIALOGUE 2 PRIMER

Exploring Innovation Network PPPs, Mature Market PPPs and Test Bed/ Demonstration PPPs

The Toledo narrative provides three pillars to the framework for the second dialogue of the AEMC Partnership:

- The crosscutting nature of advanced materials—in this case, advanced glass—and their abilities to act as foundational technologies for multiple industrial sectors;
- The power of public-private partnerships to drive regional change; and
- A platform for the deep analysis of potential PPP models for the AEMC Partnership.

The third pillar—a thorough analysis of potential PPP models—is the focus of the working lunch at the AEMC Partnership Dialogue 2.

Two PPPs instrumental to Toledo's transformation from the Glass City to a robust solar energy cluster—Ohio Third Frontier and PVIC—fit into two PPP models defined by the Council in *The Power of Partnerships*: the Ohio Third Frontier project falls under the Innovation Network model characterization and PVIC the Mature Market model:

- **Innovation Network PPPs** are generally national or international networks of applied research and demonstration organizations, often focused on a particular technology or set of technologies at each node in the network. The network nodes sometimes are linked by a broad theme.
- **Mature Market PPPs** seek to advance the objectives of more mature industries. These PPPs tend to be industry-led and focus on pre-competitive research, cooperative research on advanced manufacturing technologies, or standards. The technologies addressed by these PPPs can be early-stage or more mature, but there are enough mature companies in the market that the private sector engages heavily in the leadership.

In addition to exploring these model types, the working lunch will include an analysis of the Test Bed / Demonstration model using the Detroit-based PPP, NextEnergy.

- **Test Bed / Demonstration PPPs:** Although the other PPP models in this study may include testing and demonstration components, the Test Bed / Demonstration PPPs have testing and demonstration as their primary function. These PPPs often work to establish the market for emerging technologies and are local by nature, even if their user community is national or global in scope.

Of the many insights generated from the inaugural dialogue and the subsequent content analysis of this two-day conversation, a notable conclusion was the diminishing relevance of the Early Market PPP model to the goals of the AEMC Partnership. Simply stated, the AEMC Partnership is squarely aimed at making a positive impact in the marketplace. While Early Market PPPs are valuable to the creation of knowledge that informs the development of disruptive technologies, the AEMC Partnership is targeting activities closer to commercialization in the technology development cycle. As such, the working lunch will focus on the Innovation Network, Mature Market and Test Bed/Demonstration Facility PPPs.

Regardless of the model type chosen, there are common themes that have emerged as being essential elements of the PPP independent of the model type. Two such elements from the Inaugural AEMC Partnership Dialogue include:

- Scaling the production of prototype technologies to mass-manufactured products in the United States, and
- Personnel exchange/employee turnover as a central vehicle for knowledge transfer

The importance of scaling production in the United States and the barriers to achieving scale will be further explored in the dialogue panel session "R&D and Manufacturing: Attacking the Problem of Scaling" and is discussed in more detail in the subsequent section of this primer.

The concept and mechanism of information exchange is an important facet of any public-private partnership. Innovation scholars have identified the most common form of knowledge spillover occurs with the movement of workers between complementary firms.[28] In recognition of this avenue for information exchange, another PPP examined in *The Power of Partnerships*, the Industrial Technology Research Institute (ITRI), instituted a built-in quota for annual employee turnover to promote the diffusion of public and private co-development knowledge into the external market, in addition to helping ensure innovation does not stagnate within the Institute.[29]

Another example of knowledge transfer is the Los Alamos National Laboratory (LANL) Industrial Fellows Program created in 1995. This program assigns LANL staff members to a partnering company to help solve unique technical problems on a one or two-year term basis. The companies benefit from the exposure to new technologies, joint product development ventures and access to world-class R&D facilities. Likewise, LANL has the opportunity to gain assistance from private industry in solving unusual applied research problems, commercialize Los Alamos technologies and understand industry best practices.[30]

These two aspects—scaling production in the United States and knowledge transfer through personnel exchange—are encouraged to be woven through each of the working group conversations. These elements show promise for inclusion into any PPP model recommendation.

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Spotlight

Ohio Third Frontier

Created in 2002 within the Ohio Development Services Agency, the Ohio Third Frontier (OTF) is a $2.3 billion internationally recognized technology-based economic development initiative. An example of an Innovation Network public-private partnership, the OTF provides funding through 13 different program areas to Ohio technology-based companies, universities, non-profit research institutions and other organizations to create new technology-based products, companies, industries and jobs.[21]

A particular program area of interest to the AEMC Partnership is the Technology Commercialization Center (TCC) Program, which is designed to support accelerated commercialization of technologies and capitalization and expansion of Ohio companies in existing core technology focus areas.[22] This program is the successor to OTF's 2003 Wright Centers of Innovation program that launched The University of Toledo Wright Center for Photovoltaics, Innovation, and Commercialization (PVIC). The TCC program embodies a decade of experience in launching public-private partnerships aimed at bringing technologies to market in Ohio's technology-based industrial sectors. This experience is codified in the guidelines set forth in the 2013-2014 TCC Request for Programs. These guidelines represent factors that drive success in public-private partnerships, including:

- 2:1 Cash Cost Share requirement (no in-kind contributions) with at least half the cost share from industry and private investment capital;
- Center must build on already world-renowned work in Ohio and show clear path to manufacturing, production and distribution in Ohio within 2-6 years;
- Focuses only on late-stage emerging technologies; and
- Business-driven in the authority over direction, resource allocation, and project and technology investments.

Wright Center for Photovoltaics Innovation and Commercialization

An example of a Mature Market public-private partnership, the Wright Center for Photovoltaics Innovation and Commercialization (PVIC) is a collaborative thin-film photovoltaic directed-basic research, applied research, development and commercialization center. Working side-by-side at The University of Toledo Research Technology Complex, university and private sector researchers address numerous aspects of photovoltaic research, including improvements to materials and technology, and ways to lower production costs and improve the efficiency of thin-film solar technologies.[23] Members include three large research universities (The University of Toledo, Ohio State University and Bowling Green State University) and large and small firms from across the thin-film solar supply chain—

including PPG Industries Inc. and the Willard & Kelsey Solar Group.[24] The Center has two broad membership levels—Industry Member and Research Partner—that vary based on company size, type and location. Three prevalent project models are offered for partner organizations:[25]

- **University Research**—Intellectual Property (IP) owned by universities and accessible partners
- **Collaborative Research**—Joint ownership of IP
- **Service Research**—IP owned by industry

The PVIC, established in 2007 with an $18.6 million award from the State of Ohio's Third Frontier program, intends to secure self-sustaining funding by the end of the grant (which occurred in late 2012). The Third Frontier grant required funding to be matched—which PVIC was able to secure through $30 million from federal agencies and universities and industrial partners.[26]

NextEnergy[27]

An example of a Test Bed / Demonstration public-private partnership, NextEnergy's mission is to accelerate energy security, economic competitiveness and environmental responsibility through the growth of advanced energy technologies, businesses and industries. In order to accomplish this mission, NextEnergy provides its partners with services such as demonstration and commercialization strategies for newly-developed technologies, market analysis, venture development and program management in the areas of vehicle electrification, energy efficiency and advanced grid technologies.

NextEnergy also provides an authoritative voice in the public sector by partnering with local government, the State of Michigan and federal agencies to design future energy strategies, advise on funding priorities, and administer and evaluate programs. NextEnergy also develops curriculum and workforce development programs.

A nonprofit organization, NextEnergy was established in 2002 through a grant from the State of Michigan and the Michigan Economic Development Corporation. This PPP continues to receive an annual appropriation from the State as well as additional funding streams from federal grants, philanthropic donors and industry fee-for-service.

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Reconnecting R&D and Production to Promote Domestic Manufacturing and Innovation

In the context of R&D and manufacturing, "scale" is the process of expanding production beyond a pilot facility or process into mass-manufacturing. Scale, however, can also be thought of as the ability for the United States to capture value from the technologies that American scientists and engineers imagine, create and incubate inside industry, universities and government laboratories. Whichever country or region produces these new technologies—or applies them to an existing manufacturing process—benefits from the jobs created and increased economic activity that will result. Simply stated, America's ability to scale is directly linked to its ability to provide opportunities for Americans to prosper.

A perennial challenge of the science and technology community—dating back to the emergence of the U.S. innovation system after WWII—is that of technology commercialization. The innovation literature has coined the institutional and behavioral barriers between invention and a viable business as the valley of death. At the early stages of technology development, efficient markets do not exist for allocating risk capital. Early-stage technologies and new markets carry higher levels of risk and uncertainty, creating a market failure where the private sector foregoes investment.[31]

More recently, a second valley of death has emerged. Often referred to as the scale-up valley of death, it is made up of the challenges of growing to large scale a viable business built around innovations. In the past, vertically integrated firms housed basic and applied R&D as well as production within the same company. When innovation grew from the efforts of these large firms, they had the resources to scale the production of new technologies or processes.[32] The 1980's, however, witnessed the beginning of the transformation of the global industrial landscape—vertically integrated corporations off-loaded production processes to focus on their core competencies and shifted R&D to focus on the near-term needs of the business units.[33] This began the era of globally distributed manufacturing as well as a shift in the innovation landscape. Foundational technological breakthroughs in the United States are now more likely to come from universities, national laboratories and small start-up companies.[34] This broken linkage of R&D to manufacturing—a linkage that was once a mainstay of the U.S. industrial sector—has created the scale-up valley of death in the United States.

The desire to scale production in the United States comes from several fronts. Large multinationals will capture value regardless of where production is performed. The question that is increasingly asked is: how much? Recently history has highlighted the many ills of manufacturing abroad, such as quality control challenges, protection of intellectual property rights and high shipping and logistical costs[35]—not to mention rising labor costs. Each of these factors is chipping away at profits margins and the benefits of manufacturing offshore. Additionally, speed-to-market has become more important than any other time in history. With product development cycles accelerating and competitive advantages shifting overnight, the pace at which new technologies reach the market is more important than ever. In many cases co-locating manufacturing and R&D can accelerate the transition from laboratory to market.[36]

After the scale-up valley of death, another challenge resulting from the separation of the R&D and manufacturing is the potential impact on innovation. The value of the proximity and linkage of manufacturing to research, development and deployment (RD&D) is still largely unanswered. However, many scholars and business leaders suspect that the severe loss of manufacturing over the last 10 years is a serious threat to America's innovative capacity.[37]

Can Public-Private Partnerships Address Scale-up?

Recent research is beginning to highlight the possibility that a region's ability to support businesses that successfully scale depends on complementary capabilities and assets (including financial) available in-house or within a regional industrial ecosystem. Since the decline of patient, vertically integrated firms conducting extensive fundamental research, these capabilities are rarely found "in-house" in multinational corporations. These capabilities could be provided by a region's complementary resources and assets—i.e. the industrial commons.

Early evidence has revealed that public-private partnerships—and the industrial commons that they create—are a differentiating factor between places where many firms start-up but fail to scale, such as the United States, and places where scale-up occurs, such as Germany.[38] As described in the Report of the MIT Taskforce on Innovation and Production, "It's impossible to understand the different fates of manufacturing in the U.S. and Germany without comparing the density and richness of the resources available in the industrial ecosystem across much of Germany to the thin and shrinking resources available to U.S. manufacturers across much of our country."[34] A differentiating resource in the German system—at least relative to the United States—are the Fraunhofer Institutes (a network of 80 research units and 60 institutes that partner with industry to provide a wide variety of services for businesses of all sizes with a particular emphasis on small and medium-sized enterprises [SMEs] that do not maintain their own R&D departments). German firms able to tap into the Fraunhofer network—among other publicly-supported shared assets—often find themselves competitively positioned against U.S. and other global manufacturers.

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Metrics: Measuring the Success of Public-Private Partnerships

With the understanding that PPPs can promote a rich industrial ecosystem—understanding what PPP models are most effective and best suited to achieve the goals of the AEMC Partnership is essential. Success metrics are critical to this process.

The Power of Partnerships reveals that PPPs lack quantitative success metrics and qualitative success factors are not well understood across the public-private partnership landscape. This is a challenge the AEMC Partnership must address and, as such, will be a common thread throughout the AEMC Partnership Dialogue 2 at The University of Toledo and the entire series of dialogues. Without knowing if a PPP is succeeding, it will be hard to improve it, extend the contract, etc.

Today's need to measure success and provide accountability for government investments in science and technology is not only a mandate driven by fiscal austerity, but also a necessity in the U.S. innovation-driven economy. This is especially true for PPPs since they are a tool in the effort to bridge the gap between funded research and commercial markets.

After proving their worth in both World War II and the Cold War, public investments in R&D became practically unimpeachable. However, the current U.S. budget debates have shifted the attitude of policymakers and the general public regarding federal science and technology investments—what was once at times either an era of excitement or agnosticism is now one of skepticism.[35]

Constrained budgets are not the only driving force behind the call for better metrics. Economic competitiveness and, in turn, national prosperity in the United States are more dependent than ever on the ability to leverage the scientific and technological advancements achieved in public and private sector laboratories across the country. Rising worker compensation—a positive development—and other wealthy nation developments have made it difficult for American business to compete in any other way.

Success Metrics: *The Power of Partnerships* Insight

Each PPP stakeholder will measure success differently—metrics tend to be aligned with the origination's mission. Economic development agencies, such as Ohio Third Frontier, measure economic impact as:[36]

- Direct and indirect job creation;
- New companies established; and
- Follow-on investments.

Higher education institutions, such as The University of Toledo, will align success metrics with the mission of education and knowledge creation, such as:[37]

- Publications;
- Citations;
- Presentations;
- Invention Disclosures;
- Patent Applications;
- Start-ups; and
- Proposals Funded.

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Key Questions for AEMC Partnership Dialogue 2

How can advanced materials drive innovation across numerous manufacturing sectors?

What can we learn and replicate from the experience of Toledo's glass manufacturing sector to support the transition of existing national and regional assets into the next level of value-added, high-tech manufacturing?

How can public-private partnerships facilitate the scaling of technologies from prototypes to mass-manufactured products in the United States?

What are some ways PPPs could catalyze information exchanges to promote knowledge spillover (e.g. a research personnel exchange program)?

How does linking R&D teams and manufacturing teams accelerate innovation?

How can technologists and researchers—in both private and public laboratories—be encouraged to include manufacturing design implications from the earliest stages of technology development?

How should the success of PPPs created to meet the goals of the AEMC Partnership be measured? What are the critical leading and lagging indicators of success (i.e. job creation, spinoffs, exports, tax revenue, productivity, etc.)?

What are the critical areas within the materials supply chain that—if targeted for investment—have the potential to create an outsized impact on U.S. manufacturing competitiveness?

What is the best level of involvement of federal/state/local governments, academia, national laboratories and industry?

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Looking Forward

The outpouring of support for the Inaugural AEMC Partnership Dialogue and the deep engagement and enthusiasm displayed during this national conversation validates the premise of the AEMC Partnership—leveraging the benefits of energy efficiency and the U.S. position as world leaders in clean energy innovation is essential to revitalizing the U.S. industrial base, which remains a core driver of U.S. competitiveness and prosperity,

The Inaugural Dialogue, though largely foundational, began the processes of narrowing the field of clean energy manufacturing to a subset of platforms that have the potential to advance the goals of the AEMC Partnership. Private and public sector leaders highlighted at the Inaugural Dialogue the unique ability of materials science and engineering to act as renewable energy product as well as drive energy efficiency across a multitude of industrial sectors.

The AEMC Partnership follows this trajectory to The University of Toledo—an institution at the center of a materials-enabled regional manufacturing transformation driven by public-private collaboration. Using the development of Toledo's solar energy cluster as case study to inform the AEMC Partnership, AEMC Partnership Dialogue 2 will continue the search for 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 models that would best use these leverage points and launch the United States ahead of international competitors.

End Notes

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PART 2
Findings from AEMC Partnership Dialogue 2

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 2

Executive Summary

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.

The second dialogue of the AEMC Partnership dialogue convened 40 regional and national clean energy manufacturing stakeholders from industry, academia, the national laboratories and the public sector. The content development for this regionally-focused conversation follows 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 to have a stakeholder discussion targeted at the PPP models uncovered in *The Power of Partnerships* report that underpinned the AEMC Partnership's launch.

Though the fundamental goals of this regional conversation were similar to the inaugural dialogue—identify areas of innovation-driven strength for national investment in clean energy manufacturing and recommend PPP models 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 AEMC Partnership Dialogue 3. This strategy was reflected in the smaller size of the dialogue, which created an action-oriented atmosphere, as well as the make-up of the assembled group. Participants were selected based on their expertise and experience in manufacturing and public-private partnerships.

Participants suggested 17 distinct PPP concepts at AEMC Partnership Dialogue 2. Five of the 17 public-private partnership ideas received strong support from participants at the second AEMC Partnership dialogue:

- Development of a fellowship program promoting personnel exchange between innovation institutions;
- Design, qualification and certification of advanced materials;
- Rapid prototyping and demonstration of new technologies using modeling and simulation and high performance computing tools;
- Built-out of a virtual platform where companies could submit industrial innovations and see crowd-sourced funding; and
- Creation of a virtual portal that allows industry and research institutions to match real-world problems and challenges with tools and solutions.

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

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

The selection of a horizontal or a vertical model will have significant implications for a clean energy manufacturing public-private partnership. While both types of models have the ability to drive the goals of the AEMC Partnership, the partnerships themselves will be different in terms of scale, scope and sustainability. As such, the benefits and shortcomings of each type of model type, as they relate to 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 in *The Power of Partnerships* to facilitate this dialogue series.[1] While these models were tremendously valuable as a platform to launch a national discourse, dialogue participants begin quickly to mold and hone these models into PPP 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 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;
  - local talent pool; and
  - a focus on first-to-market differentiated technologies;
- Quantified four barriers to increasing the use of advanced materials in mass manufacturing: cost of raw materials, processing speed, joining dissimilar materials, and qualification and characterization;
- Identified institutional, practical and administrative barriers to bridging the gap between businesses and external sources of innovation (e.g. university or national laboratories);

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

- Developed a set principles intended to guide the process of selecting a target area for a clean energy manufacturing public-private partnership: utilize strategic market analysis, validate the market analysis with competitive processes (such as the presence of venture capital), select challenges that one company cannot solve on its own, avoid working against global market forces; and
- Proposed moving beyond conventional funding models, potentially leveraging the philanthropic community and crowd-sourcing to broaden the base of available risk capital.

This second dialogue 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 the AEMC Partnership Dialogue 3.

Summary of PPP Concepts from the 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 platform 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 A virtual platform where companies can submit industrial innovations and seek crowd-source funding	Research, development and demonstration facility: Information Technology Enabled Smart Manufacturing Increase interaction between business and national laboratories by having each side commit to increasing the number of collaborative agreements and enacting reforms to facilitate industry-laboratory collaborations, 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

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 2

Evolution of an Industry: Glass in the Midwest

Session Summary

Toledo was able to evolve from a center of global excellence in the glass industry—which it still is—into a solar energy cluster. This experience set the stage for a discussion on how a region can leverage the expertise and assets of a well-developed, existing industry to create new opportunities. This opening panel discussed the success factors and essential inputs that facilitated the evolution of Toledo and, more broadly, Northwest (NW) Ohio. As such, the following questions were posed to the moderator, kick-off discussants and participants.

- What can we learn and replicate from the experience of Toledo's glass manufacturing sector to support the transition of existing national and regional assets into the next level of value-added, high-tech manufacturing?
- How much did the existing materials (e.g. glass) manufacturing infrastructure in Toledo impact the changing manufacturing sector?
- What past experience would guide you in creating a new PPP (success factors, pitfalls, etc.) intended to help achieve the goals of the AEMC Partnership? How do we integrate original equipment manufacturers (OEMs) and small and medium enterprises (SMEs) into this process?
- How important is it to manufacturers in your sector to locate near customers, suppliers and/or innovators?

Mr. Peter Finamore, Manager of Product Sustainability and Energy Technology, John Deere; and Dr. Frank Calzonetti, Vice President of Government Relations, The University of Toledo.

With a mindset of understanding practices or policies that can be applied to future PPPs, numerous success factors and enabling inputs were identified during this discussion. These included:

- Establishing the importance of industry leadership from an established manufacturing base;
- Leveraging shared infrastructure;
- Securing patient, diverse and consistent funding;
- Complementing the partnership with policy tools;
- Providing in-kind equipment contributions;
- Accounting for talent spillover; and
- Focusing on first-to-market differentiated technologies.

While it is important not to over-generalize these success factors and critical inputs to other regions, technology areas and partnership types—there are wide-reaching implications for business leaders, academics and policy makers hoping to achieve results similar to the successes in Toledo and NW Ohio. In addition to exploring the development of Toledo's solar energy cluster, this session introduced a theme that would be pervasive throughout day: bridging the gap between actors in the innovation ecosystem.

The Honorable David T. Danielson, Assistant Secretary of Energy Efficiency and Renewable Energy, U.S. Department of Energy; Ms. Elizabeth "Libby" Wayman, Director–Clean Energy Manufacturing Initiative, U.S. Department of Energy; and Dr. Alvin Compaan, President and CEO, Lucintech, Inc.

Framing Remarks

Moderator
Dr. Frank Calzonetti
Vice President
Government Relations
The University of Toledo

Building off of the industrial commons established by companies such as Libby Owens Ford, Owens Illinois, Owens Corning, Glass Tech and Libby Corporation– technical entrepreneurs working in northwest Ohio glass companies in the 1970's and 1980's saw opportunities in solar power. After working on thin film photovoltaic technologies, these entrepreneurs, particularly Mr. McMaster and Mr. Nitschke through their firm Glasstech Solar, Inc. (GSI), reached out to The University of Toledo, the local business community and the local government to develop a new industry in Toledo–they cultivated a public-private partnership.

Drawing from its history of supporting the glass industry beginning in the 1950's, The University of Toledo stepped up to support Mr. McMaster and Mr. Nitschke and hired faculty with the necessary expertise–namely Dr. Compaan–as well as provided laboratory space for GSI. Dr. Compaan begin writing grants that brought in funding from the State of Ohio and the Department of Energy to begin the co-development and commercialization of thin film photovoltaic technologies.

Toledo had the know-how in manufacturing and materials research, deep connections to the entire supply chain, the commitment of The University of Toledo, seasoned patent attorneys familiar with industry-university partnerships (from previous support of the glass industry) and support from the State of Ohio–as well as the federal government–to develop this solar energy cluster based upon the strength of the incumbent glass industry. Moreover, it was an industry-driven public-private partnership that aligned each one these resources to drive the formation of the solar energy cluster in Toledo.

Mr. Michael J. Cicak, CEO, Willard & Kelsey Solar Group; Ms. Lisa Camp, Associate Dean, Strategic Initiatives, Case School of Engineering, Case Western Reserve University; and Mr. Rodney Heiple, Director of Business Technology, Alcoa, Inc.

Kick-Off Discussant
Dr. Alvin Compaan
President and CTO
Lucintech, Inc.

What happened at The University of Toledo—and broader communities of Toledo and Northwest Ohio—was an organic development. The industrialists—Mr. McMaster and Mr. Nitschke as well as Mr. Michael Cicak, President of Solar Cells, Inc.—provided the vision for a new market for glass. It should also be noted that the region recognized the societal and environmental importance of the photovoltaics. The State of Ohio provided an additional role beyond funding. In the 1980s the State challenged universities to build expertise in selected departments including physics and astronomy. The University of Toledo leveraged this program to hire the necessary faculty and begin building institutional capacity in thin film solar technologies. It was mentioned previously that funding from the State of Ohio and the Department of Energy were major milestones. Also very important, however, is the consistency of public and private support—both strategically and financially—from regional and national stakeholders over the last two or more decades. Additionally the diversity of funding sources is essential to ensuring funding continuity. The Toledo solar energy cluster benefited from both consistent and diverse support.

Another success factor was in-kind contributions. Owen Illinois donated the chamber that created the first solar cell at The University of Toledo. The University has also successfully leveraged equipment from the RCA Corporation. Though not necessarily a success factor as much as understanding how cluster development functions in practice, the Toledo solar energy cluster also provides an example of a collaborative approach to clean energy human resource development. Of the last thirteen faculty members hired at The University of Toledo, two have been recruited from industry. Moreover, eight students—typically masters or Ph.D. students—have recently gone on to work at First Solar, a leading global provider of PV solar energy solutions. This public-private interaction is very important in terms of cluster development.

Dr. Lorry Wagner, President, Lake Erie Energy Development Corporation; the Honorable Deborah L. Wince- Smith, President & CEO, Council on Competitiveness; Dr. Lloyd A. Jacobs, President, The University of Toledo; the Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy; and Ms. Elizabeth "Libby" Wayman, Director–Clean Energy Manufacturing Initiative, U.S. Department of Energy

Kick-Off Discussant
Mr. Michael J. Cicak
CEO and Chairman of the Board
Willard & Kelsey Solar Group

The Toledo narrative also provides insights about what type of investments the AEMC Partnership and the nation should be making. Solar Cells, Inc.–which later become First Solar–strategically avoided the commoditized solar panels that are currently manufactured in China. The company began with amorphous silicon thin film technology, but landed on cadmium telluride panels. Toledo and the nation should continue to operate at the frontiers of both technology and products.

Currently, the Willard & Kelsey Solar Group is pushing the envelope on transparent thin film solar panels–having previously developed a 2'x4' panel, the goal is a 4'x8' panel. These panels, if used to glaze a building, could completely eliminate a building's electricity bill. Moreover, they are developing a streetlight that runs completely on solar power. Toledo spends 11 million dollars a year on electricity for streetlights and park lights. These panels can eliminate that–it can all be zero.

Open Discussion

Using the development of Toledo's solar cluster as a platform, the dialogue participants posed clarifying questions to the discussants and each other to tease out lessons from Toledo's experience. In particular, a common theme was the exploration of what anchored solar power equipment manufacturing in NW Ohio (i.e. what kept production from being pulled to other regions—namely, low-cost foreign producers). When Glasstech Solar, Inc.—a global leader in the manufacturing of glass tempering furnaces based on Perryville, OH—spun off Glasstech Solar, Inc. in 1984, the first work was performed in Wheatridge, Colorado. It did not take long, however, for Glasstech Solar, Inc. to relocate back to Ohio. In fact, Glasstech Solar, Inc., under the new name of Solar Cells, Inc., built a 100,000 sq. ft. plant on The University of Toledo campus in the late 1980s. This decision was driven by the human capital located in Toledo and NW Ohio. When Glasstech Solar, Inc. left for Colorado, they left behind the expertise in glass handling—heating, tempering, etc. As a result, Glasstech Solar, Inc. had problems with glass breaking before the end of the production line, because the Colorado team had expertise in amorphous silicon, but not in manufacturing the glass panels. Moreover, there was very little physical manufacturing infrastructure in

Colorado. Northwest Ohio had all these assets, both human and physical capital, which brought the panel manufacturing back to Toledo.

> *"In this area, Southeast Michigan and Northwest Ohio, there is know-how, an ability work with one's hands that exists almost nowhere else in the world...manufacturing is intrinsic in the people and culture here."*
>
> **Dr. Lloyd A. Jacobs**
> President, The University of Toledo

The conversation also returned to funding of the Toledo solar energy cluster. In addition to reiterating the importance of the diversity and consistency of funding sources—the group acknowledged that companies like Solar Cells, Inc. benefited from patient capital (i.e. funding from investors comfortable with longer timelines for expected returns) and subsequently bemoaned that present-day challenge of obtaining patient capital. The importance of integrating philanthropic sources of capital was commonly suggested as a way to increase the patience of capital.

With a mind toward integrating small and medium-sized businesses in an AEMC Partnership initiative, the question of whether or not Glasstech Solar, Inc. had a distinctive relationship with The University of Toledo was also introduced during this session. Did the leadership of Glasstech Solar, Inc. understand what they had as a resource (e.g. The University of Toledo)? The Toledo contingent confirmed that this was true; Glasstech Solar, Inc. was proactive in engaging The University of Toledo in what it does well—interacting with businesses once the connection has been made. However, more work needs to be done around making the initial connection between the university and businesses. Small businesses often lack the time to build relationships with universities or do not have the expertise to do so.

Lastly, the anecdotal experiences of several of the participants reveal that universities often find it difficult to transition from performing academic research to focusing on applied research and development for industry. Institutions such as The University of Toledo have held the latter perspective for several decades. However, many other universities struggle with acting at the speed of business. Specifically, building institutional capacity, such as facility recruitment and research infrastructure, to assist local businesses—small and large—often takes years to complete.

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 2

Cross-Cutting Materials: The Nexus of Renewable Energy Products and Energy Productivity

Session Summary

The content analysis of the Inaugural AEMC Partnership Dialogue revealed that multiple stakeholders began coalescing around materials science and engineering as a technology platform for a potential public-private partnership to drive the goals of the AEMC Partnership. This panel session was meant to further explore the potential of advanced materials to drive U.S. competitive advantage in clean energy manufacturing as well as identify technology challenges, barriers or leverage points that the efforts of the AEMC Partnership can target. To that end, the group was presented with the following guiding questions:

- How can advanced materials drive innovation across numerous manufacturing sectors?
- What improvements or investments—particularly around materials—has your organization made that increased energy productivity and, in turn, provided competitive advantage?
- Are there materials, technologies or a mission (standards, demonstration, etc.) in which the nation should invest to create sustainable competitive advantage in clean energy manufacturing?
- What focus of PPPs (standards development, demonstration, etc.) can best create this sustainable competitive advantage?

The moderator and discussants each provided compelling responses to these questions by drawing from their experiences within innovation-driven institutions leveraging advanced materials. Building on these opening remarks, the group identified the key barriers to the increased use of advanced materials in manufactured goods, yet understood that all innovation challenges are not appropriately overcome through the creation of a PPP. Based on participant responses, materials qualification and characterization seemed to present the best opportunity for multi-stakeholder collaboration.

Mr. Joe Needham, Director—Corporate Business Development and Public Policy, The Andersons, Inc.; and Dr. Phillip C. Yu, Director—Corporate Science & Technology, PPG Industries, Inc.

While the conversation remained grounded in advanced materials, the discussion built on the opening discussion to include general, technology-agnostic challenges of industry collaboration with both universities and national laboratories (i.e. bridging gaps between the actors in the innovation ecosystem). Considering the cross-section of representatives from global technology companies, SMEs, universities, and national laboratories, this session generated deep insights—inclusive of all innovation stakeholders—into the barriers hindering increased public-private connectivity as well a potential PPP concepts designed to overcome these barriers.

Framing Remarks

Moderator
Dr. Phillip C. Yu
Director, Corporate Science & Technology
PPG Industries, Inc.

Based in Pittsburgh, PA, PPG is a global company with 40,000 employees and sales in 2012 in excess of 15 billion dollars. The company has been around for 130 years and has a strong American presence with manufacturing plants in 24 states. Strategically, PPG is focused on coatings, glass, fiberglass, and optical and specialty materials. Thus, innovation in advanced materials plays a significant role in driving value for PPG and our customers.

Fifty percent of the energy used to manufacture an automobile goes into the paint process, from the protective layers for the structural metal to the decorative layers and the clear coat. PPG customers needed energy-saving solutions to stay competitive in the marketplace, which PPG was able to provide through the development of new coatings technology that reduced both energy consumption and CO_2 emissions for our customers by 30 percent. This is just one example among many that displays how advanced materials drive innovation, create competitive advantage and increase energy productivity.

Partnerships are also core to PPG's business model. Through an open innovation framework, PPG looks at both internal and external sources of knowledge to leverage for innovation and the commercialization of new products. PPG works with universities, the Department of Energy, the Department of Defense and the SBIR program to identify companies that have technologies which align with PPG's business needs. Not only does this model bring more ideas into PPG's innovation funnel, but it also shortens the product development cycle.

Kick-Off Discussant
Dr. Peter Littlewood
Associate Laboratory Director for Physical Sciences and Engineering
Argonne National Laboratory

It is important to understand the scale of the clean energy challenge. The United States uses, on average, three terawatts of power each day. Suppose 30 percent of this power came from the most efficient and commercially viable solar power technologies. To achieve the 30 percent mark, the United States would need to deploy 15,000 square kilometers of solar cells. That is an area of a few small states. Last year, the United States deployed roughly 10 square kilometers. Progress is being made, but there is a long way to go.

Solar power is one example. There are others such as battery technology where the scale of the challenge is similarly large. This is an area, thanks to continuous funding from the DOE, where Argonne National Laboratory has been working for 20 years and significant progress has been made. Lithium ion technology, for example, has improved at a rate of about 3 to 5 percent per year. However, this is not fast enough. Understanding the need to accelerate progress, the DOE recently launched the Joint Center for Energy Storage Research (JCESR). This industry-laboratory partnership has been charged with developing batteries that are five times cheaper and five times more energy dense within five years.

Mr. Dan Radomski, Vice President–Industry & Venture Development, NextEnergy; and Dr. David Wagner, Vehicle Engineering Technical Leader, Ford Motor Company.

The JSCER is one way a national laboratory can work with industry. At Argonne National Laboratory, there are numerous resources for the business community including a battery cell testing facility and battery cell fabrication capabilities. User facilities also provide free public access to a large cyclotron, high performance computing and a nano-science center. Nonetheless, the laboratories need to expand this portfolio and find new ways to interact with businesses while continuing to fulfill the role of a national laboratory.

Kick-Off Discussant
Dr. David Wagner
Vehicle Engineering Technical Leader
Ford Motor Company

Henry Ford once said, "Saving even a few pounds of a vehicles' weight could mean that we could also go faster, and consume less fuel. Reducing weight involves reducing materials, which in turn means reducing our costs as well." This quote embodies the ability of material science and engineering to boost the clean energy economy while also creating competitive asymmetries for Ford Motor Company (Ford). The fact that this message came from Mr. Ford in 1923 exemplifies Ford Motor Company's long-standing commitment to delivering great products, a strong business, and a better world.

Most of Ford's environmental impact is from the use stage of the vehicle with the remainder from the manufacturing process. Regarding the latter, Ford has invested more than a quarter of a billion dollars in plant and facility energy efficiency upgrades since 2000–including natural lighting, natural ventilation, living roofs and water use reduction. In the Michigan assembly plant in particular, Ford has combined the Focus, the C-Max vehicles, the Focus SFE and the Focus battery electric vehicle all on the same assembly line, significantly reducing manufacturing costs. Currently eight Ford plants are using a 3-Wet paint process–a advanced chemical composition of paint materials processes that allows for three layers of paint–primer, base coat and clear coat–to be applied while each layer is wet. This eliminates a dedicated oven that was previously required in the paint process, which reduces electricity, natural gas usage, CO_2 emissions, cure time and material usage. Each year more plants are upgrading to this system.

On the vehicle side, a materials-focus is essential to Ford's mission. With the help of companies like PPG, the use of recycled materials in Ford vehicles has increased and environmentally sensitive

materials have been eliminated or significantly reduced. Ford has also developed material specifications to drive improvements throughout the supply chain. For example, three quarters of Ford's North American vehicles now use soy-based biofoams in the head restraints, seat cushions and seat backs.

As much as Ford is driving improvements in-house, public-private partnerships are very important to the company. One area of interest for Ford, where a PPP may be able to help, is material specification. For example, a handbook containing the specifications for materials other than steel and aluminum is something that would be very useful. Currently, Ford engineers can pull the specifications and properties of dual phase 600 steel from a database and immediately know if this material will work for a project. For carbon fiber, the carbon fiber producer, the coating supplier and the manufacturer must produce and test the part before the properties can be understood. This is a major challenge to increasing the use of advanced materials in Ford vehicles.

Open Discussion

When opened up to the group, the participants explored further the obstacles to the increased use of advanced materials in manufactured products. There were three barriers common to multiple industrial sectors that were raised during the discussion: cost of raw materials, the time to manufacturer the part and the difficultly of joining dissimilar materials.

Using proven production processes such as injection molding for plastics, manufactured parts can be made for less than 10 cents. Producing parts with materials such as carbon fiber are well beyond this price point. Regarding processing speed, traditional metal stamping operations can produce up to 10 parts per minute. A single carbon fiber assembly can take up to one hour to cure in an autoclave.

> *"The word autoclave is bad."*
>
> **Dr. David Wagner**
> Vehicle Engineering Technical Leader
> Ford Motor Company

Joining dissimilar materials—typically through welding—is both a technical challenge as well as an organizational hurdle. Dissimilar materials by definition have different material properties and are often chemically incompatible. From an organizational perspective, training the workforce in new methods of joining materials (often different for each type of new material) and establishing new manufacturing processes around these new methods is a large undertaking often undermined by the inertia of incumbent processes such as spot welding.

After being introduced during the opening remarks for this panel, the group continued its focus on the topic of materials characterization and qualification.

> *"Remember, the OEMs are risk averse. In the manufacturing world it is not the race to be first, it's the race to be second."*
>
> **Mr. Steve Hatkevich**
> Director—Research and Development, American Trim

The creators and suppliers of an advanced material that could provide significant vehicle weight savings need to prove that this new material is safe for a particular product. Without a database—including

Dr. Peter B. Littlewood, Associate Director for Physical Sciences and Engineering, Argonne National Laboratory; and Ms. Jean Redfield, President & CEO, NextEnergy.

real world testing and simulation data—this process can take as much three years for a single company to complete. Moreover, once the material has been qualified, other suppliers benefit from this industry knowledge. Thus, there is an externality present in the development of advanced materials that provides a disincentive for innovation.

> *"Alcoa has been the maker of 95 percent of every aluminum alloy flying around the world today. Yes, our closest competitor is, in many cases, eating our lunch because they did not need to make the investment required to develop those alloys."*
>
> **Mr. Rodney Heiple**
> Director of Business Technology, Alcoa, Inc.

Understanding where to focus a PPP concept (technology, standards, mission, goals, etc.) is only one function of the AEMC Partnership regional dialogue series. There is the broader goal understanding how to bridge the gaps between innovation institutions—specifically, understanding how the United States can better leverage national resources such as university and national laboratories for regional and national economic benefit. In the context of building better public-private partnerships, this discussion included a survey of what this particular group views as the major barriers to increasing industry partnerships with external laboratories—be they national laboratories or the universities. Broadly, these barriers can be described as institutional, practical and administrative.

Regarding the institutional barriers, universities—on the organizational and individual level—do not operate at the speed of business. University leaders explain how difficult it is for academic institutions to prepare themselves to be responsive to the needs of industry in a timely manner. Investing in appropriate researchers and laboratory infrastructure as well as developing the curriculum to complement regional industrial strengths can take several years. On the individual level, there are friction points between industry researchers and universities. University researchers operate on the academic calendar and will often take the time—as it is core to a university's mission—to teach in the laboratory. Research in this environment often struggles to keep pace with business needs.

On a practical level, the research being performed in public national laboratories often does not match the needs of businesses. The challenge occurs on at least two levels. The first is that there are simply few avenues to translate the needs of businesses to publicly funded national laboratories.

> *"The challenge I see is that the right people are not getting the right information... [How do we communicate] the top 50 clean energy material manufacturing challenges that we need to solve for the next 10 years, with the specification defined well enough so that people will innovate in the right direction to solve them?"*
>
> **The Honorable David T. Danielson**
> Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy

> *"[Let's think] about how to bridge the gap between problems that need to be solved and the inventors, innovations, and thinkers who are trying to solve the problems."*
>
> **Ms. Jean Redfield**
> President and CEO, NextEnergy

The second barrier is related to institutional differences. University laboratories tend to focus on revolutionary innovation, while a profitable manufacturing company tends to innovate in ways that leverage existing manufacturing assets (i.e. evolutionary innovation). This difference in perspective causes a mismatch of needs and solutions. Not many businesses are interested in adopting a revolutionary technology platform that will make existing manufacturing infrastructure obsolete and create new competitors.

> *"What we need to do is find a way to recognize that there is the need for evolutionary innovation, but there's also a need for revolutionary innovation."*
>
> **Mr. Steve Hatkevich**
> Director—Research and Development, American Trim LLC

Mr. Michael J. Cicak, CEO, Willard & Kelsey Solar Group; Dr. Rob Ivester, Acting Director, Advanced Manufacturing Office, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy; Dr. Alvin Compaan, President and CTO, Lucintech, Inc.; Dr. Frank Calzonetti, Vice President of Government Relations, The University of Toledo, Ms. Judith M. Cowen, President, Ohio Energy and Advanced Manufacturing Center, Inc.; Dr. Phillip C. Yu, Director–Corporate Science & Technology, PPG Industries, Inc.; and Mr. Rodney Heiple, Director of Business Technology, Alcoa, Inc.

Relating back to the issue of speed are the administrative barriers to public-private cooperation. Though progress has been made in this area—namely the recent Agreement for Commercializing Technologies (ACT) pilot program—industry representatives expressed persistent challenges when negotiating industry-laboratory agreements. Including ACT, there are six different types of Department of Energy national laboratory—industry cooperative research agreements, nearly all which require preapproval from the Department of Energy. This approval process can be lengthy and complex. By one account, the Idaho National Laboratory catalogued 110 requirements that the laboratory and researchers must meet to facilitate technology transfer.[2]

There were also two sub-themes that emerged during this panel discussion that have the potential to impact the design of a PPP to advance the AEMC Partnership goals. The first was the unique challenges faced by SMEs. The barriers explained above—institutional, practical and administration—are exacerbated for SMEs, as they often do not have idle human or financial resources to allocate to overcoming these barriers. Moreover, they often lack of the institutional knowledge of establishing and participating in cooperative research projects with public research institutions.

The second sub-theme is that of regionalism; whether or not linking problems and solutions needs to reside on a regional platform. The Toledo solar energy cluster example provides a case study where a university and local businesses shared a common industrial history. Thus, The University of Toledo was well equipped to meet the needs of the emerging solar energy sector; it was not a difficult institutional shift for The University of Toledo. This is not to imply that public-private partnerships should not include super-regional partners, according to the participants, but a regional center of gravity seems an important consideration for any PPP.

2 CL Cejka and BJ Harrer, Agreement Execution Process Study: CRADA's and NF-WFO Agreements and the Speed of Business, February 2011.

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 2

Highlights from the Working Lunch: Exploring Networks of Innovation, Mature Market PPPs and Test Bed/Demonstration

There were certainly insights unique to a particular PPP model type generated during the lunch working group sessions. However, this discussion tended more toward the holistic, with key insights emerging that would apply to all PPP concepts. More specifically, this session developed a set of principles intended to guide the process of selecting a target area for a clean energy manufacturing public-private partnership.

Pulling from their organizational history, representatives from both Ohio Third Frontier and NorTech stressed the importance of using strategic market analysis to target nascent areas of innovation-based industrial strength for acceleration. This, however, should be more than an academic exercise; competitive processes such as the presence of venture capital funding should be used to validate the market. The analysis should go even deeper to understand for what class of problems is a public-private partnership the right solution. The industrial leaders described this class of problems as being those which individual entities do not have access to a unique set of resources—be they human or capital—to solve the problem on their own. Or, an area where externalities are so large they create a disincentive for the activity.

"The partnership agreement and the role of the partnerships need to be structured so that it's the right answer; it's a critical element. [When] it comes down to your dues into the partnership, it should be the last thing you cut before you cut payroll."

Dr. Rob Ivester
Acting Director, Advanced Manufacturing Office, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy

It is also important, according to participants, not to work against global market forces; a PPP should build on or make investments in ways that make the United States the most economically feasible place to locate production.

"If assembly and manufacturing comes back [to the United States], it's because it's the best place to do it. We need to create the conditions to make the United States the best place to locate manufacturing."

Dr. Peter B. Littlewood
Associate Director for Physical Sciences and Engineering, Argonne National Laboratory

This conversation opened up the broader question of what anchors manufacturing to geographic locations and how can this be built into the mission of the public-private partnership. The group was mixed on whether or not geographical demand creates a sustainable manufacturing anchor. Regardless, government procurement as a means of creating initial demand, which in turn begins the cultivation of an industrial commons (i.e. supply chains—which most

participants do agree anchor manufacturing) was recommended by dialogue participants as a beneficial policy to support a PPP. Encouraging mass customization was also suggested as a means to keep manufacturing near the source of demand. The massive increase in unique SKU numbers brought about by mass customization would be too difficult to manage globally, hence keeping manufacturing close to consumers.

Capital availability was also raised in more than one of the working groups. Venture capital investment in clean energy innovation plummeted 33 percent last year.[3] Much of the discussion was around new ways to fill this investment gap. In addition to the crowd-funding idea that was suggested in the previous panel session, a common theme within the working groups was leveraging the philanthropic communities for investment in clean energy technology development—mainly around capital-intensive physical innovation, which tends to be manufacturing-related work. The diversity of funding was also considered key in terms of long-term sustainability; finding the right balance between membership fees, IP royalty income, state funding and federal funding.

3 Martin LaMonica, MIT Technology Review, “For Energy Startups, a Glass Half Full or Empty?” January 2013.

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 2

R&D and Manufacturing Linkages: Attacking the Problem of Scaling

Session Summary

The transition of prototypes to deployable products marks the second of two valleys of death in the technology innovation cycle, often called the scale-up valley of death. Without expertise, infrastructure and capital to scale production of a new technology, prototypes often become stranded in laboratories—unable to make the transition to a commercially deployable product. By creating and raising awareness about methods to facilitate this transition, the participants at the Inaugural AEMC Partnership Dialogue explained, more viable technologies will traverse the scale-up valley of death. The moderator and discussants of this panel were selected because of their unique perspective and experience with bridging this gap. To elucidate this experience and tease out best practices, the following questions were posed to the group:

- How does linking R&D teams and manufacturing teams accelerate innovation? Please provide examples.
- Is there a difference if the link between manufacturing and R&D is physical (co-located) or remote, but in the same company?
- How can technologists and researchers—in both private and public laboratories—be encouraged to include manufacturing design implications from the earliest stages of technology development?
- What types of public-private partnerships can support or create this dynamic?

The moderator and both discussants reinforced the importance of including manufacturing expertise as early in the technology development cycle as possible to precipitate rapid transition from laboratory to market. Further, they relayed the mechanisms their respective organizations use to achieve this dynamic. Opening up the discussion to the group, participants began to explore ways in which these mechanisms could be built into public-private partnership concepts. This conversation was a natural extension of the previous session, in that it was focused on connecting innovation stakeholders with underutilized national assets such as high performance computational tools. Yet, it further refined this concept by identifying what target areas are most appropriate for public-private collaboration.

Framing Remarks

Moderator
Mr. Peter Finamore
Manager, Product Sustainability
& Energy Technology
Deere & Company

Innovation occurs when an invention comes to the marketplace. Deere & Company (Deere) has recently changed its technology centers into innovation centers to reflect this perspective—inventions cannot be utilized until the manufacturing and commercialization implications are understood. Moreover, doing this sequentially would take many years and can derail a project. Thus, concurrent early engagement of all business units is essential for technological innovation.

Once a technology has been demonstrated, it is time to get serious about what can be done with that technology. Through the use of strategic innovation scenarios, Deere can predict project oppor-

tunities, potential barriers and possible pathways to production. Multiple scenarios are concurrently developed that take into account factory systems, market analysis, testing, proofing, safety, operator training, etc. This process is critical to choosing the investments that are most likely to succeed—i.e. scale-up to mass manufacturing. Moreover, these innovation scenarios are used to identify the touch points between engineering and manufacturing—facilitating the transition from invention to innovation.

There is also the question of whether or not concurrent early engagement can be modeled using high performance computing. Can we develop dynamic system models to home in on the most effective ways to bring products to market? These models could also be extended out beyond one organization to include the social, economic and environmental risks associated with a new product or process.

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

Kick-Off Discussant
Mr. Rodney Heiple
Director of Business Technology
Alcoa, Inc.

Manufacturing expertise is critical within the R&D environment. However, R&D expertise will not thrive in a manufacturing environment; it will be squelched by the urgency of today. Nonetheless, Alcoa, Inc. (Alcoa) has developed and implemented three tools to maintain this connection.

First, Alcoa has put into place a program that requires manufacturing experts to rotate between production and R&D environments. Newly hired engineers and researchers are placed first on the production floor knowing that they will move into R&D at some point in their career. Laboratory personnel will also spend in few years in a manufacturing environment to gain production expertise. In addition to this personnel exchange program, the R&D facilities also invest heavily in production-scale processes. For example, the central R&D operation in Pittsburgh has the largest smelter in Pennsylvania to perfect smelting technology. Lastly, a multi-stakeholder, stage-gate process is used to review the feasibility of a new technology at numerous stages of development. Alcoa actually has rewards for the best project kills of the year that—during this stage-gate process—were determined to lack business sense. Each of these programs enables rapid and timely validation of innovation as well as efficiently and quickly reorienting resources away from dead-end projects.

These efforts are intended to assist rapid product development, qualification, prototyping and demonstration of new technologies. Having resources to do this is very important. Ensuring that more companies have access to such resources is a need that can be addressed through a PPP.

Kick-Off Discussant
Mr. Michael Peck
Chairman
Isofoton North America

Partnerships have been essential to the success of Isofoton North America. In fact, the first thing Isofoton did when it came to Ohio—even before opening the factory doors in December of 2012—was partner with The University of Toledo and others to compete for—and win—one of two awards under the Department of Energy's Sunshot Initiative to develop "plug-and-play" photovoltaic systems that can be purchased, installed and operational in one day. Being the panel supplier for the plug-and-play team has been tremendously beneficial to Isofoton.

In the world that today's U.S. businesses face, these types of multi-stakeholder partnerships are critical, namely because they have the ability to shift the economy away from one driven by shareholders to one driven by stakeholders. The shareholder economy limits the assets at our disposal to compete with command-and-control economies that have a fraction of U.S. labor costs. Global labor arbitrage has been a race to the bottom for this country. But, there are new models today with the power to reverse this trend. Inculcating production workers with the American ownership ethos can produce greater returns for busineses and empower the workers—creating a more engaged and participatory workforce.

Open Discussion

A common theme of the opening remarks was the desire for rapid validation of new inventions through the application of manufacturing expertise in the early stages of technology development. While a number of mechanisms to drive this process were presented by the discussants, dialogue participants focused on two particular ideas as having the potential to develop into public-private partnerships: personnel exchange programs and modeling and simulation of dynamic systems.

> *"Could there be a faculty/researcher National Manufacturing Corps—akin to a Peace Corps? Faculty, researchers, post-doctoral researchers, graduate students, etc., could be embedded in manufacturing companies throughout the country to understand how products are manufactured. This has been done at Alcoa—it would be great to understand how to do this on the national level."*
>
> **Ms. Lisa Camp**
> Associate Dean—Strategic Initiatives, Case School of Engineering, Case Western Reserve University

The value of a national-scale personnel exchange program is multi-dimensional, according to participants. Embedding manufacturing expertise within university laboratories and the national laboratory system lowers technological barriers to transitioning inventions from publicly funded national laboratories into the private sector. Moreover—as was discussed in the Cross-Cutting Materials session—a personnel exchange program can facilitate the understanding of the resources available and the challenges within disparate innovation institutions, i.e. matching problems with solutions.

Also explored during this session was the possibility of using computational tools to perform a robust critical path and lifecycle analysis that includes the points of interaction between engineering and production. The nature and scale of computational tools required to perform this type of analysis make it a potential target for a PPP.

> *"Just the computational horsepower alone required to handle all the data...goes well beyond any one company's capabilities."*
>
> **Mr. Rodney Heiple**
> Director of Business Technology, Alcoa, Inc.

This assessment is consistent with the conclusion drawn in the lunch working groups—a target area for a PPP should be one where individual entities do not have access to a unique set of resources to solve a particular problem, or, an area where externalities are so large as to create a disincentive for that activity.

With this in mind (developing modeling and simulations tools to simultaneously map all possible technology development scenarios including manufacturing touch points), the conversation returned to thinking critically about how to better leverage national resources, specifically high performance computing (HPC). This discussion, however, was more nuanced relative to the morning's discussion of this topic. While industry applications of HPC are very demanding, they do not typically exist at the frontier of computational ability. Thus, a public-private partnership—according to dialogue participants—should focus on increasing private sector access to existing HPC resources, not the creation of next generation computational tools. As part of increasing access to these resources, easy to use tools and applications should be developed that allow a diversity of users—regardless of expertise in modeling and simulation—to access these capabilities without the burden of developing the code architecture. As was discussed in a previous panel, this is especially true for small and medium size businesses.

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 2

Measuring the Success of a Public-Private Partnership

How should success in PPPs that meet the goals of the AEMC Partnership be measured? What are the critical indicators of success (i.e. job creation, spinoffs, exports, tax revenue, productivity, etc.)? Who should perform the evaluation? Are there examples of successful measurement models that could be applied to the AEMC Partnership? These are questions that continue be raised during the AEMC Partnership dialogue series. While it is difficult to home in on specific metrics at this relatively early stage of engagement, participants reiterated the importance of effective measurement and evaluation of PPPs and offered valuable insights based their collective experience working with or within PPPs:

- Metrics drive the behavior of the partnership;
- The mission of the PPP has to drive the metrics;
- Rapid insertion of strategic technologies is what this partnership is driving at and, thus, this is where the metrics should be targeted;
- Due the nature of PPPs and the complexity of modern science, technology and innovation, metrics need to be multifaceted;
- Metrics need to be based on a shared understanding of objectives;
- Not everything is quantifiable; data-driven metrics need to be complemented with qualitative measures;
- Measurements should be made by a third party; and
- Metrics often are driven by funders.

"One metric is jobs. I argue that this is a problematic metric—it is difficult to measure and, more importantly, does not drive the right behavior. Why not just take the funding [for the AEMC Partnership] and build a Wal-Mart? This would create jobs, but would not drive innovation."

Mr. Ralph Resnick
Founding Director, NAMII and President and Executive Director, NCDMM

"It is essential that there be clarity around why we are all partnering. What is our joint purpose? What are we hoping to get out of it? What do we want to accomplish together? The metrics will evolve from that."

Mr. Jeffery M. Brancato
Vice President of Strategic Initiatives, NorTech

"When I receive dollars from an entity, whether it's the Manufacturing Extension Program or the Department of Energy, we often follow their metric model."

Mr. Patrick Valente
Executive Director, Ohio Fuel Cell Coalition

PART 2: FINDINGS FROM AEMC PARTNERSHIP DIALOGUE 2

The Path Forward

The United States is facing a critical moment. After decades of public and private investment, American innovation has brought clean energy technologies within five to ten years of direct cost competitiveness with incumbent fuel sources. The clean energy market is set to explode and the United States needs to align the vectors of the nation's manufacturing and innovation systems to capture a dominant share of the manufacturing value-add of this emerging sector. The ultimate goal of the AEMC Partnership is that ideas cultivated during this dialogue and throughout the first year of the AEMC Partnership will be analyzed, understood and activated to develop a new generation of public-private partnerships that leverage world class U.S. innovation assets and opportunities to build on and develop game-changing capabilities that will propel America ahead of the global competition.

As summarized by Ms. Wince-Smith, "the rest of the world is moving fast, and we need to move faster."

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1500 K Street, NW
Suite 850
Washington, D.C. 20005
T 202-682-4292
Compete.org

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1500 K Street, NW, Suite 850
Washington, D.C. 20005
T 202 682 4292
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