American Energy & Manufacturing Competitiveness Partnership

Launch.

Inaugural Dialogue

Compete.

Council on Competitiveness

THE COUNCIL ON COMPETITIVENESS has developed this report with the support of the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, in fulfillment of Contract #DE-EE0006099.000.

THE COUNCIL is a nonprofit, 501 (c) (3) organization as recognized by the U.S. Internal Revenue Service. The Council's activities are funded by contributions from its members, foundations, and project contributions. To learn more about the Council on Competitiveness, visit www.compete.org.

Printed in the United States of America

Inaugural Dialogue
Table of Contents

AEMC PARTNERSHIP INAUGURAL DIALOGUE

Letter from the President

On behalf of the Council on Competitiveness (Council), it is my pleasure to release *Launch*, the first 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), as a part of EERE's Clean Energy Manufacturing Initiative (CEMI), 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 build on this distinctive time in its energy history over the next five to ten years and to dramatically bolster its energy, manufacturing and economic competitiveness over the next 20, 30, 40 years and beyond.

This inaugural dialogue launches a progressive conversation over the next year and across the nation to convene leaders in industry, academia, national laboratories and government—including a second dialogue in Toledo, Ohio on June 20th, a third dialogue in Niskayuna, New York on August 13th, and a fourth dialogue in 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.

I extend special thanks to my partner and co-host for this kick-off dialogue—the Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy—for his vision and leadership during the development of the AEMC Partnership. Over the coming years, the Council and EERE will work together across the country, engaging the nation's top energy and manufacturing stakeholders to define key barriers, challenges and problems in the manufacturing of clean energy products and energy efficient products—and then generate potential models for scalable, public-private partnerships, to increase the competitive manufacturing of clean energy and energy efficient products, and to make the U.S. manufacturing sector more energy efficient.

The inaugural dialogue sets the foundation for the continuing and progressive conversation to generate potential models for scalable public-private partnerships. *Launch* details the preparatory work and presents insights captured during the inaugural dialogue in two parts. Section one, a primer developed in advance of the inaugural AEMC Partnership dialogue, maps out the tremendous and timely opportunities in the manufacturing and energy sectors national leaders can lever to create good jobs, new innovations and higher living standards. The report's first section also examines the effects public-private partnerships can have in stimulating outsized benefits through local, regional and national economies.

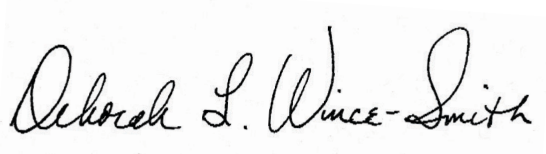
Section two reports on the proceedings of the April 11-12, 2013 inaugural AEMC Partnership dialogue held at the Gallup Building in Washington, D.C. This post-report presents the insights on barriers a public-private partnership could target to stimulate growth and innovation in clean energy manufacturing.

I would like to recognize the generosity of Council members and participants in contributing to the success of the AEMC Partnership inaugural dialogue. The Council thanks our dialogue host, Council member Mr. James K. Clifton, CEO of

Gallup Inc. I also am grateful to our many speakers including: Council on Competitiveness Executive Committee members Dr. Pradeep Khosla, Chancellor of the University of California, San Diego and Mr. James Phillips, Chairman and CEO of NanoMech, Inc.; Council member Dr. Dan Arvizu, Director and Chief Executive of the National Renewable Energy Laboratory and Chairman of the National Science Board; Dr. J. Michael McQuade, Senior Vice President, Science & Technology for United Technologies, member of the Council's Technology Leadership & Strategy Initiative and co-chair of the Council's High Performance Computing Advisory Committee; Mr. Jason S. Miller, Special Assistant to the President for Manufacturing Policy; Dr. Omkaram Nalamasu, Chief Technology Officer for Applied Materials, Inc.; Mr. Andrew Ginger, President, Industrial, Snap-On Incorporated; and Mr. Sean McGarvey, President, Building and Construction Trades Department, AFL-CIO.

I look forward to continuing to engage leaders in industry, academia, national laboratories and government as the Council and EERE continue to capture insights and recommendations from this and future dialogues, and set 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.

INAUGURAL AEMC PARTNERSHIP DIALOGUE

Participants

CO-HOSTS

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

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

PARTICIPANTS

Major General Anders B. Aadland
President/Owner
CASTLELINK LLC

Dr. Montgomery "Monty" Alger
Senior Vice President
Research & Development
Myriant Corporation

Mr. Samuel R. Allen
Chairman & CEO
Deere & Company
-and-
Chairman
Council on Competitiveness

Dr. Dan Arvizu
Director & Chief Executive
National Renewable Energy Laboratory
-and-
Chairman
National Science Board

Dr. Steven Ashby
Deputy Director
Science & Technology
Pacific Northwest National Laboratory (Battelle)

Mr. Thomas R. Baruch
Partner
Formation 8 Partners

Dr. Wolfgang Bauer
University Distinguished Professor
Department of Physics and Astronomy
Michigan State University

Dr. Craig Blue
Director
Manufacturing Demonstration Facility
Oak Ridge National Laboratory

Mr. William H. Bohnett
President
Whitecap Investments LLC

Mr. D. Drew Bond
Vice President
Public Policy
Battelle Memorial Institute

Mr. Nolan Browne
Managing Director
Fraunhofer Center for Sustainable Energy Systems

Dr. Frank Calzonetti
Vice President
Government Relations
University of Toledo

Mr. Steve Cardona
CEO & Founder
Nzyme2HC, LLC

Mr. Michael Carr
Principal Deputy Assistant Secretary
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Major General Matthew Caulfield
Chairman & CEO
Hire Quality, Inc.

Dr. Jeffery "Jeff" Chamberlain
Deputy Director
Development & Demonstration
The Joint Center for Energy Storage Research
Chemical Sciences and Engineering
Argonne National Laboratory

Mr. John Cohen
Vice President
Environmental Policy & Government Affairs
Alstom Inc.

Dr. Paul J. Componation
Director
Graduate Education for Engineering Management
-and-
Professor
Industrial and Manufacturing Systems Engineering
Iowa State University

Ms. Phyllis Cuttino
Director, Clean Energy Program
The Pew Charitable Trusts

Dr. Tomás Díaz de la Rubia
Director
Deloitte Consulting LLP

Mr. Earl Dodd
Chairman Elect
LGT Advanced Technology Limited

Mr. Joseph Dooley
Senior Associate
Clean Energy Program
The Pew Charitable Trusts

Ms. Marjorie Duske
Director
Science & Technology
University of California Systems-Regents

Mr. Travis Earles
Senior Manager
Advanced Materials and Nanotechnology Initiatives
Lockheed Martin Corporation

Dr. Karina L. Edmonds
Technology Transfer Coordinator
U.S. Department of Energy

Mr. Karl Engelbach
Associate Chancellor &
Chief of Staff
University of California, Davis

Mr. Chad Evans
Executive Vice President
Council on Competitiveness

Ms. Lisa Ferris
Chief Operating Officer
Third Wave Systems

Dr. Henry "Hank" Foley
Vice President
Research
The Pennsylvania State University

Mr. Paul Gilman
Chief Sustainability Officer &
Senior Vice President
Covanta Energy

Mr. Andrew Ginger
President, Industrial
Snap-On Incorporated

Dr. William Goldstein
Deputy Director
Science & Technology
Lawrence Livermore National Laboratory

Mr. Alan C. Goodrich
Senior Analyst
Solar PV Costs
National Renewable Energy Laboratory

Mr. Thomas Halbouty
Vice President, CIO & CTO
Pioneer Natural Resources Company

Dr. Paul Hallacher
Director
Research Program Development
The Pennsylvania State University

Dr. Jonna Hamilton
Vice President
Policy
Securing America's Future Energy

Ms. Sheryl Handler
President & CEO
Ab Initio

Dr. Klaus G. Hoehn
Vice President
Advanced Technology & Engineering
Deere & Company

Mr. Ted James
Energy Analyst
National Renewable Energy Laboratory

The Honorable Alexander "Andy" A. Karsner
Chairman & CEO
Manifest Energy, LLC

Dr. Martin Keller
Associate Laboratory Director
Energy and Environmental Sciences
Oak Ridge National Laboratory

Mr. Christopher King
Director
Policy and Analysis
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Dr. Pradeep K. Khosla
Chancellor
University of California, San Diego

Dr. Donald J. Leo
Vice President & Executive Director
National Capital Region Operations
-and-
Professor
Mechanical Engineering
Virginia Polytechnic Institute and State University

Mr. Brian Lombardozzi
Senior Policy Analyst
BlueGreen Alliance

Dr. Robert Bruce Lung
Director
Industrial Programs
Alliance to Save Energy

Mr. Bill Macy
Deputy Director
Technology Transition
National Additive Manufacturing Innovation Institute

Dr. Michael Makowski
Senior Research Associate
Corporate Platform Manager
PPG Industries R&D

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

Dr. Thomas "Thom" Mason
Director
Oak Ridge National Laboratory

Ms. Sarah Jane Maxted
Senior Consultant
Deloitte Consulting LLP

Mr. Sean McGarvey
President
Building and Construction Trades Department, AFL-CIO

Dr. J. Michael McQuade
Senior Vice President
Science & Technology
United Technologies Corporation

Mr. Jason S. Miller
Special Assistant to the President
Manufacturing Policy
National Economic Council
The White House

Mr. Michael Monroe
Chief of Staff
Building and Construction Trades
Department, AFL-CIO

Dr. Mark G. Mykityshyn
Executive Chairman
Tangible Software, Inc.

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

Ms. Allison Newman
Associate Vice President
External Relations and Administration
Rensselaer Polytechnic Institute

Dr. Mark Peters
Deputy Laboratory Director
Programs
Argonne National Laboratory

Mr. James M. Phillips
Chairman & CEO
NanoMech, Inc.

Dr. Luis M. Proenza
President
The University of Akron

Mr. Dan Rafferty
Senior Corporate Advisor
Verdant Power, Inc.

Mrs. Radha Ratnaparkhi
Vice President
Software Defined Environments
Thomas J. Watson Research Center
IBM

Dr. Gregory Raupp
Director
Macro Technology Works (MTW) Initiative
Office of Knowledge Enterprise
Development (OKED)
Arizona State University

Ms. Jean M. Redfield
President & CEO
NextEnergy

Dr. J. Stephen Rottler
Vice President
California Laboratory
-and-
Vice President
Energy, Climate & Infrastructure Security
Sandia National Laboratories

Dr. Kenan E. Sahin
Founder & President
TIAX LLC

Mr. D. Scott Seaton
Vice President
Engineering R&D
SRI International

Mr. Ryan Steyer
Legislative Assistant
Office of Congresswoman Marcy Kaptur

Mr. Patrick Sullivan
President
Mississippi Energy Institute

Mr. Robert ter Kuile
Senior Director
Environmental Sustainability
PepsiCo

Ms. Elizabeth "Liz" Thorstensen
Vice President
Knowledge Management & Economic
Development Practice
International Economic Development
Council

Ms. Barbara Tyran
Director
Washington & State Relations
Electric Power Research Institute

Dr. Jud Virden, Jr.
Associate Laboratory Director
The Energy & Environment Directorate
Pacific Northwest National Laboratory

Mr. Robert Walther
Deputy Director
Energy
Third Way

Dr. Ben Wang
Director
Manufacturing Research Center
Georgia Institute of Technology

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

Mr. Thomas Weirich
Vice President
Corporate Relations
-and-
Director
International Programs
American Council on Renewable Energy

Dr. Charles W. Wessner
Director
Technology, Innovation, and Entrepreneurship
The National Academies

Mr. Frank Wolak
Vice President
FuelCell Energy, Inc.

Ms. Jetta Wong
Special Advisor
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Ms. Laurel "Laurie" Zelnio
Director
Environment, Safety, Standards, & Energy
Deere & Company

KEY PARTNERS

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

Dr. James Nachbaur
Economist & AAAS Policy Fellow
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Mr. Teryn Norris
Special Assistant
Public Engagement
Office of the Secretary
U.S. Department of Energy

Dr. Lidija Sekaric
Program Manager
Technology R&D and Commercialization
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

COUNCIL ON COMPETITIVENESS STAFF

Mr. William Bates
Executive Vice President
Council on Competitiveness

Mr. Michael Bush
Policy Director
Council on Competitiveness

Ms. Lisa Hanna
Vice President
Council on Competitiveness

Dr. Walter Kirchner
Chief Technologist
Council on Competitiveness

Ms. Deborah Koolbeck
Vice President
Council on Competitiveness

Mr. Jack McDougle
Senior Vice President
Council on Competitiveness

Dr. Cynthia McIntyre
Senior Vice President
Council on Competitiveness

Mr. John Mizroch
Senior Fellow
Council on Competitiveness

Mr. Chris Mustain
Vice President
Council on Competitiveness

Dr. Clara Smith
Senior Policy Director
Council on Competitiveness

Mr. Phillip Typaldos
Program Manager
Council on Competitiveness

Mr. Gourang Wakade
Policy Director
Council on Competitiveness

INAUGURAL AEMC PARTNERSHIP DIALOGUE

Agenda
April 11, 2013

Gallup
901 F Street, NW
Washington, D.C. 20004
Room: The Great Hall

AFTERNOON

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

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

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

2:50 Leadership Perspective

Dr. Dan Arvizu
Director & Chief Executive
National Renewable Energy Laboratory
-and-
Chairman
National Science Board

3:00 State and Define

A moderated conversation focused on key competitiveness barriers, challenges, and problems focusing on the manufacturing of clean energy and energy efficiency products and increased industrial energy productivity.

Moderator

Dr. J. Michael McQuade
Senior Vice President
Science and Technology
United Technologies Corporation

Kick-Off Discussants

Mr. Thomas R. Baruch
Partner
Formation 8 Partners

Mr. Paul Gilman
Chief Sustainability Officer & Senior Vice President
Covanta Energy

Dr. Pradeep K. Khosla
Chancellor
University of California, San Diego

Mr. Frank Wolak
Vice President
FuelCell Energy, Inc.

4:00 Perspectives from the National Laboratories

Partnering with industry and academia to enhance American competitiveness in producing clean energy and energy efficient products and in boosting manufacturing competitiveness through increases in energy productivity and fuel switching.

Moderator

Dr. Thomas “Thom” Mason
Director
Oak Ridge National Laboratory

Kick-Off Discussants

Dr. Steven Ashby
Deputy Director
Science & Technology
Pacific Northwest National Laboratory (Batelle)

Dr. William Goldstein
Deputy Director
Science & Technology
Lawrence Livermore National Laboratory

5:00 Dialogue Day 2 Preview and Closing Remarks

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

5:30 Dialogue Day 1 Close

6:00 Optional AEMC No-Host Happy Hour

INAUGURAL AEMC PARTNERSHIP DIALOGUE

Agenda
April 12, 2013

MORNING

8:00 Registration and Continental Breakfast

8:30 Opening Remarks

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

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

8:45 Briefing: Clean Energy Manufacturing Initiative and the Role of Partnerships

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

9:00 Mapping the Landscape Part 1: The AEMC Partnership

The U.S. Department of Energy Office of Energy Efficiency and Renewable Energy (EERE) and the Council have formed the American Energy and Manufacturing Competitiveness (AEMC) Partnership. The goals of the AEMC Partnership are to:

- Increase U.S. competiveness in the production of clean energy products: Strategically invest in technologies that leverage American competitive advantages and overcome competitive disadvantages.
- Increase U.S. manufacturing competitiveness across the board by increasing energy productivity: Strategically invest 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 first phase of the AEMC Partnership—in preparation for this inaugural dialogue—has examined:

- Links between energy efficiency efforts, clean energy, and manufacturing competitiveness in the United States and internationally;
- Barriers to manufacturing competitiveness as they relate to energy productivity in the United States and internationally; and
- Models for public-private partnerships (PPPs) to foster competitive industries in the United States or abroad.

The Council and EERE documented findings of this first phase in *The Power of Partnerships*.

Moderator

Mr. Chad Evans
Executive Vice President
Council on Competitiveness

Kick-Off Discussants

Dr. Henry “Hank” Foley
Vice President
Research
The Pennsylvania State University
Representing Energy Efficient
Buildings Hub (EEB Hub)

Dr. Martin Keller
Associate Laboratory Director
Energy and Environmental Sciences
Oak Ridge National Laboratory (ORNL)
Representing ORNL Manufacturing Demonstration
Facility (ORNL-MDF)

Dr. Donald J. Leo
Vice President and Executive Director
National Capital Region Operations
-and-
Professor
Mechanical Engineering
Virginia Polytechnic Institute and State University
Representing Commonwealth Center for Advanced
Manufacturing (CCAM)

Dr. Jeffrey “Jeff” Chamberlain
Deputy Director
Development & Demonstration
Joint Center for Energy Storage Research (JCSER)
Chemical Sciences and Engineering
Argonne National Laboratory
Representing JCESR

Ms. Jean M. Redfield
President and CEO
NextEnergy
Representing NextEnergy

Mr. Nolan Browne
Managing Director
Fraunhofer Center for Sustainable Energy Systems
(CSE)
Representing CSE

10:15 Break

10:45 Connecting with CEMI Partners—Strategic Analysis of Clean Energy Opportunities

As part of CEMI, NREL leadership, in partnership with other national laboratories and the private sector, is developing new-to-the-world analysis of and insight into the value chains of key clean energy technologies. This session will preview some initial findings—and seek input from dialogue participants on next steps and opportunities to leverage this critical tool.

Moderator

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

Kick-Off Discussants

Mr. Alan C. Goodrich
Senior Analyst
National Renewable Energy Laboratory

Mr. Ted James
Senior Analyst
National Renewable Energy Laboratory

Mr. Michael Carr
Principal Deputy Assistant Secretary
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

12:00 Perspectives from the Administration: Keynote & Luncheon Session

Introduction

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

Keynote

Mr. Jason S. Miller
Special Assistant to the President
Manufacturing Policy
National Economic Council
The White House

1:15 Perspectives from Industry

The Role of Industrial Energy Efficiency in American Manufacturing Competitiveness

Moderator

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

Kick off Discussants

Ms. Lisa Ferris
Chief Operating Officer
Third Wave Systems

Mr. Andrew Ginger
President, Industrial
Snap-On Incorporated

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

Mr. Robert ter Kuile
Senior Director
Environmental Sustainability
PepsiCo

Ms. Laurel "Laurie" Zelnio
Director
Environment, Safety, Standards, & Energy
Deere & Company

2:15 Laying the Foundations for a Clean Energy Manufacturing PPP

This 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 increasing energy productivity in the manufacturing process, and on the development of at least one PPP concept.

Moderator

Dr. Tomás Díaz de la Rubia
Director
Deloitte Consulting LLP

Kick-Off Discussants

Dr. Montgomery "Monty" Alger
Senior Vice President
Research and Development
Myriant Corporation

Mr. Sean McGarvey
President
Building and Construction Trades Department, AFL-CIO

Dr. Mark Peters
Deputy Laboratory Director
Programs
Argonne National Laboratory

Dr. Kenan E. Sahin
Founder & President
TIAX LLC

3:15 Steps Forward in Creating Clean Energy and Energy Efficient Products and Partnerships: Stakeholder Perspectives on the Day

This session will bring together stakeholders to capture thoughts expressed during the day and discuss the policy recommendations needed to promote the increased development of clean energy and energy efficient products and increased energy productivity in the manufacturing process.

Moderator

The Honorable Alexander "Andy" A. Karsner
Chairman & CEO
Manifest Energy, LLC

Kick-Off Discussants

Mr. James M. Phillips
Chairman & CEO
NanoMech, Inc.

Dr. J. Stephen Rottler
Vice President
California Laboratory
-and-
Vice President
Energy, Climate & Infrastructure Security
Sandia National Laboratories

Mr. Patrick Sullivan
President
Mississippi Energy Institute

4:15 The Path Forward and Closing Remarks

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

5:00 Conclude

PART 1
Inaugural AEMC Partnership Dialogue Primer
Rebuilding the Industrial Commons

PART 1: INAUGURAL AEMC PARTNERSHIP DIALOGUE PRIMER

Introduction

Despite a mid-2012 growth slump, the U.S. manufacturing sector has been steadily growing for almost three years,[1] often being referred to by analysts as an economic "bright spot."[2] Pundits have also lauded the growing number of American companies moving their manufacturing operations back to the United States (i.e. re-shoring).[3] Although there are less than 100 firms known to have brought production back to the United States, there are likely many more companies making this shift.[4] While individual firms will have unique reasons for adding domestic production jobs or re-shoring parts of their supply chain, some common factors have been identified as driving this shift:

- Labor costs in the developing world—namely China—have been rising relative to the more developed world.[5]
- Real wages in American manufacturing have declined by 2.2 percent since 2005—largely driven by the financial crisis.[6]
- The recently commercialized extraction of shale gas has lowered U.S. energy costs relative to the rest of world—breathing new life into struggling industries such as steel production.[7]
- The dollar has been weakening relative to the Chinese renminbi.[8]
- Combined, these factors make investment in U.S. manufacturing more attractive for both domestic and foreign firms.

1 Bureau of Labor Statistics, "Data, Tables, & Calculators by Subject—Manufacturing," Accessed March 27 2013.

2 Norris, Floyd, "Manufacturing Is Surprising Bright Spot in U.S. Economy," *The New York Times*. 5 January 2012.

3 *The Economist*, "Reshoring Manufacturing: Coming Home," 19 January 2013.

4 Ibid.

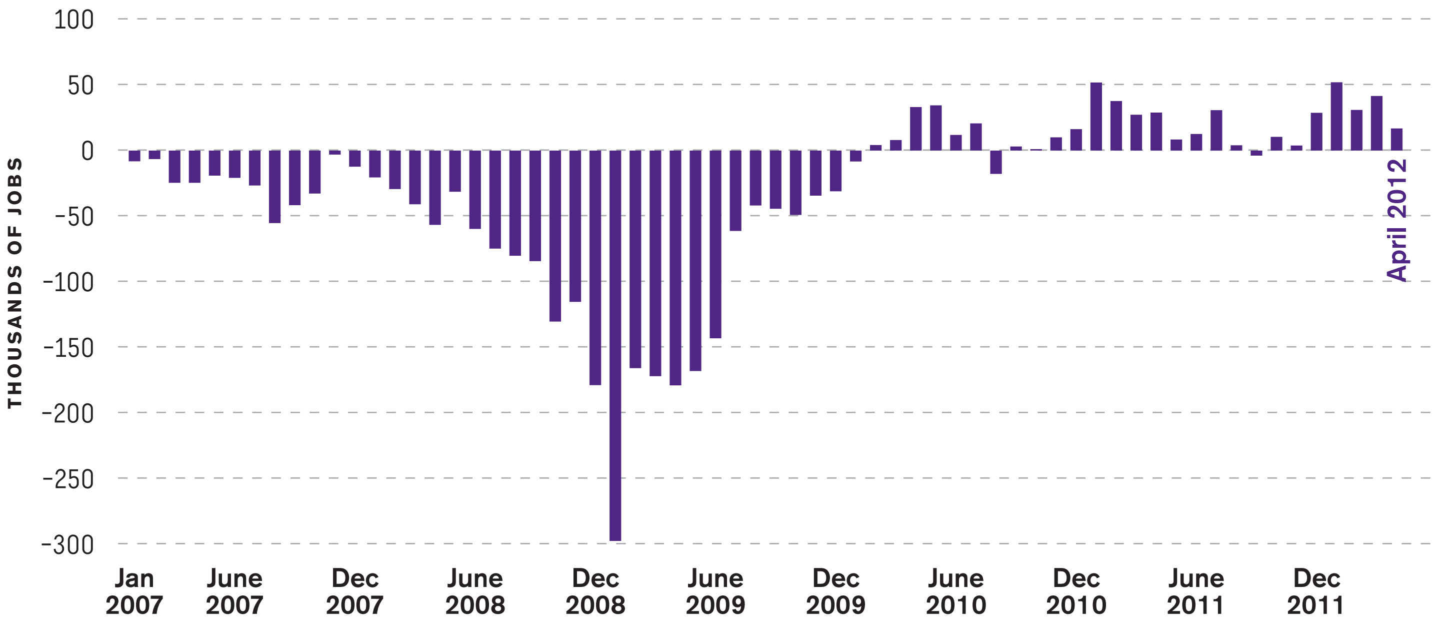
5 Ibid.

6 Ibid.

7 Brady, Jeff, "Gas Drilling Boom Brings New Life to Steel Industry," *National Public Radio*, 13 October 2011.

8 The Boston Consulting Group, *Made in America, Again*, August 2011.

Figure 1. Monthly Change in U.S. Manufacturing Jobs, January 2007–April 2012
Source: Bureau of Labor Statistics



After a decade of decline, this boost in manufacturing is a welcome development. However, competitive advantage gained largely through the comparatively low cost of production inputs is highly susceptible to world economic cycles, exchange rates and shifting factor advantages. In short, the current uptick in U.S. manufacturing is fragile. It is challenging for high-wage nations, such as the United States, to compete based on low price and high volume—i.e. commodities. The long-term competitiveness of the United States depends on its innovation ecosystem—that is, its ability to generate new technologies and translate them into new products, revitalize existing markets and create entirely new ones. It is important to ensure that recent, short-term trends do not distract from the investment needed in the U.S. innovation infrastructure to propel U.S. manufacturing into a new era of excellence that offers hope for good jobs, new innovations and a higher standard of living—in essence, America's competitiveness.

PART 1: INAUGURAL AEMC PARTNERSHIP DIALOGUE PRIMER

Clean Energy Manufacturing: the Time is Now

A vital path to revitalizing U.S. manufacturing is through harnessing the growth opportunities presented by the wide-reaching benefits of energy-efficient manufacturing and capturing competitive advantage in clean energy technology production by leveraging America's world-class science, technology and innovation capabilities.

The United States has come upon a distinct moment in the history of the energy landscape. Market and political forces—driven by industry and public support—are converging to create the national will to invest in, develop, manufacture and deploy clean energy technologies. At the same time, low-cost domestic resources and enhanced energy productivity are creating new and important opportunities for manufacturers operating in the United States to reduce their costs and grow their competitiveness. The nation must capitalize on this opportunity. As such, the inaugural dialogue of the American Energy and Manufacturing Competitiveness (AEMC) Partnership comes at a time advantageous to all interested stakeholders.

The global renewable energy (RE) sector has been on a decade-long rally, attracting $263 billion worth of investment in 2011 alone—a 600 percent increase over 2004 investment levels.[9] Driven by concerns about environmental, economic and national security—nations are expected to continue prioritizing investments in clean energy technologies. Global energy demand is projected to increase 44 percent by 2030 from 2006 values, including a 73 percent increase in energy demand from the non-OECD countries (Figure 2). Half of the new electricity generating capacity installed to meet this demand during the next 25 years, according to the International Energy Agency (IEA), will come from clean energy.[10] This will contribute, according to *Bloomberg New Energy Finance* estimates, to a global RE market expansion of up to $460 billion by 2030.[11]

> The global renewable energy market is expected to grow from $263 billion of investment in 2011 to $460 billion by 2030.

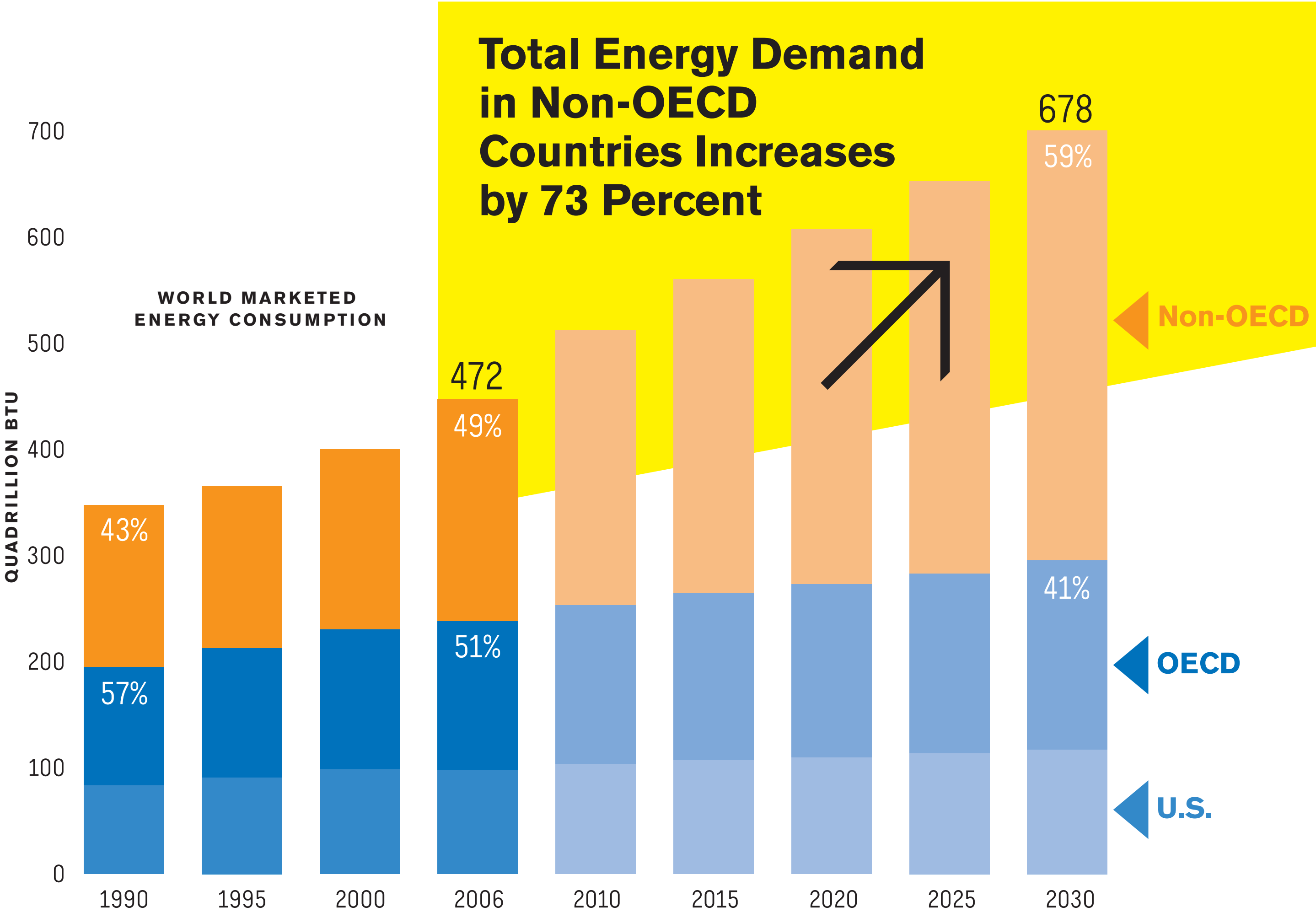
To be clear, this expansion is not limited to one nation, region or stage of development. Rapid adoption of clean energy technologies is occurring in the mature economies of the West, as well as the emerging economies of Asia and Latin America (Figure 3). Businesses, governments and communities are also embracing energy efficiency (EE), strengthening existing industrial technology markets, and creating new opportunities for businesses developing technologies and processes that reduce energy requirements. With demand for RE and EE technologies increasing in regions all over the world, the United States must gain a competitive foothold in the growing clean energy sector.

9 The Pew Charitable Trusts, *Who's Winning the Clean Energy Race?—2011 Edition*, 2012.

10 International Energy Agency, *World Energy Outlook 2011*, November 2011.

11 Bloomberg New Energy Finance, "Global Renewable Energy Market Outlook," November 2011.

Figure 2. Global Energy Demand Projected to Increase 44 Percent by 2030
Source: Energy Information Administration

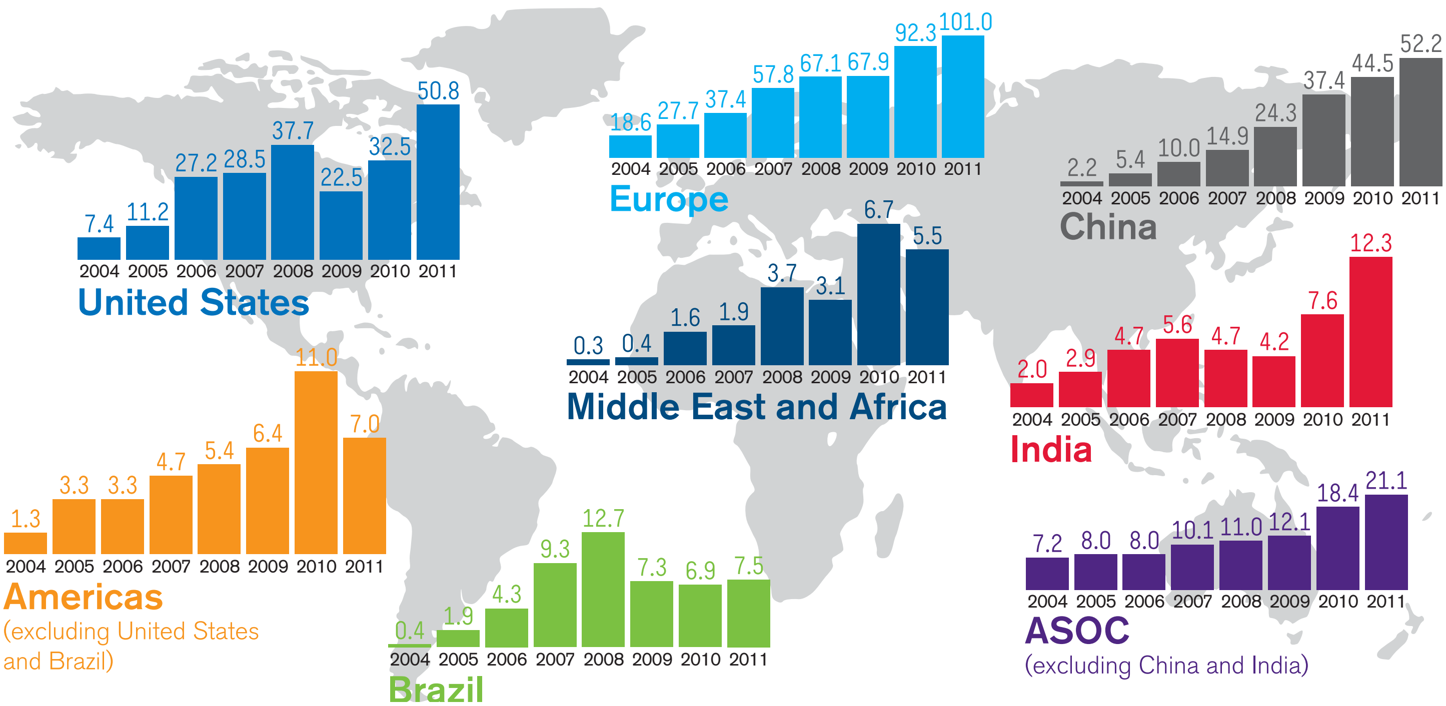


The Obama Administration has expressed its commitment to the related goals of a clean energy future and revitalized manufacturing sector for America. During his 2013 inaugural address, President Barack Obama exclaimed, "It's time to… double down on a clean energy industry that has never been more promising." Research shows that investment in clean energy helps create jobs, reduces harmful CO_2 emissions, and strengthens national security by decreasing U.S. dependence on foreign sources of oil. In the last 15 years, the amount of energy produced by wind and solar in the United States has more than doubled—with thousands of new well-paying jobs to show for it.[12] The Pew Charitable Trust estimates that 100,000 Americans were employed in the solar industry, and 75,000 in the wind industry, in 2011.[13] Gains are also made with the increased use of EE technologies. A Citigroup report states that demand for oil is dropping due in part to gains in EE. Moreover, emissions of CO_2 have been falling since 2005 due in part to EE improvements by vehicles, commercial buildings

12 U.S. Energy Information Administration, "Electric Power Monthly—January 2013," Accessed 28 March 2013.

13 The Pew Charitable Trusts, *Innovate, Manufacture, Compete*, 2012.

Figure 3. Global New Investment in Renewable Energy by Region, 2004-2011 ($Billion)
Source: *Bloomberg New Energy Finance*



and utilities.[14] When combined with the increased production of domestic oil and gas, the report goes on to say, energy productivity gains could help to ensure U.S. energy independence by the end of this decade.[15]

Though significant progress has been made toward cleaner and more secure energy sources, there is more work to be done. President Obama released the "Blueprint for a Clean and Secure Energy Future" in March of 2013. Included in this all-of-the-above energy strategy are investments in the development of RE and EE technologies, as well as the basic science that underpins this work. Moreover, the blueprint promotes policy measures that help build demand for these new or improved technologies into the market.

The United States needs to capture the value of current and future investments in clean energy by producing these technologies at home. In the words of Ms. Wince-Smith, "America's future productivity, prosperity, and security are functions of the success of our nation's manufacturing enterprise—and, more specifically, a manufacturing enterprise enabled by and generating clean energy and energy efficient technologies."

Fortunately, the nation's policymakers have not overlooked the centrality of manufacturing to U.S. prosperity. The 2010 reauthorization of the America COMPETES Act contains numerous advanced manufacturing provisions. The Act calls for the identification of barriers to U.S. manufacturing and encourages the development of public-private partnerships to address these barriers, ultimately enhancing U.S. manufacturing competitiveness.

14 Bloomberg New Energy Finance, "Sustainable Energy Factbook Release," 31 January 2013.

15 Clark, Aaron, "U.S. May Achieve Energy Independence This Decade, Citigroup Says," *Bloomberg.com*, 15 February 2013.

Building off these foundational provisions, President Obama successfully launched the creation of the National Additive Manufacturing Innovation Institute (NAMII)—the pilot facility for the National Network of Manufacturing Innovation (NNMI)—last year in Youngstown, Ohio. As the president explained, this institute "has the potential to revolutionize the way we make almost everything."

Furthermore, the president announced during his latest State of the Union address that he will take executive action in 2013 to co-create with the private sector and federal agencies (led by the departments of Energy and Defense) three additional institutes with an initial focus on manufacturing technologies that address critical needs.

The Obama Administration has also recognized the tremendous potential of industrial EE to improve the competitiveness of U.S. manufacturing by lowering energy costs and freeing up future capital for businesses to invest. In 2012, President Obama signed an executive order that—among other provisions—established a goal to have 40 gigawatts of new combined heat and power capacity installed by 2020, which has the potential to "save energy users $10 billion per year (and) result in $40 to $80 billion in new capital investment in manufacturing and other facilities that would create American jobs…" In his 2013 State of the Union Address, President Obama continued to promote the benefits of increased energy productivity by proposing the doubling the EE of the entire U.S. economy by 2030.

In preparation for this dialogue, the Council documented 184 distinct public policy recommendations supporting EE and RE technologies and manufacturing, made during the last four years by a range of non-profits, think tanks, research institutions, and governmental agencies.[16]

From this literature review, it is clear the focus on energy productivity and clean energy manufacturing is driven not only by the Obama Administration and Washington, D.C., community, but also by business leaders, the general public, and a range of think tanks and academic research institutions. In February of 2013, the Harvard Business School (HBS) published a survey focused on the state of U.S. competitiveness, including nearly 7,000 HBS alumni from 50 states and 115 other countries, as well as the views of more than 1,000 members of the general public. When asked about a set of policies that would improve U.S. competitiveness, a strong majority of business leaders and the general public supported the federal government prioritizing support "for clean energy manufacturers in the U.S. to invest and develop new technologies."[17]

These converging business, public and political interests have created a golden opportunity for the United States to move into a remarkable new era of industrial transformation, sustainability, innovation and market opportunity, while improving competitiveness and boosting American prosperity. The nation's innovation institutions—businesses, universities and national laboratories—must come together to optimize the U.S. energy portfolio and manufacturing capacity for long-term growth in productivity and prosperity. This is the context in which the Council and the U.S. Department of Energy (the Department) Office of Energy Efficiency and Renewable Energy (EERE) have come together to create the AEMC Partnership.

16 The Council on Competitiveness, *The Power of Partnerships*, April 2013.

17 Harvard Business School, *Competitiveness at a Crossroads*, February 2013.

PART 1: INAUGURAL AEMC PARTNERSHIP DIALOGUE PRIMER

American Energy & Manufacturing Competitiveness (AEMC) Partnership

The AEMC Partnership is a 3-year effort by the Council and EERE to bring together national leaders to address a rapidly shifting national and global energy landscape. In discussions, participants will uncover actions that can be taken during this distinctive time to enable America to bolster dramatically its energy, manufacturing and economic competitiveness during the next 20, 30, 40 years and beyond. This is a new partnership formed under the EERE's Clean Energy Manufacturing Initiative, a strategic integration and commitment of manufacturing efforts focusing on American competitiveness in clean energy manufacturing.

The AEMC Partnership is broadly divided into two phases, the first of which has been completed in preparation for this dialogue (Detailed in "AEMC Partnership Phase 1: Mapping the Landscape"). The Inaugural AEMC Partnership Dialogue signifies the beginning of phase two, which will include a series of four successive dialogues in 2013 to generate new insights pertaining to the overall goals of the AEMC Partnership—as well as present at least one concept for a public-private pilot project to advance further the initiative's goals. This year will culminate in an inaugural American Energy and Manufacturing Competitiveness Summit in December 2013 in Washington, D.C. Future dialogues will continue this conversation during the next two years.

The focus of the AEMC Partnership will be to identify means to:

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

Goals of the AEMC Partnership

- State and define key barriers, challenges and problems in U.S. competitiveness in manufacturing of clean energy products, EE products and advanced manufacturing products.
- Dive deeply into these problems and generate possible policies, solutions and models where the U.S. public and private sectors can work together to prioritize and solve these problems.
- Catalyze policy solutions–presenting several models for scalable, public-private partnership pilot projects–to increase competitive manufacturing of RE and EE products in the United States.
- Generate a proposal of at least one public-private partnership concept that could be carried out by EERE and/or the Council to increase the competitive production of clean energy products, EE products and advanced manufacturing products in the United States.
- Understand, elevate and increase awareness of the importance and benefits of competitive clean energy manufacturing in the United States, and explore other important energy and manufacturing issues impacting U.S. competitiveness.
- Understand how energy game-changers, like breakthrough technologies, impact U.S. clean energy and EE manufacturing.

PART 1: INAUGURAL AEMC PARTNERSHIP DIALOGUE PRIMER

Industrial Commons and PPPs

The AEMC Partnership seeks to boost U.S. competitiveness in clean energy product manufacturing and U.S. manufacturing competitiveness through enhanced energy productivity. Public-private partnerships (PPPs) and their capabilities and benefits are a valuable mechanism to explore.

What the recent uptick in manufacturing output obscures is what Gary P. Pisano and Willy C. Shih of the Harvard Business Review have called "the erosion of the industrial commons." Industrial commons, according to Pisano and Shih, are geographically rooted "collective R&D, engineering and manufacturing capabilities that sustain innovation."[18] This concept is at the center of the "clusters of competitiveness and innovation" work by the Council and Professor Michael Porter of the Harvard Business School.[19] Moreover, it is a key theme—under the names of innovation infrastructure or shared infrastructure—in recent writings on U.S. leadership in advanced manufacturing by the President's Council of Advisors on Science and Technology (PCAST) and the National Science and Technology Council (NSTC).[20, 21] A rich industrial commons—or innovation infrastructure—is essential if the United States intends to overcome competitive disadvantages in the production of clean energy technologies and to increase industrial EE.

Industrial commons are widely studied because of their ability to create a powerful, virtuous circle that feeds the growth of the vital innovation inputs, reduces the benefits of offshoring, and—most important—boosts regional productivity and prosperity. For example, biological scientists and engineers flock to the biotechnology cluster in the greater Boston area to tap regional knowledge networks and increase their chances of employment. Biotechnology firms are attracted to those same knowledge networks for partnership opportunities with complementary firms and access to top talent in the field.[22] A robust supply chain also will emerge to meet the equipment and service needs of both firms and researchers.

These centers of innovation—labor markets, businesses and universities—are more effective when they work together. This is due to the knowledge spillover effect—the inability for a firm to keep know-how completely private, which is common in knowledge-intensive sectors of the economy.[23] When located in a network, intellectual, financial and human capital flow between institutions at every phase of technology development, boosting the innovative capacity of all institutions involved. Moreover, recent research has revealed that for particular high-technology sectors—such as advanced materials fabrication, super-miniaturized assembly and specialty

18 Pisano, Gary P. and Willy C. Shih, "Restoring American Competitiveness," *Harvard Business Review*, July-August 2009.

19 The Council on Competitiveness, Michael E. Porter, Monitor Group, ontheFrontier, *Clusters of Innovation Initiative: Regional Foundations of U.S. Competitiveness*, October 2012.

20 President's Council of Advisors on Science and Technology, *Report to the President on Ensuring American Leadership in Advanced Manufacturing*, June 2011.

21 National Science and Technology Council, *A National Strategic Plan for Advanced Manufacturing*, February 2012.

22 Boston Consulting Group, *Made in America, Again*, August 2011.

23 Audretch, David B. and Maryann P. Feldman, "Knowledge Spillovers and the Geography of Innovation," *Handbook of Regional and Urban Economics*, Edition 1, Volume 4, Number 4, 2004.

chemicals (all important to clean energy technologies)—the presence of manufacturing in this regional network is a necessary innovation input.[24] All the benefits of this ecosystem produce social returns that are not available outside the ecosystem. Losing these social returns may outweigh the cost benefits of offshoring production, R&D, or both. This is exactly the type of dynamic that can help ensure the clean energy and EE products invented in the United States are produced here.

Industrial commons also can spur completely new industries. A historical example of this is when the U.S. military decided to establish armories—arguably the most successful public-private partnership in history—and have them produce weapons with interchangeable parts. This resulted in the development of the American system of manufacturing and the development of an industrial commons that provided the foundations for the manufacture of sewing machines, textile machinery, furniture, locks, clocks, bicycles, locomotives, machine tools and eventually automobiles.[25]

A more recent and relevant example is the success of solar panel manufacturing in China, Japan, Taiwan and Korea. Capabilities developed in the manufacturing of consumer electronics—flat panel displays—and semiconductors in the 1980s and 1990s allowed these countries to transition easily into solar panel manufacturing, which are based on the same foundational technologies and processes.[26] These regional capabilities in Asia explain—at least in part—the disadvantages the United States faces when competing in the clean energy economy.

The lesson is that future—seemingly unrelated—advances in clean energy science, technology and manufacturing are deeply connected to industrial commons. For example, the Department is focusing

Critical Materials Hub

A sustained, multidisciplinary effort to develop solutions across the lifecycle as well as reduce the impact of supply chain disruptions and price fluctuations of materials critical to technologies that enable wind turbines, solar panels, electric vehicles, and energy efficient—materials that could affect clean energy technology deployment in the coming years.

This hub plans to focus on:

- Diversifying supply;
- Developing substitutes;
- Improving reuse and recycling; and
- Conducting crosscutting research.

24 Pisano, Gary P. and Willy C. Shih, "Producing Prosperity," *Harvard Business Press*, 2012.

25 Hounshell, David A., "From the American System to Mass Production," The Johns Hopkins University Press, 1984.

26 Pisano, Gary P. and Willy C. Shih, "Restoring American Competitiveness," *Harvard Business Review*, July-August 2009.

on the advancement of high performance, lightweight materials to advance its EE mission. The ability to manufacture these products at scale, however, is dependent on tapping into the advanced materials industrial commons that are embodied in diverse industries such as aerospace, automotive, medical device, and consumer products.[27] Unfortunately, U.S. presence in these sectors has been fragmented by the decline of American manufacturing and the corresponding erosion of the industrial commons.

As the creation of industrial commons is both a public and private effort, so is their decline. Government commitment to R&D overall began to wane after the turn of the century and has been focused toward basic research more than applied research, as well as shrinking relative investments in the physical sciences.[28] Businesses have also been neglecting industrial commons. There has been a flight of hard assets to foreign competitors driven by a "buy verses build" paradigm enabled by the rise of a highly competitive world that offers more than just cheap labor. Data from Compustat shows that in the 2000s, U.S. companies began shifting investments from R&D and capital expenditures to stock dividends and buybacks, thus reducing their investment in manufacturing assets in the United States and abroad.[29] The decline of American industrial commons was certainty enabled by a challenging global landscape, but it was by no means inevitable. Decisions by both the private and public sectors contributed to a lack of investment in the foundational resources needed for a relevant, flourishing and innovative advanced manufacturing sector.

Fortunately, the private sector has a long history of partnering with the public sector to build—and rebuild—innovation infrastructure. The second industrial revolution was spurred by public investments in national railroad and communication systems. This allowed the private sector to leverage economies of scale, which enticed private firms to make large-scale investments in production, distribution and eventually R&D. The funding of the national highway system during the Eisenhower Administration had a similar effect. This interplay of public and private co-investment began the growth of industrial commons that firmly took hold after World War II, when the federal government took responsibility for supporting basic scientific research. Another oft-cited example is that of SEMATECH—an unprecedented industry/government partnership that is credited by some for sustaining U.S. leadership in the semiconductor industry after the rise of competition from Japan and Europe in the 1980s. These examples—among others—have led academics, business leaders and non-government organizations to see the creation of new public-private partnerships as a key component in boosting the competitiveness of U.S. manufacturing of clean energy and EE products.[30]

Though businesses, universities and communities will ultimately be responsible for rich, clean energy manufacturing industrial commons, public-private partnerships are distinctly capable of promoting the factors that encourage their development.

27 Pisano, Gary P. and Willy C. Shih, "Restoring American Competitiveness," *Harvard Business Review*, July-August 2009.

28 The National Science Foundation, *Science and Engineering Indicators 2012*, "Chapter 4. R&D: National Trends and International Comparisons," Accessed 28 March 2013.

29 Pisano, Gary P. and Willy C. Shih, "Producing Prosperity," *Harvard Business Press*, 2012.

30 The Council on Competitiveness, *The Power of Partnerships*, April 2013.

As previously explained, innovation infrastructure is deeply connected to the regional clustering of firms, talent and research institutions. Research on agglomeration effects and empirical evidence reveal that there are three broad factors that entice clustering: labor market pooling, common infrastructure and knowledge spillovers.[31] Some of the most productive and innovative technology clusters—such as Silicon Valley, Route 128 and Research Triangle—have developed organically, with the investments from both the public and private sectors. Nonetheless, deliberate actions can be taken to promote the factors that incentivize clustering, and public-private partnerships are uniquely capable of these actions.

The benefits of PPPs go well beyond the elemental contributions they make to industrial commons. PPPs strengthen the ideas-to-market chain (the perennial challenge of science and technology policy) and increase the return on R&D spending by linking knowledge creation, sources of capital and enterprises that can deploy new technologies.[32] Additionally, PPPs that include both small and medium-sized enterprises (SMEs) and large corporations as members increase the chances of success for innovative SMEs, revitalize the corporations and strengthen local supply chains—all of which generates new jobs.[33] Large companies also find advantage in providing SMEs with capital equipment—such as high performance computing. This strengthens the full supply chain, improves the competitiveness of all stakeholders, further strengthens local ties and creates disincentives to offshoring.

Partnering employers with educational institutions—namely community colleges—is tremendously valuable for working Americans, as labor market needs are not easily communicated between employers and employees. Public-private partnerships form a mechanism to convey rapidly the workforce needs of manufacturing firms to the local labor pool and can help develop the necessary training programs. This is a pivotal tool in addressing the well-known skills gaps that many U.S. manufacturers face.[34]

Industrial commons are critical to the nation's innovative capacity, which is essential to sustaining competitive advantage in a world where advantages are constantly shifting. Unfortunately, both the private and public sectors have neglected this innovation infrastructure. Nonetheless, public-private partnerships are particularly capable of rebuilding the industrial commons. The AEMC Partnership is a forum for national leaders from businesses, universities, labor and national laboratories to inform and develop a public-private partnership with the potential 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.

31 Marshall, Alfred, *Principles of Economics*, MacMillan, 1980.

32 Kanter, Rosabeth Moss, "Enrich the Ecosystem", *Harvard Business Review*, March 2012.

33 Ibid.

34 American Society for Training & Development, *Bridging the Skills Gap*, October 2012.

Examples of three factors and the actions taken by three PPPs to address them.

Developing Skilled Labor	Shared Infrastructure	Knowledge Spillover
The National Additive Manufacturing Innovation Institute (NAMII) is committed to developing the labor force necessary for an additive manufacturing ecosystem to prosper in the United States. This is achieved by including community colleges and workforce development organizations as partnership members, and by ensuring workforce training and educational outreach are part of the projects NAMII selects and funds. A regional workforce with the unique skills in advanced additive manufacturing draws enterprises hoping to tap this labor pool.	The Manufacturing Demonstration Facility at Oak Ridge National Laboratory (ORNL-MDF) provides industry access to physical and virtual tools, as well as R&D expertise for the design, evaluation and rapid prototyping of new technologies and optimizing essential manufacturing processes. This common innovation infrastructure may factor into a firm's calculus for siting a production facility—just as firms calculate siting decisions based on the availability of traditional public infrastructure like airports and seaports.	The most common form of knowledge spillover occurs with the movement of workers between complementary firms. The Industrial Technology Research Institute's (ITRI) built-in quota for annual employee turnover promotes diffusion of public and private co-development knowledge into the external market, in addition to helping ensure innovation does not stagnate within the Institute.

To inform the inaugural AEMC Partnership dialogue, help cultivate topics for the subsequent progressive dialogues, 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 to:

- Understand the scope of research to date on the links between EE efforts, RE and manufacturing competitiveness; barriers to manufacturing competitiveness as they relate to energy; and models for PPPs for fostering competitive industries.
- Identify links, barriers and public-private partnership models that have not been studied or on which studies are out of date.

The purpose of this literature review is to provide a resource for the AEMC Partnership dialogue series for establishing effective PPP concepts to advance competitive manufacturing of clean energy products in the United States, and to advance the competitiveness of manufacturing in the United States across the board through enhanced industrial energy productivity. The findings in this report will be discussed, and expanded on in dialogues to design critical PPPs for advancing the AEMC Partnership's goals. The literature review is documented in the Council publication *The Power of Partnerships* and the accompanying infographic titled *A Summary of Public-Private Partnerships*, both of which can be found at www.compete.org. The following section summarizes key findings.

PART 1: INAUGURAL AEMC PARTNERSHIP DIALOGUE PRIMER

AEMC Partnership Phase 1: Mapping the Landscape

Manufacturing Barriers

The Council has derived and summarized seven barriers in the United States that relate to manufacturing clean energy products and enhancing energy productivity in the manufacturing sector. These barriers fall under three broad categories: Enabling Innovation, Securing the Talent Pipeline, and Improving the Business Climate.[35]

Barriers to ***innovation*** in clean energy technologies, foundational advanced manufacturing technologies and manufacturing processes include:

- **Capital Requirements:** The two "valley of death" zones wherein start-up companies struggle to meet their capital requirements present a barrier to both technology development and manufacturing at scale.
- **Innovation Infrastructure:** A lack of shared infrastructure and expertise from which industry scientists and engineers can draw to increase speed and lower costs on the path to production and commercialization hinders innovation and decreases the likelihood that production is established in the United States.
- **Low Investment in Advanced Manufacturing Technology:** The current level of investment in advanced manufacturing technologies and processes that would convey an advantage to the United States, if leveraged here first, is currently too low.

The ***talent*** barrier, also referred to as the "skills gap," is consistently ranked by CEOs as the top impediment to manufacturing competitiveness. This barrier refers to the limited availability of skilled workers—such as researchers, scientists, engineers, skilled welders and production technicians—to meet the needs of manufacturing firms.

Business leaders and industry associations will often cite the ***business climate*** as a barrier to locating manufacturing in the United States:

- **Structural Costs:** As defined by the Manufacturing Institute and the Manufacturers Alliance for Productivity and Innovation (MAPI), structural costs include the U.S. expense of corporate taxes, employee benefits, tort litigation, regulatory compliance and energy costs. High structural costs, compared to the costs of operating a facility within the borders of America's largest trading partners, drive manufacturing abroad.
- **Public and Cyber Infrastructure:** The diminishing quality of physical (largely public) and cyber infrastructure on which manufacturers rely—including roads, rail, ports, dams, air transport, energy transmission, communication networks, and water supplies—is currently in need of significant investment and improvement.
- **Trade Policy:** Trade barriers include (1) the cost to U.S. manufacturers to source and export globally versus their competitors, (2) U.S. export controls, and (3) non-tariff trade barriers and market distortions that arise from foreign government subsidies to their domestic producers.

35 Note: These categories were adapted from the July 2012 President's Council on Science and Technology report, *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing.*

The Council acknowledges a fourth type of manufacturing barrier that has been labeled "Addressing Clean Energy Market Risks" and includes issues such as split incentives, technical risks, low-cost incumbent energy sources, bounded rationality, etc., that tend to lower global demand for clean energy technologies and, thus, limit the potential for domestic production of these technologies. Though outside the scope of the barriers discussion, clean energy market risks were explored as they relate to PPPs.

Policy Analysis

Of the 184 sources, 28 studies produced public policy recommendations to the federal government. As such, these reports received a more extensive side-by-side analysis. Each recommendation was categorized and grouped with similar recommendations made within the 28 studies. This expansive dataset is located on the Council website (www.compete.org). The most commonly targeted subjects across the reports are tax policy, improving innovation institutions, procurement, talent and research. Fourteen of the reports advocated for the creation of public-private partnerships to spur U.S. clean energy innovation, manufacturing and increased industrial energy productivity.

Public-Private Partnership (PPP) Analysis:

There were few PPPs that focused solely on clean energy and enhanced energy productivity. The Council performed a cursory review of 30 domestic and international PPPs, 19 of which were chosen because of their relevance to clean energy manufacturing competitiveness and energy productivity. Additional PPPs will be considered and explored in the forthcoming dialogues.

Those 19 PPPs examined were further analyzed across 23 different characteristics used to populate a side-by-side analysis, also available on the Council website (www.compete.org). Those 19 PPPs were grouped into four broad characterizations.

Early Market PPPs tend to focus predominantly on research for technologies that are less established in the market and/or have few mature firms able or willing to support a PPP on their own. Some Early Market PPPs also engage in prototyping and early commercialization activities. Several of the Energy Innovation Hubs fall into this category, working for example on battery technologies, rare earth mineral substitutes or artificial photosynthesis. Industry often partners in Early Market PPPs, but tends not to lead them due to the earlier stage of the market or technology.

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.

Test Bed / Demonstration PPPs have a primary function of testing and demonstrating technologies—other PPP models in this study may include testing and demonstration functions, but as secondary or tertiary goals.

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, such as advanced manufacturing technologies under the NNMI or nanotechnology applications under the Interuniversity Microelectronics Centre.

It is important to note that, rather than a strict categorization, the Council suggests considering the predominant characterization of each public-private partnership. For example, a PPP may have the primary function of a Mature Market PPP, but also have attributes of a Test Bed/Demonstration PPP. With this in mind, Figure 4 reveals the PPPs analyzed by the Council and their respective characterization.

Insights

After analyzing the data on each PPP and reviewing the relevant literature, the Council developed insights to help understand: (1) how to match PPP models to clean energy technology challenges, (2) the optimal scope of PPP activities across Technology Readiness Levels, (3) which manufacturing barriers PPPs are well-suited to address, (4) the government role in PPP funding and formation, and (5) critical success factors for PPPs.

Key Highlights from the PPPs Analysis

- Technology Readiness Levels (Figure 5) are essential to structuring a PPP—the first step toward matching a PPP to a particular EE or RE manufacturing challenge is to assess the market readiness and availability of test bed facilities for a particular technology or basket of technologies.
- To take advantage of the virtuous feedback loop between production and innovation, a PPP is more likely to be effective if it extends across Technology Readiness Levels.
- Not all barriers to clean energy product manufacturing and energy efficient manufacturing are most effectively addressed by PPPs; capital requirements, innovation infrastructure, low investment in advanced manufacturing technologies,

Figure 4. Public-Private Partnerships Characterized by Model
Source: Council on Competitiveness, *The Power of Partnerships*, 2013.

PPP Model	PPPs Analyzed by Council
Early Market (E)	Joint Center for Energy Storage Research (JCESR)
Mature Market (M)	Commonwealth Center for Advanced Manufacturing (CCAM) Fraunhofer Center for Sustainable Energy Systems (CSE) SEMATECH Smart Grid Interoperability Panel (SGIP) Photovoltaic Manufacturing Consortium (PVMC) PDES, Inc.
Test Bed / Demonstration (T)	Energy Efficient Buildings (EEB) Hub NextEnergy Oak Ridge National Laboratory—Manufacturing Demonstration Facility (ORNL-MDF) Solar Technology Acceleration Center (SolarTAC)
Innovation Network (I)	National Additive Manufacturing Innovation Institute (NAMII) National Network of Manufacturing Innovation (NNMI) National Digital Engineering and Manufacturing Consortium (NDEMC) Catapult Centres (Catapult) Industrial Technology Research Institute (ITRI) Fraunhofer-Gasellschaft (Fraunhofer) Interuniversity Microelectronics Centre (IMEC) GTS Advanced Technology Group (GTS)

talent, and clean energy market risks are commonly addressed by PPPs, while structural costs, public and cyber infrastructure, and trade policy are largely addressed using policy.

- Federal and state governments play critical roles in the formation of PPPs as both a key funder (seed and long-term) and neutral convener—bringing stakeholders together to tackle problems they would not pursue on their own.
- PPP Success Factors:
  - Strong leadership
  - Clear, compelling mission
  - Early funding stream to establish a PPP, usually from the public sector
  - Intellectual property practices that draw corporate participation
  - Participation across industry value chains
  - Engagement by multiple large companies
  - Affordable membership terms for small companies
  - Regional organization or other mechanism to engage entrepreneurs and risk capital community
  - Talent development
  - Universities and institutions with a culture of applied research
  - Demonstrably positive community impact
  - Acceptance of high failure rates for new firms and products
  - Establishment or enhancement of standards, as needed
- Literature Review "White Space": Most of the PPPs reviewed expressed the importance of success metrics and measurements systems, however, few PPPs actually have precise measurement systems and metrics. A similar conclusion was drawn regarding intellectual property (IP)—all PPPs promote the importance of IP protection, but there are few insights on best practices.

Figure 5. Technology Readiness Levels (TRLs)

Source: Department of Energy, Office of Energy Efficiency and Renewable Energy

	Research & Development							Technology Deployment
TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9
Basic Research	Applied Research	Proof of Concept	Testing Components or Processes	Testing Systems	Prototype System Verified	Pilot System Demonstrated	System in Commercial Design	Ready for Full Commercial Deployment
Innovation			Emerging Technologies			Systems Integration		Market Penetration

PART 1: INAUGURAL AEMC PARTNERSHIP DIALOGUE PRIMER

Key Questions for the Inaugural Dialogue

What barriers to the U.S. manufacturing of clean energy products and increased energy productivity in the manufacturing sector can a public-private partnership effectively address—and what public policies can complement this effort?

What are the common and unique barriers and roles of public-private partnerships in the manufacturing of clean energy products, and increasing energy productivity in the manufacturing sector?

Of the PPP models described in *The Power of Partnerships* report produced for the inaugural AEMC Partnership dialogue, what models would be optimal for existing and/or emerging clean energy, increased energy productivity and foundational manufacturing technologies?

What steps or actions would most improve the U.S. current clean energy manufacturing landscape and generate the greatest return on investment?

What priority areas (technologies, barriers, infrastructures, stakeholders, etc.) should the AEMC Partnership and the eventual PPP model target?

What aspects of a PPP would incentivize your organization's involvement or keep it from participating (i.e. what are the must-haves and deal breakers)?

As a stakeholder, what do you see as the benefit of participating in a PPP, and what are you willing to trade for that participation?

Is one of the four PPP models more attractive than another?

PART 1: INAUGURAL AEMC PARTNERSHIP DIALOGUE PRIMER

Looking Forward

A range of major studies, initiatives and efforts across the nation during the past quarter century have made the case that manufacturing remains a core driver of U.S. competitiveness, innovation and job creation—even as automation and technology make manufacturing more efficient. Creating the conditions that foster the promotion of EE, the adoption of clean energy technologies, and the deepening of clean technology manufacturing investment in the 21st century, while propelling private sector innovation and elevating EE management to a more strategic level, will help to improve dramatically the U.S. economy, U.S. job growth, the environment, national security and U.S. living standards–in essence, America's competitiveness. It will also lead the United States to the forefront of a remarkable new era of technological advances, market and industrial transformation, and innovation of all kinds on every scale.

As innovators, investors and adopters, the private sector is the pivotal actor at the nexus of clean energy technology manufacturing. Nonetheless, the government has the power to strengthen the business case for investment and innovation in clean technology manufacturing solutions. Together, the public and private sectors must set the enabling conditions on a number of interdependent fronts to have an impact on EE, technological innovation, investment, infrastructure modernization and workforce readiness to unleash the inherent investment and innovative capacity of American enterprises and create a U.S. clean energy manufacturing revolution.

PART 2
Findings from the Inaugural AEMC Partnership Dialogue

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

Introduction

As a part of EERE's Clean Energy Manufacturing Initiative and the Council's continued efforts in energy and manufacturing, EERE and the Council formulated the American Energy & Manufacturing Competitiveness (AEMC) Partnership. This three-year partnership brings together national leaders to address a rapidly shifting national and global energy landscape and uncovers actions that can be taken now to enable America to build on this distinctive time in its energy history to bolster dramatically its energy, manufacturing and economic competitiveness over the next 20, 30 , 40 years and beyond. The inaugural dialogue was the first in a series of four dialogues over the first year of the AEMC Partnership, aimed at developing a potential public-private partnership (PPP) as an actionable vehicle in which the public and private sectors work together to advance clean energy manufacturing.

This inaugural dialogue convened leaders from nearly every sector of the economy, all of whom understand the importance of and are committed to enhancing U.S. competitiveness in the clean energy manufacturing sector.

To focus the dialogue, Dr. Danielson posed the following questions:

- How do we capitalize on the investments in R&D that have been made by the U.S. government and the private sector in the previous 30 years to develop and manufacture clean energy technology here in the United States?
- How do we implement new energy efficient technologies across the spectrum of manufacturing industries?
- As other nations continue to increase their investment in R&D and technology innovation, where should the United States target investments to remain a top innovating country in the global marketplace?
- How should the U.S. apply its higher education advantage in the STEM fields to ensure an appropriately trained workforce across all elements of the manufacturing value chain?

This first dialogue served to frame future discussions on concepts for a PPP that EERE and the members of the Council could carry out to increase the competitive manufacturing of clean and energy efficient products in the United States. The rich conversation throughout the two-day dialogue centered on research areas that could benefit from intense focus and support from the public and private sectors. Central to the dialogue was the exploration of possible methods to structure PPPs to leverage existing expertise and capabilities in academia, national laboratories, industry, and the public sector.

The dialogue's opening comments highlighted several important areas ready for public and private sector investment. These include: scaling up technologies from prototypes to mass manufactured products; developing advanced materials; using tools—like modeling and simulation, robotics, sensors, big data, additive manufacturing—to bolster manufacturing competitiveness; and, taking advantage of shale gas and liquids resources without undermining further development in non-fossil fuel based clean energy technologies.

The Honorable David Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, 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, The White House National Economic Council; Ms. Elizabeth Wayman, Director, Clean Energy Manufacturing Initiative, Office of Energy Efficiency and Renewable Energy, Department of Energy; Mr. Chad Evans, Executive Vice President, Council on Competitiveness.

Creating PPPs is one serious approach to accelerate the development of clean energy technology and increase U.S. manufacturing competitiveness—PPPs were the focus of Council research preceding this dialogue.[1, 2] Through this research, the Council determined that pulling together a successful PPP requires attention to many factors and drivers, including: selecting the appropriate Technology Readiness Level (TRL) to affect the biggest outcome; understanding the full spectrum of financing options; weighing the advantages and disadvantages of strategic intellectual property management; co-designing the solution to a selected problem; and structuring a partnership with both successful and unsuccessful outcomes in mind.

1 Council on Competitiveness. The Power of Partnerships. April 2013. Available at: http://www.compete.org/publications/detail/2473/the-power-of-partnerships/.

2 Council on Competitiveness. A Summary of PPPs. April 2013. Available at: http://www.compete.org/publications/detail/2474/a-summary-of-public-private-partnerships/.

Dialogue participants kept an eye on the over-arching goal to generate one or more potential concepts for scalable PPPs the DOE and/or members of the Council could carry out to increase the competitive manufacturing of clean energy and energy efficient products in the United States. Specifically, participants targeted portions of the innovation cycle in discussions, with detailed thinking in terms of achieving a quantifiable success and broad thinking in terms of creating an advanced manufacturing industry. By investing resources in targeted areas, dialogue participants stated that stakeholders in government agencies and the clean energy and manufacturing sectors can create incentives to attract members of the private sector into strengthening clean energy manufacturing and in turn build a highly efficient energy economy to grow gross domestic product (GDP). These efforts will foster an innovation ecosystem that retains jobs located in the United States, creates jobs in the clean energy technology and manufacturing space, and repatriates jobs with companies returning manufacturing plants to the United States.

The actions prompted by the AEMC Partnership dialogues will induce innovation, implementation, and impact in the U.S. clean energy manufacturing sector. The inaugural dialogue, though largely foundational, began the process of narrowing the field of clean energy manufacturing to a subset of platforms with the potential to advance the goals of the AEMC Partnership. Private and public sector leaders highlighted three areas for further discussion: the distinctive ability of materials science and engineering to affect the competitiveness of clean energy products as well as drive energy efficiency across a multitude of industrial sectors; the ability for institutionalized systems and processes to transition better prototypes to commercially deployable products and reduce the number of technologies stranded in U.S. research centers; and the ability for improved communication within the innovation ecosystem to unleash collaborative capabilities and expertise instrumental in reinvigorating the clean energy and manufacturing sectors.

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

Leadership Perspective

During the Leadership Perspective session, Dr. Dan Arvizu, Director and Chief Executive of the National Renewable Energy Laboratory (NREL) and Chairman of the National Science Board, shared his thoughts on taking advantage of the cumulative investment in research the United States has poured into the clean energy and advanced manufacturing fields to become leaders in producing clean energy products and optimizing the U.S. manufacturing sector.

Dr. Arvizu observed that the clean energy economy is global and rapidly moving. Advances in research and development can be quickly deployed by the manufacturing sector. From his perspective, clean energy products can be developed, manufactured and deployed in any country—and countries around the world are vying for leadership. Historically, the United States has led the field of clean energy; the U.S. cumulative investment in clean energy has been substantial—more than 270 billion U.S. dollars from 2004-2012.[3] To use the solar sector as an example, solar energy technology used and manufactured world-wide was originally developed in the 1980s and 1990s largely by government-funded researchers in the United States. In spite of this investment, the United States had a total of only 4.5 gigawatts of solar energy technology deployed in 2011[4]—a small percentage of the 100 gigawatts of solar energy deployed globally.[5] While the United States led the world in 2011 in venture capital and research and development investments in overall clean energy technologies, China led the world in solar energy technology manufacturing and wind energy technology investment, manufacturing, and deployment in the same year.[6] According to Dr. Arvizu, other countries are reaping the benefits of energy technologies developed here in the United States by selling and deploying these products.

Dr. Dan Arvizu, Director and Chief Executive, National Renewable Energy Laboratory and Chairman, National Science Board

Should the United States wish to recapture leadership in the clean energy sector, Dr. Arvizu stated that there is a major advantage to lever—the surge in available, domestic shale gas and liquids. Shale gas and liquids represent low-cost electricity with lower CO_2 emissions than electricity generated from burning other fossil fuels as well as a low cost feedstock for many manufacturing processes. According to Dr. Arvizu, the United States should use this competi-

3 Bloomberg New Energy Finance. Global Trends in Clean Energy Investment. July 11, 2013 Accessed July 29, 2013. Available at: http://about.newenergyfinance.com/about/fact-packs/global-trends-in-clean-energy-investment-q2-2013-fact-pack/.

4 United States Energy Information Administration. Annual Energy Outlook 2013: Market Trends – Electricity. May 2013. Available at: http://www.eia.gov/forecasts/aeo/MT_electric.cfm#solar_photo.

5 Green Tech Solar. "More than 100 Gigawatts of Solar PV Now Installed Worldwide." Published: February 11, 2013, Accessed: July 5, 2013. Available at: http://www.greentechmedia.com/articles/read/global-solar-pv-capacity-passes-the-100-gigawatt-mark.

6 The Pew Charitable Trusts. Who's Winning the Clean Energy Race? 2011 Edition, Available at: http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Report/FINAL_forweb_WhoIsWinningTheCleanEnergyRace-REPORT-2012.pdf.

tive differentiator to surge ahead in the field of clean energy—creating a bridge to develop innovative technology and manufacturing process solutions in the clean energy sector that are cost-competitive or economically preferable to fossil fuel based power sources. A danger the nation must monitor is using this shale gas and liquids advantage solely to subsidize the cost of electricity or manufacturing without concurrently investing in innovative new clean energy technology and processes for the future. Should the lead provided by shale gas and liquids be temporary (as other countries learn how to unlock their own shale reserves), using shale gas and liquids to subsidize business-as-usual processes would lead to a future where the United States is faced with a similar situation.

The United States needs solutions to improve the state of clean energy development and manufacturing. By investing in research and development, the nation can reduce the cost of clean energy technologies to compete with products sold by foreign countries and incumbent fossil fuel-based power technologies. By investing in domestic manufacturing, the nation can further enhance its ability to innovate in the production of these products in addition to strengthening its industrial base and manufacturing sector. Private sector leaders can pave the way to a clean energy-fueled future by creating a strategic investment plan for the long-term productivity and prosperity of the United States based on competitive clean energy technology production and increased energy productivity in the manufacturing sector in general.

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

State and Define

The first panel of the dialogue focused on stating and defining the key competitiveness barriers, challenges, and problems facing the manufacturing of clean energy and energy efficiency products and increased industrial energy productivity.

The panel consisted of Dr. J. Michael McQuade, Senior Vice President, Science & Technology at United Technologies Corporation, who moderated the discussion between Mr. Thomas Baruch, Partner at Formation 8 Partners; Mr. Paul Gilman, Chief Sustainability Officer and Senior Vice President at Covanta Energy Corporation; Dr. Pradeep Khosla, Chancellor at University of California, San Diego; and Mr. Frank Wolak, Vice President at FuelCell Energy, Inc. Questions shaping the conversation included:

- What are the key barriers, challenges, and problems impeding U.S. competitiveness in manufacturing of clean energy and energy efficiency products?
- How do these barriers, challenges and problems relate to those in increasing energy productivity in the manufacturing sector?
- What are the key characteristics of the rapidly shifting national and global energy landscape underpinning these barriers, challenges, and problems?
- What actions can the nation undertake over the next 5-10 years to seize on the opportunities presented by this distinctive time in its energy history and to bolster dramatically America's energy, economic and manufacturing competitiveness over the next 20, 30, 40 years and beyond?

Mr. Thomas Baruch, Partner, Formation 8 Partners; Mr. Paul Gilman, Chief Sustainability Officer and Senior Vice President, Covanta Energy; Dr. Pradeep Khosla, Chancellor, University of California, San Diego; and Mr. Frank Wolak, Vice President, Fuel Cell Energy, Inc.

This discussion defined several key barriers and challenges impeding the overall development of the U.S. manufacturing sector. Participants discussed the creation of PPPs to facilitate the collaboration of stakeholders in clean energy manufacturing to bolster dramatically America's energy, economic and manufacturing competitiveness over the next 20 years and beyond.

The introduction of low cost shale gas and liquids, along with technical progress in developing, manufacturing, and deploying clean energy technology have strengthened the U.S. energy portfolio and diversified it in recent years. However, as highlighted by Chancellor Khosla, it is critical that political leaders, policymakers, the business community, and the nation at large are cognizant of America's salient energy trends: the United States uses and

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

will continue to use increasing amounts of fossil fuels each year and the power grid is approaching saturation—a growing capacity problem as the need for electricity increases. Additionally, the country retains a continual interest in reducing dependence on foreign fossil fuels.

Increasing the deployment of clean energy technologies can reduce U.S. dependence on foreign fuels, but impediments to increased deployment of clean energy technologies remain. Dialogue participants discussed these impediments, principally including inconsistent, confusing, and unstable energy policy, a business climate wary of new technologies, and a financial sector that is only sluggishly unlocking access to investment capital. If the United States is to realize a meaningful shift toward clean energy technology, the United States must create coherent and consistent national policy supporting clean energy technology development, manufacturing, and deployment.

In addressing these potential problems through policy, the United States should harness its competitive advantages including natural resources, knowledge resources, and human resources. As highlighted by Dr. Arvizu and pointed out earlier in this document, the increased abundance of inexpensive domestic shale gas provides a competitive but possibly temporary natural resource advantage to the U.S. manufacturing sector in a global marketplace. Panelists stated that the nation should become a leader in developing, manufacturing, and deploying technologically advanced, high-efficiency clean energy products before the competitive advantage provided by domestic shale resource availability disappears.

Mr. Baruch discussed the competitive advantages of a culture and economy in which innovation, entrepreneurship, and collaboration throughout the innovation ecosystem are inherent. He suggested that clean energy technology development, manufacturing, and deployment are in the long-term interest of the domestic economy, these competitive advantages should be applied toward the clean energy sector.

Mr. Wolak stated that energy technology development and manufacturing are intricately intertwined and sensitive to market forces. According to Mr. Wolak, the United States could benefit by finding pockets of raw demand, where market forces can encourage the acceptance and implementation of

innovation. To enhance further the U.S. competitive advantage in innovation, Dr. McQuade shared that technologists, manufacturers and the federal government need to team up as they have in the past and create targeted PPPs that bring new ideas and products to market quickly and effectively. This public-private investment can be directed at a particular technology to advance clean energy manufacturing. As mentioned by Chancellor Khosla, renewable energy technologies hold a lot of promise to reduce U.S. dependence on fossil fuels, but these technologies do not integrate easily into the existing infrastructure. The United States could, for example, meet an immediate need in the field of renewable energy technologies by investing in power electronics to solve the challenge of converting alternating current to direct current (rectification).

A PPP could also bridge a gap in the technology development and deployment cycle. Mr. Gilman suggested putting in place a PPP to increase connections between industry and experts in the national laboratories and universities—simplifying access to technical experts who can quickly address industrial needs. Another approach to facilitating clean energy manufacturing would be to create an easy and defined process to transition a prototype to a mass-manufactured product, as described by Mr. Thomas Baruch. A PPP offering consulting services in how to re-design a prototype to be easily manufactured with a high degree of automation simplifies the current transitions of a prototype to a mass-manufactured product. This re-design for increased automation can make manufacturing in the United States cost-competitive with labor-intensive manufacturing processes in low-wage countries, according to Chancellor Khosla. A third approach, described by Mr. Wolak focuses on increasing the velocity of releasing capital in the technology marketplace—using a public-private investment to reduce risk.

The discussion in the State and Define panel laid the foundation for the rest of the dialogue's conversation. By highlighting barriers and challenges in the clean energy technology innovation ecosystem, participants highlighted the leverage points—where public-private investments could create more value within the marketplace and strengthen U.S. competitiveness in clean energy manufacturing.

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

Perspectives from the National Laboratories

The second panel of the dialogue convened leaders from U.S. Department of Energy national laboratories who shared their perspectives on working towards a future with increased U.S. competitiveness in clean energy products and increased energy productivity in the U.S. manufacturing sector.

Arguably, the United States still has the world's best universities and national laboratory system, and these institutions represent a clear competitive advantage in stimulating innovation and growth in the clean energy sector. During the Perspectives from the National Laboratories panel session Dr. Thomas Mason, Director of Oak Ridge National Laboratory moderated the discussion with kick-off discussants Dr. Steven Ashby, Deputy Director for Science and Technology at Pacific Northwest National Laboratory and Dr. William Goldstein, Deputy Director for Science and Technology at Lawrence Livermore National Laboratory. The discussion was framed with the following questions:

- How can the United States leverage the distinctive capabilities of national labs to enhance clean energy manufacturing?
- What are the benefits and challenges of participating in partnerships between industry, national labs and academia?
- What drives success when advancing clean energy and energy efficiency technology manufacturing through partnerships?
- Are there different drivers to propel increased energy productivity across the entire industrial base?

Dr. Thomas Mason, Director, Oak Ridge National Laboratory; Dr. Steven Ashby, Deputy Director for Science and Technology, Pacific Northwest National Laboratory; and Dr. William Goldstein, Deputy Director for Science and Technology, Lawrence Livermore National Laboratory

The general discussion of this panel focused on how the U.S. innovation ecosystem of industry, academia, and the national laboratories can be a powerful and stimulating factor for increasing U.S. economic competitiveness. As explained by Dr. Ashby, industry leaders are well positioned to offer a crisp definition of the problems they face. Members of private industry also have inherent R&D capabilities—often tied directly to their manufacturing processes and products—and a clear understanding of what needs to be done. Academia brings broad and deep disciplinary strengths. The national laboratories have deep expertise in basic and applied science, and excel at taking multi-disciplinary approaches to problem-solving.

Ms. Elizabeth Wayman, Director, Clean Energy Manufacturing Initiative, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy; Dr. Tomás Díaz de la Rubia, Director, Deloitte Consulting LLP; the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; and Dr. Steven Ashby, Deputy Director for Science and Technology, Pacific Northwest National Laboratory

Panelists emphasized that the national laboratories are interested in collaborating with industry to increase U.S. competitiveness in developing clean energy products and increasing energy productivity in the manufacturing sector. However, difficulties exist that should be addressed prior to national laboratories participating in PPPs with industry. As described by Dr. Mason, it is important for government entities, distributing public taxpayer money, to prepare for both successes and failures in PPPs—because both can be problematic. Two concerns arise if a PPP results in a great success: the federal government is underwriting work that generates significant revenue for a specific private entity, and the federal government may be perceived as picking winners and losers. If a PPP results in a failure, the federal government can be viewed by some as squandering precious taxpayer money. Dr. Mason suggested that these concerns can be addressed by creating transparent and open paths to the national laboratories that ensure fairness of opportunity and by articulating the national need during the formation of a PPP.

According to the panelists, as government-owned entities, national laboratories face additional barriers in partnering with industry. Some stipulations in the most common contracting mechanisms are difficult for industry to accept: no fixed-price contract guaranteeing delivery on date, advance payments are often required, and no performance guarantees. Complications in agreements for intellectual property can also arise and inhibit industry partnering with national laboratories. The panelists suggested taking these issues, and others, into account up front during the formation of a PPP should help alleviate the burden from future successes or failures. The Agreement to Commercialize Technology (ACT) contracting vehicle aims to address several of these deficiencies and is being piloted by several national laboratories.

By forming PPPs, industry, academia, and national laboratories should work toward a shared goal where the strengths and capabilities of each member contribute to progress. Dr. Ashby suggested the AEMC Partnership approach the formation of a PPP using the Innovation-Driven Economic Advantage (IDEA) model, an approach used at Pacific Northwest National Laboratory. In this scenario, team members first focus on the desired outcome of a project, then engage experts early to conduct a landscape analysis and determine areas in need of research. When examining the needs of a sector early, the team also identifies organizations in in-

dustry with interest, expertise or existing intellectual property in the technology of interest. This organized beginning greatly increases the success in commercializing technology.

National laboratories could add value in many PPPs. One target area supported by both Dr. Mason and Dr. Goldstein was the creation of a PPP to address the second valley of death in the technology development cycle—transitioning prototypes into commercially deployable products. According to Dr. Mason, technology and research efforts in the national laboratories are generally considered complete once a prototype provides the proof-of-concept. The participation of industry through a PPP increases the likelihood of technology or research smoothly transitioning out of the national laboratories and into the venture capital or other technology development communities.

The discussion made clear that national laboratories are interested in partnering with academia and industry to further development in clean energy and manufacturing. Unfortunately, some of the barriers described above remain, and industry sometimes has difficulty negotiating the terms of a contract with a national laboratory. As mentioned previously, ACT, the new approach to industrial partnerships introduced formally by the DOE at the Council on Competitiveness 2011 Annual Meeting and supported by the Council on Competitiveness, promises to simplify these relationships and to make the terms of engagement more akin to those used in the private sector. While innovative new approaches to partnerships such as ACT are promising, the DOE and the national laboratories must continue to make strengthening the U.S. innovation ecosystem and increasing U.S. competitiveness in clean energy manufacturing a priority.

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

Briefing: Clean Energy Manufacturing Initiative and the Role of Partnerships

During this briefing, Ms. Elizabeth Wayman, Director of the Clean Energy Manufacturing Initiative (CEMI or Initiative) at the Office of Energy Efficiency and Renewable Energy (EERE), described the motivation for the new Initiative and for the American Energy & Manufacturing Competitiveness Partnership. The CEMI is a strategic integration and commitment of manufacturing efforts across EERE's technology offices, focusing on American competitiveness in clean energy manufacturing. During this briefing, Ms. Wayman detailed several manufacturing resources available across EERE's technology offices and new efforts and resources available through the Initiative.

The Initiative serves to both advise and implement President Obama's manufacturing initiatives in the energy field and aligns with the efforts of the Advanced Manufacturing National Program Office and the President's Export Initiative. CEMI specifically aligns EERE resources to promote U.S. manufacturing competitiveness in the production of clean energy technologies and through the application of energy productivity measures across the manufacturing sector. To meet these objectives, the Department uses five tools:

1. Resources for research and development in manufacturing;
2. Facilities for manufacturing innovation and demonstration;
3. Resources for energy productivity in manufacturing;
4. Competitive analysis for evaluating U.S. manufacturing competitive position with respect to other regions; and
5. Engaging the community and facilitating partnerships.

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

CEMI promotes advanced manufacturing technology by directly funding technology research and development and facilities. For example, earlier this year EERE awarded $15 million through this Initiative to five cross-cutting research and development projects aimed at increasing energy productivity in manufacturing. In addition to funding research and development, EERE funds shared facilities where innovators can independently or collaboratively carry out manufacturing-scale R&D on innovative products using shared equipment. Examples of such facilities include the Carbon Fiber Technology Facility at Oak Ridge National Laboratory,[7] which started operations earlier this year, and the institutes in the National Network for Manufacturing Innovation (NNMI).

7 The commissioning of the Carbon Fiber Technology Facility at Oak Ridge National Laboratory in 2013 served as the official, public announcement of CEMI and the AEMC Partnership.

These investments in research and facilities increase expertise and knowledge in the U.S. innovation ecosystem and provide centers of gravity for further clean energy research, development, and manufacturing.

In addition to funding manufacturing R&D for clean energy technologies and foundational manufacturing technologies and shared facilities for manufacturing innovation and demonstration, EERE supports a range of energy productivity resources to help all manufacturers increase their energy productivity to lower their costs and increase their competitiveness through CEMI. Resources for energy productivity in manufacturing include combined heat and power technical assistance partnerships, industrial assessment centers, and programs like the Better Plants Challenge. The Better Plants Challenge motivates manufacturing plants to reduce energy consumption in their building portfolios by 20 percent by 2020, and encourages participants to share best practices and success stories to accelerate the implementation of solutions by other organizations. To inform future resources and investments in clean energy manufacturing to promote U.S. competitiveness, CEMI conducts competitive analyses to evaluate the costs of producing technologies in the United States compared to competitor regions. Competitive analyses, such as those presented in the Connecting with CEMI Partners session of this inaugural dialogue, inform decision-makers by defining the required cost improvements or other enabling factors needed to impact U.S. competitiveness in manufacturing clean energy technologies.

CEMI also fosters clean energy manufacturing innovation and growth through partnerships with industry and engagement with the community. The American Energy & Manufacturing Competitiveness Partnership is an engagement to shape the future of PPPs formed to advance clean energy technology and manufacturing. Steered by CEMI, leaders in industry, academia, national laboratories and government will work together to tackle the challenge of increasing U.S. competitiveness in clean energy products and in the manufacturing sector overall.

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

Mapping the Landscape Part 1: The AEMC Partnership

The Mapping the Landscape Part 1: The AEMC Partnership session focused on performing an environmental scan and mapping the clean energy product and manufacturing landscape. Mr. Chad Evans, Executive Vice President of the Council on Competitiveness, kicked off the session by providing an overview of two reports prepared by the Council in advance of the dialogue to frame the AEMC Partnership's potential—*The Power of Partnerships* and *A Summary of PPPs*. These reports were the product of an extensive literature review and "mapping" of 184 past and current research efforts across the United States and internationally on three topics:

- linkages between the efforts of energy efficiency (EE) manufacturers, renewable energy (RE) developers and manufacturing competitiveness;
- energy-related barriers to manufacturing competitiveness; and
- models for PPPs for fostering competitive industries.

These reports provide the foundation for the AEMC Partnership and answer 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 required 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.

Following the overview of the two reports, leaders from PPPs shared their views on best practices on how to structure and focus a PPP to facilitate the growth of clean energy manufacturing in the United States. The session was moderated by Mr. Evans and included: Mr. Nolan Browne, Managing Director of the Fraunhofer Center for Sustainable Energy Systems; Dr. Donald Leo, Vice President and Executive Director of the National Capital Region Operations and a Professor of Mechanical Engineering at Virginia Polytechnic Institute and State University; Dr. Jeff Chamberlain, Deputy Director for Development and Demonstration at The Joint Center for Energy Storage Research (JCESR), Argonne National Laboratory; Ms. Jean Redfield, President and Chief Executive Officer of NextEnergy; Dr. Henry Foley, Vice President for Research at The Pennsylvania State University; and Dr. Martin Keller, Associate Laboratory Director for Energy and Environmental Sciences at Oak Ridge National Laboratory. To focus the discussion, Mr. Evans posed the following questions to the group:

- What barriers to U.S. clean energy manufacturing can a PPP effectively address—and what public policies can complement this effort?

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**

- Of the PPP models described in *The Power of Partnerships*, what models would be optimal for existing and/or emerging clean energy and foundational manufacturing technologies?
- Are the PPP models for deployment of industrial energy productivity technologies different?
- What steps or actions would most improve the current U.S. clean energy manufacturing landscape and generate the greatest return on investment?
- What factors are critical for the success of a PPP?
- How should the nation measure success of a PPP?

The rest of the session explored PPPs and how they advance the production of clean energy products and increase energy productivity in the manufacturing sector. Participants explained that PPPs offer particular advantages in promoting collaboration from a wide range of perspectives, and yet are situated in a precarious position between often competing interests. Nevertheless, PPPs, if structured correctly, can provide the focal point for collaboration between normally competing and even disparate entities.

Collaborating in a PPP can encourage the growth of roots in a community, enticing some industries to stay in the area when they might otherwise consider off-shoring, and even pull in new businesses, such as Dr. Keller observed with the opening of the Oak Ridge National Laboratory Manufacturing Demonstration Facility (ORNL-MDF). The ORNL-MDF provides a single location where companies can come to test the newest and most advanced manufacturing methods, such as additive manufacturing. Com-

Ms. Jean Redfield, President and Chief Executive Officer of NextEnergy; Mr. Nolan Browne, Managing Director of Fraunhofer Center for Sustainable Energy; and Dr. Jeff Chamberlain, Deputy Director for Development and Demonstration at The Joint Center for Energy Storage Research in Chemical Sciences and Engineering at Argonne National Laboratory

panies build new facilities close to the ORNL-MDF because they want to learn the technologies, work side-by-side with national laboratory scientists and engineers to understand and contribute to the next stage of development; and/or co-locate their own equipment in the ORNL-MDF. Similarly, Ms. Redfield noted from her work at NextEnergy, a PPP in Michigan, rather than watching U.S. companies move overseas to manufacture products in early markets, foreign companies directly invest in facilities in the United States where technology development and innovation ecosystems exist. She suggested that this further strengthens the U.S. innovation ecosystem.

Kick-off discussants in this panel also described the mutual benefits of working with all members of the innovation ecosystem in PPPs. As stated by Mr. Browne, PPPs encourage valuable bonding between participants, with industrial partners ensuring strong applicability of the research to market needs. Personnel exchanges exemplify the strong ties across the innovation ecosystem that develop in successful PPPs. This "knowledge spillover" occurs when employees transfer between different organizations through ties built during collaborations and serve to further solidify relationships between academia, industry, and non-profit organizations.

A growing community of personnel who spend time between organizations is a good indicator of the success of a PPP—as mentioned by Mr. Browne, employees positively interacting with their counterparts in industry (and often ultimately being hired by them) results in a virtuous spillover effect spreading capabilities through the national industry—but there are other factors that lay the groundwork for success. A PPP must address a significant need in the marketplace, have clear and seamless membership, and have clear intellectual property (IP) agreements to allow all ideas and findings to be shared productively to be successful, according to panelists. Along these lines, Dr. Leo shared his experience of the formation of the Commonwealth Center for Advanced Manufacturing (CCAM), where the development of agreements covering governance and leadership, funding, and intellectual property ownership early in the development of a PPP then simplified the process of adding future members. The clearest way to achieve such a partnership requires that all interested parties contribute funds, personnel, and resources to the partnership. Each participant must have a vested interest in the success of the whole PPP, stated Dr. Foley.

Funding models can affect many attributes of a PPP. Investment or fees—whether from the public or private sector—must cover capital and operating costs. As an example, state government and donor grants—at a base level and up to 30 percent—fund the operating costs at the Fraunhofer Center for Sustainable Energy, according to Mr. Browne. Each principal investigator (PI) must thereafter earn 70 percent of their budget through industry or government funded projects in order to continue their research in that area. Mr. Browne explained that this requirement forces PIs to integrate with industry and ensure their research has immediate or near-term market application but went on to illustrate that the base funding support is critical to ensure that Fraunhofer has the flexibility to pursue projects for the benefit of the entire national industry rather than maximizing its revenue exclusively supporting the focused interests of any one individual partner. Similarly, Dr.

Foley mentioned that the Energy Efficient Buildings Hub (EEB Hub) required industry-matching funds in every membership category. This model differs from work at CCAM, shared Dr. Leo, where all capital and operating costs are funded by the private sector. Dr. Leo conveyed that up-front public sector funding for infrastructure and infrastructure maintenance costs would help increase the value-proposition for industry members participating in a PPP. This was further supported by Dr. Chamberlain regarding JCESR, funded by the Department of Energy and the State of Illinois, an example of a PPP largely funded by public investment,[8] where industry partners are expected to share in the work through in-kind contributions.

Panelists also discussed the critical importance of negotiating IP agreements during the early stages of formation of a PPP. As Dr. Chamberlain stated, the importance of IP agreements cannot be overestimated—they set a boundary of trust when assembling a team. The discussants, however, did not agree on only one method to treat IP ownership. For most of the panelists, the ownership of IP from a PPP collaboration is directly related to the amount an industry partner contributes. As an example of a different model, the EEB Hub encourages partnering companies to own IP for developed technology or have it as a very low-cost license to facilitate the deployment of technology into the marketplace quickly. In particular, Dr. Foley shared that it is more important for The Pennsylvania State University and the EEB Hub to create ongoing relationships with industry that produce innovation over the long term than lose time arguing over IP ownership from EEB Hub projects.

After discussing membership, funding, and IP agreements, the PPP representatives shared their thoughts on possible ways a new PPP could add value to the clean energy technology development and manufacturing sector. A PPP could attack a major technology bottleneck that affects progress in industry. Many companies do not tackle these types of grand-challenge research problems under the assumption that someone else will find the first solution that can be easily replicated without the required research. Describing a more specific industry leverage point, Dr. Chamberlain mentioned that JCESR addresses early market research required to develop battery technology into a prototype. As conveyed by Dr. Chamberlain, the AEMC Partnership could suggest that a PPP provide strong industrial leadership in road-mapping the future direction of batteries, and in transitioning battery technology from prototype to mass-manufactured product.

Dr. Donald Leo, Vice President and Executive Director of the National Capital Region Operations, and Professor of Mechanical Engineering, Virginia Polytechnic Institute and State University; and Dr. Martin Keller, Associate Laboratory Director for Energy and Environmental Sciences, Oak Ridge National Laboratory.

Through these discussions, key attributes of successful PPPs have emerged: rules for membership and intellectual property agreements, and structuring a PPP to tackle an important and challenging technology barrier to progress in the relevant industrial sector. Panelists concluded that if stakeholders in the U.S. energy and manufacturing community can strategically arrange these pieces, PPPs have the ability to create long-standing, and highly productive collaborations that can improve clean energy manufacturing, create high-skill jobs, and further innovation that will increase U.S. competitiveness well into the future.

8 http://articles.chicagotribune.com/2012-11-30/business/ct-biz-1130-argonne-20121130_1_battery-technology-argonne-national-laboratory-energy-storage-research.

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

Connecting with CEMI Partners—Strategic Analysis of Clean Energy Opportunities

In the Connecting with CEMI Partners—Strategic Analysis of Clean Energy Opportunities session, Mr. Michael Carr, Principal Deputy Assistant Secretary, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, Ms. Elizabeth Wayman, Director of the CEMI, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, Mr. Alan Goodrich, Senior Analyst, National Renewable Energy Laboratory, and Mr. Ted James, Senior Analyst, National Renewable Energy Laboratory discussed the results of a competitive analysis of clean energy technologies.

Mr. Goodrich and Mr. James developed a tool with the support of CEMI and DOE to perform competitive analyses and introduced the methods and results during the dialogue's Briefing on the Clean Energy Manufacturing Initiative and the Role of Partnerships session. DOE uses competitive analyses to articulate clear goals for programs and to analyze the barriers to making power from clean energy technologies as efficient, reliable, and cost-competitive as power generated with fossil fuels and incumbent technologies. Increased profits, increased energy productivity, and benefits to the environment should drive increased use of clean energy and energy efficient technologies.

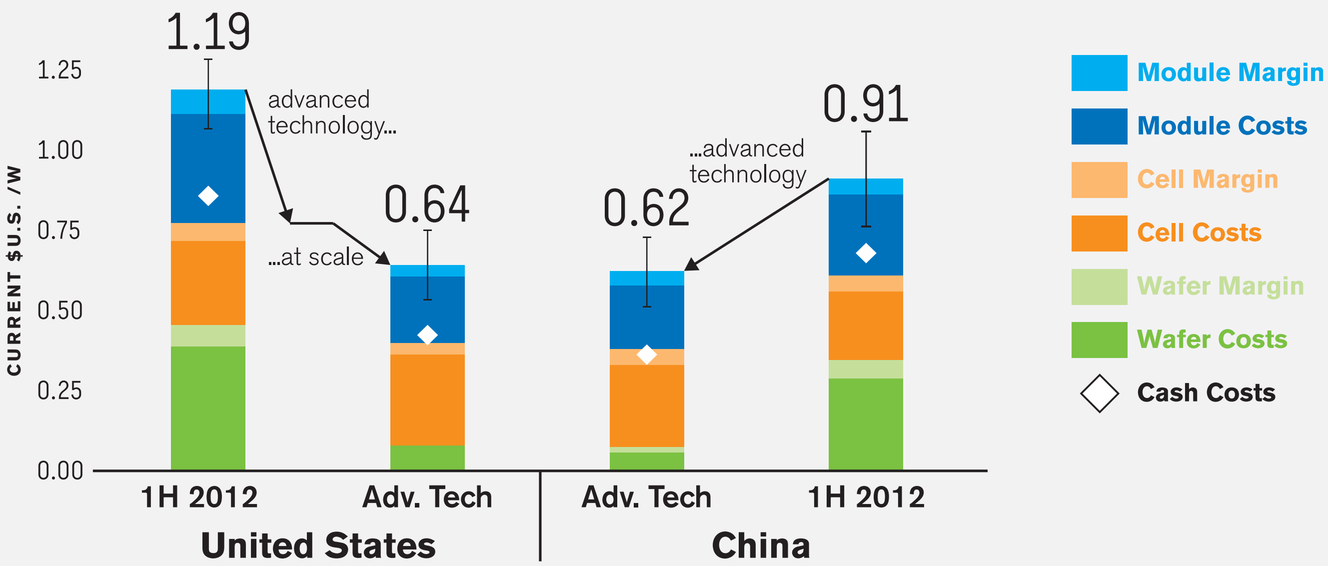
Using market analysis to understand product demand and market locations, trade flow analysis to understand the crucial points in the manufacturing system, and detailed regional cost analysis to understand advantages and disadvantages facing the U.S. manufacturing sector, the presentation described the market forces impacting the attractiveness of manufacturing in the United States. This analysis provides strategic insights about competitive advantages in U.S. based manufacturing opportunities. For example, using a quantifiable cost comparison between manufacturing a product in the United States versus a competitor overseas highlights areas the United States can reduce costs and become more competitive. In the case of wind, solar, and battery technologies, analyses have uncovered areas where costs are comparable and areas where costs are disproportionate as discussed in further detail in the following section. Based on the results of these analyses, DOE is using insights from these and other related analyses to inform national strategies to advance clean energy and energy efficiency technologies and domestic manufacturing opportunities.

Mr. Michael Carr, Principal Deputy Assistant Secretary, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy; Ms. Elizabeth Wayman, Director, Clean Energy Manufacturing Initiative, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy; Mr. Alan Goodrich, Senior Analyst, National Renewable Energy Laboratory; and Mr. Ted James, Senior Analyst, National Renewable Energy Laboratory

SOLAR

Today, only 4 percent of solar photovoltaic module manufacturing occurs in the United States, even though a large portion of the technology was invented and developed in the United States.[9] As presented by Mr. Goodrich, prior to 2006 there was no production of solar technologies in Asia, but since that time production in Asia has grown dramatically. While China's historical advantage of low-cost labor has been counteracted by other regional influences (e.g. country investment risk, inflation), the dominant reason behind that region's success in photovoltaic manufacturing has primarily been the scale of solar panel manufacturing, at least partly enabled by preferential access to low-cost capital and a less restrictive business and regulatory environment. The support of large manufacturing plants has also created clusters of technology experts in other nations. Cluster regionalization, in turn, has contributed to reducing manufacturing and product costs abroad.

Figure 5. Comparative Cost Assessment for Silicon Photovoltaic Technology[10]



The presented solar analysis also reveals that the market price for some solar modules today may not be sustainable. In this situation, manufacturers cannot collect a profit. Therefore, they have few funds to re-invest to further improve photovoltaic technology and continue lowering costs through technology innovation. Without further investments or performance improvements, prices of photovoltaic technologies could rise in the near future—moving further away from the SunShot Initiative goal of electricity from solar power reaching cost-competitiveness with electricity from fossil fuels and incumbent technologies by 2020.[11]

9 Inventors in the United States filed 55% of the solar patents from 2002-2012 Clean Energy Patent Growth Index. "Clean Energy Patent Growth Index 2012 Year in Review," Published: March 15, 2013. Accessed: July 29, 2013. Available at: http://cepgi.typepad.com/heslin_rothenberg_farley_/clean_energy_patent_growth_index/.

10 Goodrich, A; Powell, D.M.; James, T; Woodhouse, M; Buonassisi, T. "Assessing the drivers of regional trends in solar photovoltaic manufacturing." Energy & Environ. Sci. Accepted: 23rd July 2013, DOI: 10.1039/c3ee40701b.

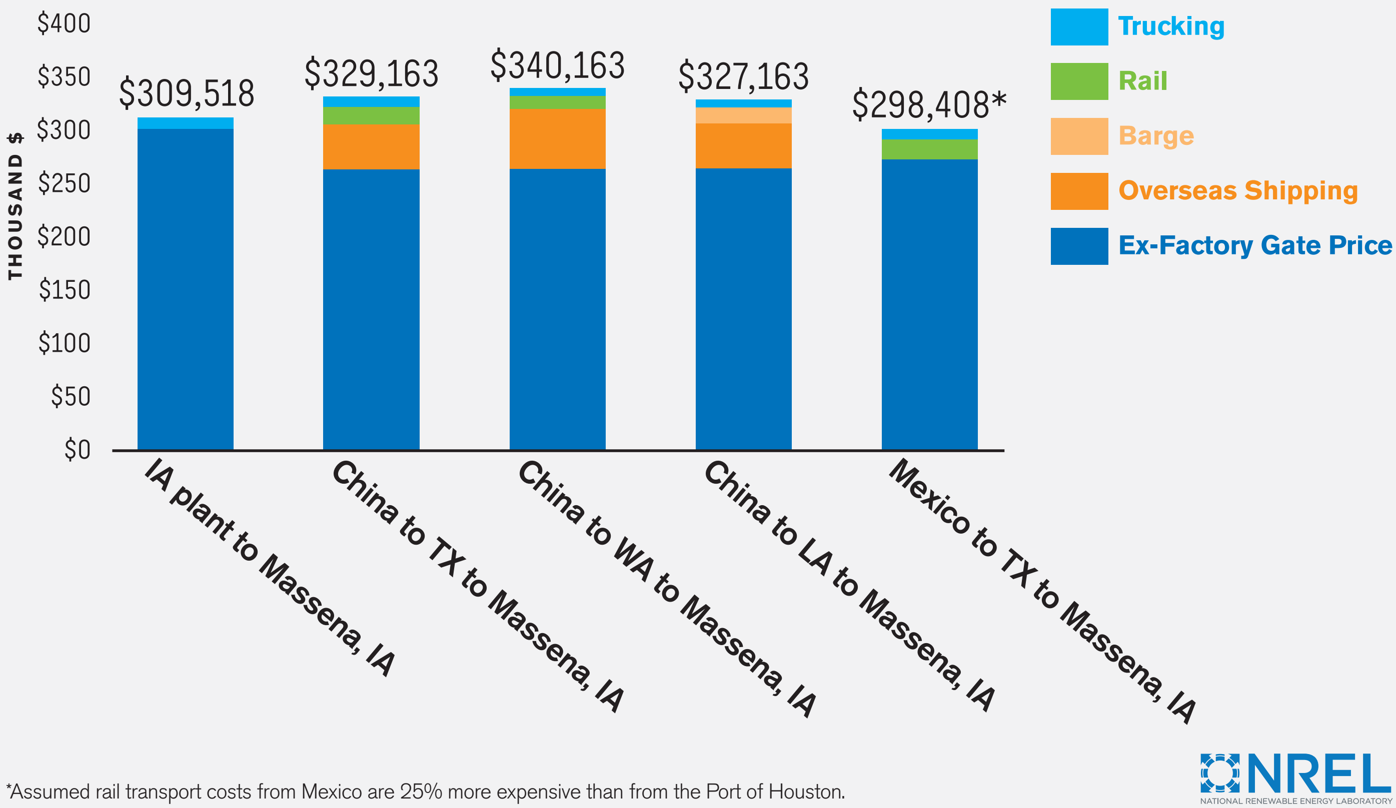
11 U.S. Department of Energy, "SunShot Initiative." Updated February 7, 2013. Accessed July 29, 2013. Available at: http://www1.eere.energy.gov/solar/sunshot/about.html.

WIND

The development and deployment of wind technologies is a success story for manufacturing. Even through the economic recession that started in December 2007,[12] power produced by wind has grown with strong deployment of wind power technologies in the Midwest. As presented by Mr. James, the NREL competitive analysis shows wind blade technology manufacturing often optimizes around both factory-gate blade costs and transport costs. As seen in Figure 6, transportation costs have become a deciding factor influencing the siting of wind turbine manufacturing plants near areas of deployment.

The analysis suggests that demand for wind components is a key driver for domestic manufacturing and this demand is affected by a number of issues including: policy uncertainty, competing low cost natural gas, and general economic growth. The Production Tax Credit, debated every 2 years, provides an effective incentive for industry to invest. Because the deployment considerations are often based on 20-year time horizons, policy uncertainty makes it challenging for stakeholders to accurately assess the value of deployment opportunities.

Figure 6. Landed Costs: Wind Blades
NREL Wind-Blade Manufacturing Cost Model, Preliminary Results (March 5, 2013)



*Assumed rail transport costs from Mexico are 25% more expensive than from the Port of Houston.

12 National Bureau of Economic Research. "Business Cycle Dating Committee," September 20, 2010. Available at: http://www.nber.org/cycles/sept2010.html.

BATTERIES

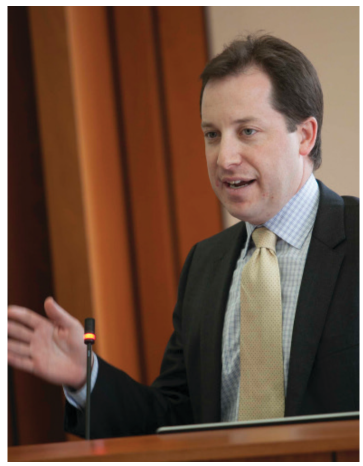
Battery production occurs largely in Asia—far from demand centers like the United States and Europe. This is an example of manufacturing occurring in a region due to factors other than local demand. One factor enabling battery production in Asia is the leadership of countries such as Japan and Korea in producing consumer electronics. By becoming leaders in consumer electronics, these countries have access to similar suppliers, increased buying power, and increased expertise in electronic components—competitive advantages applicable to producing automotive batteries today. With expertise in two similar technologies in different sectors, these countries benefit with increased flexibility, applicability and resiliency in the global marketplace.

As demand for electric vehicles increases, opportunities to establish new battery manufacturing infrastructure outside of Asia—to decouple vehicle battery production from consumer electronics battery production—will increase for all regions. Energy and transportation costs, rather than labor costs, are expected to be of critical importance to battery cell and pack manufacturers as these firms consider expanding production capacity in order to leverage global supply chain opportunities. Many regions in the United States have access to inexpensive and abundant energy resources, including hydroelectricity and natural gas that can be used to cost-effectively manufacture vehicle battery cells. Additionally, even as vehicle battery pack sizes are reduced, shipping costs are expected to be a significant driver in the decision to locate production facilities. For the foreseeable future, U.S. demand for vehicle batteries is expected to surpass demand in all of Asia, thus making the United States a competitive location for pack assembly operations.

Clean energy technologies, such as the ones discussed in this session of the inaugural dialogue, will become efficient, reliable, and cost-competitive through investment and innovation. However, these technologies operate in a global market, and industry will optimize the global supply chain and manufacturing processes. The United States should, therefore, be strategic in selecting which technology research, development, and manufacturing investments it will make to strengthen its leadership in the clean energy sector. There are great opportunities to further innovation and lead in developing, manufacturing and deploying solar power, wind power, and battery technologies. The main questions are: when will clean energy technologies be competitive with incumbent technologies, and which countries will make the first investments to become leaders in clean energy?

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

Perspectives from the Administration



At left: *Mr. Jason Miller, Special Assistant to the President for Manufacturing Policy, National Economic Council in the White House.*

Below: *Mr. Jason Miller, Special Assistant to the President for Manufacturing Policy, National Economic Council; the Honorable David T. Danielson, Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy; and Dr. Omkaram Nalamasu, Chief Technology Officer, Applied Materials, Inc.*

In the Perspectives from the Administration session, Mr. Jason Miller, Special Assistant to the President for Manufacturing Policy with the National Economic Council, shared his knowledge of the energy and technology manufacturing sectors along with perspectives from the Obama Administration. In his keynote speech, Mr. Miller discussed the Administration's interest in supporting the manufacturing sector throughout the United States, and highlighted several initiatives underway.

From Mr. Miller's perspective, four major changes are necessary to increase U.S. industrial competitiveness: major corporate tax reform; greater investment in our infrastructure; better use of our domestic energy resources; and smarter investments in industrial energy productivity. Mr. Miller specifically discussed the National Network for Manufacturing Innovation, which aims to increase investment in manufacturing infrastructure.

As one of the key administration initiatives, the NNMI works to bolster the manufacturing sector by creating access and awareness of innovative processes and technologies through relevant organizations. Investing in NNMI infrastructure facilitates supply chain access to the innovation ecosystem to accelerate technology and process implementation throughout the manufacturing network, as described by the administration. Additionally, the NNMI facilities bolster the skills of America's workforce through training programs, where employers and potential employees can directly communicate.

Mr. Miller also discussed how leaders must safeguard the economy and level the playing field to increase national competitiveness, while opening up new markets for U.S. manufacturing products. He described the Interagency Trade Enforcement Center that organizes the effort to ensure U.S. trading partners follow standards in environmental practices, occupational welfare, and economic practices. By targeting these areas, U.S. industry, government, labor organizations, universities, and national laboratories can work together to build clusters of expertise, that will attract talent and lead to regional economic growth.

Potential Leverage Points in Increasing U.S. Clean Energy Manufacturing Competitiveness

When looking for opportunities to improve and innovate clean energy technology or manufacturing processes, stakeholders come across barriers and challenges. Dr. Danielson challenged dialogue participants to determine possible paths to lower barriers to accelerating technology development and increasing the competitiveness of the U.S. manufacturing sector.

Dialogue participants shared the following suggestions to increasing U.S. competitiveness in clean energy manufacturing:

- **Accessing National Laboratories:** Create policy clarifying the role of the national laboratories in increasing U.S. economic competitiveness to increase industry access to the national laboratories. Transparency in capabilities and expertise within the national laboratory system will further increase its accessibility by industry;
- **Raising Awareness through Manufacturing Demonstration Facilities:** Build manufacturing demonstration facilities that can flexibly and quickly showcase new materials and innovative methods to small and medium-sized enterprises enabling the faster delivery of better products to market;
- **Creating a "Race-to-the-Top" Economic Development Program:** Stimulate the creation and execution of economic development plans and policies to increase clean energy manufacturing through a Race-to-the-Top initiative for local and regional governments;
- **Extending the Research and Experimentation Tax Credit:** Institute the Research and Experimentation Tax Credit for longer periods of time or even permanently, which will allow long-term planning and incentivize research and development;
- **Developing the Workforce:** Institute programs to update workforce skills with industry input for advanced technologies and manufacturing processes;
- **Identifying Effective Supply Chains:** Conduct a cluster review and/or create a roadmap that describes collaborative opportunities for members of a supply chain and creates a powerful knowledge base to foster additional relationships that would not otherwise occur;
- **Conducting Analyses Projected into the Future:** Extend analyses on the current and past states of technology in the United States to project the value of technologies and manufacturing methods in the future. The results of these analyses will help decision-makers determine the value and therefore increase investments in research; and
- **Searching for the Next "Big Idea":** Create programs to stimulate continual development of revolutionary products and processes to ensure the continued technological and economic success of the manufacturing industry in the United States.

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

Perspectives from Industry

The Role of Industrial Energy Efficiency in American Manufacturing Competitiveness

As discussed previously, industry is a key player in building effective partnerships to foster innovation in clean energy technology development, manufacturing, and deployment. While national laboratories and academia provide new ideas and expertise in specific areas, industry provides on-the-ground knowledge of problems that need solutions, expertise in commercializing products, and funds to contribute to relevant research.

The Perspectives from Industry: The Role of Industrial Energy Efficiency in American Manufacturing Competitiveness session convened members of industry to share their views on the relationship between industrial energy efficiency and manufacturing operations, and the benefits of partnering with academia and the public sector to increase energy efficiency in the manufacturing sector. The Honorable Deborah L. Wince-Smith moderated the discussion with the following kick-off discussants: Ms. Lisa Ferris, Chief Operating Officer of Third Wave Systems; Mr. Andrew Ginger, President, Industrial of Snap-On Incorporated; Dr. Omkaram "Om" Nalamasu, Chief Technology Officer of Applied Materials, Inc.; Mr. Robert ter Kuile, Senior Director for Environmental Sustainability at PepsiCo, Inc.; and Ms. Laurel "Laurie" Zelnio, Director of Environment, Safety, Standards, & Energy at Deere & Company. Panel participants focused on the following questions:

- How can industry leverage energy efficiency efforts to enhance U.S. manufacturing?
- What are the benefits and challenges of partnering with academia and the public sector to advance industrial efficiency?
- What unique opportunities for U.S. manufacturing competitiveness are presented by the low cost shale gas boom in the U.S.?

All panel participants agreed that increased energy efficiency and energy productivity are a benefit for the manufacturing sector. Beyond the obvious benefits to the environment of reduced waste, reduced pollution, and conserved resources, energy efficiency promotes optimization and reduced costs. Dr. Nalamasu expressed that some increases in efficiency occur naturally from market forces, such as the doubling in computational power of a semiconductor chip every eighteen months with minimal increase in power consumption. Companies also institute efficiency programs and measures that result in significant savings. Mr. ter Kuile described how PepsiCo saved approximately $120 million in avoided costs and actual cost savings, combined, in their U.S. operations over a 10-year period through their Resource Conservation program. An issue inhibiting massive energy optimization, argued Mr. ter Kuile, is that energy is a low-cost resource in many countries. The low cost of energy means that energy efficiency projects have low internal rates of return and therefore are low priority, hindering manufacturing innovation as projects compete for a fixed amount

Opposite page: *Dr. Omkaram Nalamasu, Chief Technology Officer of Applied Materials, Inc.; and the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness.*

Top: *Mr. Robert ter Kuile, Senior Director for Environmental Sustainability at PepsiCo, Inc., and Dr. Omkaram Nalamasu, Chief Technology Officer of Applied Materials, Inc.*

Center left: *Ms. Laurel Zelnio, Director for Environment, Safety, Standards, and Energy at Deere & Company.*

Center right: *Ms. Lisa Ferris, Chief Operating Officer of Third Wave Systems and Mr. Andrew Ginger, President, Industrial of Snap-On Incorporated.*

of company funds. As clarified by Ms. Zelnio, better understanding, demonstrating, and valuing of energy efficiency in the manufacturing sector will entice companies to pursue industrial energy efficiency more seriously.

On a related topic, Mr. Ginger described the current lack of workers trained to operate or maintain tools or processes and discussed workforce development as a major need of the industry. By incorporating all-inclusive workforce development into a PPP, industry and academia could collaborate to train workers ready to address the needs of industry, including increasing industrial energy efficiency. PPPs can also make tools like modeling and simulation more easily understood and accessible. One such tool is the software developed by Third Wave Systems to analyze manufacturing processes. This tool has previously reduced technology development time by 25 percent for a Third Wave Systems client with a correlated decrease in energy use, extended tool life, and reduced manufacturing costs, shared Ms. Ferris. Ms. Zelnio also suggested PPPs should increase connections between innovators and companies, matching industrial processes and facilities that can act as test beds for new products generated by academia, national laboratories, and small and medium sized enterprises.

Overall, panel participants reiterated their interest in participating in PPPs and their commitment to increasing industrial efficiency but cautioned that, as stewards of their organization's funds, return on investment calculations heavily influence investment decisions.

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

Laying the Foundations for a Clean Energy Manufacturing PPP

The overall goal of the AEMC Partnership is to provide concepts for future PPPs. In a session devoted to Laying the Foundations for a Clean Energy Manufacturing PPP, leaders from industry, the national laboratories, and labor unions discussed foundational topics in forming clean energy manufacturing PPPs. Dr. Tomás Díaz de la Rubia, Director at Deloitte Consulting LLP moderated the conversation with Dr. Montgomery "Monty" Alger, Senior Vice President for Research and Development at Myriant Corporation; Mr. Sean McGarvey, President of the Building and Construction Trades Department, AFL-CIO; Dr. Mark Peters, Deputy Laboratory Director for Programs at Argonne National Laboratory; and Dr. Kenan Sahin, President and Founder of TIAX LLC. Panelists addressed the following questions posed to focus the conversation:

- What priority areas (technologies, barriers, infrastructures, stakeholders, etc.) should the AEMC Partnership and the eventual PPP concept target?
- How do we structure a PPP to best support domestic manufacturing of domestically innovated products?
- What aspects of a PPP would incentivize your organization's involvement or keep it from participating (i.e. what are the deal breakers)?
- How do we design PPPs to accomplish the AEMC Partnership's goals (i.e. formulate a single PPP to address its goals or several PPPs for different sectors and different goals)?

PPPs have the ability to continue growing U.S. capabilities in clean energy technology innovation, manufacturing and deployment. Universities and national laboratories have a long history of working together and collaborating with industry. However, according to Dr. Díaz de la Rubia, successful, future PPPs must incorporate better communication of industry needs to universities and national laboratories. Similarly, an effort is required to improve the way in which the national laboratories communicate, market and make available their capabilities to the private sector.

Dr. Mark Peters, Deputy Laboratory Director for Programs at Argonne National Laboratory and Dr. Tomás Díaz de la Rubia, Director at Deloitte Consulting LLP

To be effective, any proposed PPP must focus on an area or issue informed by industry needs. Experts could conduct an analysis of industry investments to illuminate market needs and determine specific areas that could benefit from the expertise, capabilities, and resources in the innovation ecosystem, such as in vehicle technologies and materials science, proposed Dr. Alger. More specifically, Dr. Peters suggested PPPs target the materials science and engineering strengths and capabilities of the national laboratories, and focus on materials devel-

Mr. Sean McGarvey, President of the Building and Construction Trades Department, AFL-CIO and Dr. Montgomery Alger, Senior Vice President for Research and Development at Myriant Corporation

Dr. Kenan Sahin, President and Founder of TIAX LLC; Dr. Mark Peters, Deputy Laboratory Director for Programs at Argonne National Laboratory; and Dr. Tomás Díaz de la Rubia, Director at Deloitte Consulting, LLP

opment for high-impact applications like batteries, catalysts, and solar technologies. With the competitive advantage brought by the abundance of shale gas and liquids, Mr. McGarvey suggested a PPP ought to focus on optimizing manufacturing plants to attract the repatriation of petrochemical processing. Dr. Sahin suggested PPPs need to create teams to escort technologies from development to mass-manufacturing. He pointed out that the most difficult part of the technology development cycle is not traversing the valley of death, but overcoming the difficulties of taking market share away from incumbent technologies.

In addition to selecting a focus area, panel participants agreed that leaders in industry, academia, national laboratories, and the public sector should define applicable agreements prior to participating in partnerships. Successful partnerships, shared Dr. Sahin, set rules in place early and anticipate the dissolution of agreements at the beginning. Panel participants converged on three points that need to be resolved up front when structuring a PPP:

- Leadership structure: Strong leadership is a prerequisite. A partnership must be structured around a singular leader and a management plan from the beginning, articulated Dr. Peters. While setting the structure in place early is important, flexibility is another requirement to maximize effectiveness or reflect changes in industry.
- Funding models: Structuring a funding model that will encourage collaboration and a focus on problems important in clean energy manufacturing is essential. While different levels of involvement are necessary, the funding model can also contribute to the dominance of some parties over others. Mr. McGarvey suggested that PPPs require participants to borrow or pay to fund their access to PPP capabilities and expertise to establish serious participants.

- Intellectual Property agreements: PPPs must establish IP agreements at the start to eliminate future legal disagreements over IP ownership. Dr. Sahin stated that all parties must accept that funding research does not automatically equate to owning the resulting IP.

Moving forward, the panel offered insights in creating a PPP capable of accomplishing the AEMC Partnership's goals. A successful partnership would address the long cycle of return on investment in energy efficiency, according to Dr. Alger. The partnership should involve stakeholders from all sectors, taking advantage of the U.S. innovation ecosystem. By developing a congruent and communicative ecosystem throughout the value chain of industry and in partnership with academia, national laboratories, and the public sector, the United States can move forward and increase efficiency and overall competitiveness in clean energy manufacturing.

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

Steps Forward in Creating Clean Energy and Energy Efficient Products and Partnerships

Stakeholder Perspectives on the Day

This objective of the Steps Forward in Creating Clean Energy and Energy Efficient Products and Partnerships panel session was to synthesize the day's deliberations and discuss policy recommendations needed to promote the increased development of clean energy and energy efficient products and increased energy productivity in the manufacturing process. The Honorable Alexander "Andy" Karsner, Chairman and Chief Executive Officer of Manifest Energy, LLC moderated the conversation with the following kick-off discussants: Mr. James Phillips, Chairman and Chief Executive Officer of NanoMech, Inc.; Dr. J. Stephen Rottler, Vice President of the California Laboratory and Vice President of Energy, Climate, and Infrastructure Security at the Sandia National Laboratories; and Mr. Patrick Sullivan, President of the Mississippi Energy Institute. The group focused their conversation around addressing the following questions:

- From your perspective, what is the proper role of a government agency like EERE in creating PPPs?
- What type of policy is effective in incentivizing American innovation and manufacturing of energy efficiency and renewable energy products and boosting energy productivity in the manufacturing sector?

As expressed by Mr. Karsner, the goal of the AEMC Partnership dialogues, beginning with this inaugural dialogue, is to create a real plan of action to inform the government how to impact the U.S. clean energy economy and increase its competitiveness. In the session, participants shared their personal experiences in partnering within the U.S. innovation ecosystem and their insights on structuring a PPP to strengthen clean energy manufacturing.

Mr. James Phillips, Chairman and Chief Executive Officer, NanoMech, Inc.; the Honorable Alexander "Andy" A. Karsner, Chairman and Chief Executive Officer, Manifest Energy, LLC; and Dr. J. Stephen Rottler, Vice President, California Laboratory and Vice President, Energy, Climate, and Infrastructure Security, Sandia National Laboratories

PPPs help drive the U.S. economy and play a key role in America's technological advances. Strong inclusive partnerships result in long arcs of technological innovation leadership and economic success, both attributes that are needed to increase U.S. competitiveness in clean energy manufacturing. As expressed by Mr. Karsner, the United States made very significant investments in nanotechnology, biotechnology, information technology, materials science, and advance genomics for many years, creating a surge in knowledge and placing the country in a position of global leadership in these fields. Stakeholders in the clean energy and manufacturing ecosystems should strategically exploit this expertise to increase U.S. competitiveness.

When creating PPPs, partners should structure the partnership to encourage U.S. companies to manufacture in the United States when it makes sense. For example, IP protection is one of the greatest

Mr. James Phillips, Chairman and Chief Executive Officer, NanoMech, Inc.; the Honorable Alexander "Andy" A. Karsner, Chairman and Chief Executive Officer, Manifest Energy, LLC; Dr. J. Stephen Rottler, Vice President, California Laboratory and Vice President, Energy, Climate, and Infrastructure Security, Sandia National Laboratories; and Mr. Patrick Sullivan, President, Mississippi Energy Institute

competitive advantages of the United States and Mr. Phillips described how he chose to manufacture in the United States because there are insufficient intellectual property protections in foreign countries.

The panel agreed that government agencies have a significant role to play in the formation of PPPs. Government agencies guide the strategic direction of research, finance projects and initiatives, and aid in pairing parties to facilitate the formation of partnerships. Using public investment in the formation of a PPP supports research on early stage technologies that individual companies may deem too financially risky to develop. However, Dr. Rottler suggested that from their inception, PPPs should plan for positive return on the public investment. He pointed out that PPPs must generate revenue through membership fees or fee-for-service models, and the government should be able to gradually remove its funding as the technology advances to a higher level of technical readiness.

According to Dr. Rottler, the success of a PPP hinges on the strategic alignment of numerous organizations in the innovation ecosystem, including federal, state and local governments, the private sector, national laboratories and academia. Having worked in the innovation ecosystem, Mr. Phillips supported the participation of universities, national laboratories and industry. In his experience, universities contribute technology research and trained scientists to partnerships, while industry licenses technologies from universities or national laboratories to graduate products to the market. Working together, stakeholders can succeed in making progress that benefits the rest of the world as well, expressed Mr. Sullivan. The general consensus of the panel was that the United States has the resources, capabilities and talent, but can do more to commercialize and market technologies and lead the world in clean energy manufacturing.

PART 2: FINDINGS FROM THE INAUGURAL AEMC PARTNERSHIP DIALOGUE

The Path Forward

Going forward, the AEMC Partnership will focus on facilitating the creation of partnerships and collaborations to develop innovative clean energy products and increase manufacturing efficiency. With stakeholder input to ensure effective leverage points are targeted and pivotal partners are included, PPPs can spur the development of the most advanced clean energy technologies, increase U.S. manufacturing competitiveness and stimulate economic growth across the board.

The United States needs to put in place policy that will not only create jobs, but retain and retrieve manufacturing and other jobs into the future. The United States has many natural advantages in the global economy: large and open markets, energy resources, entrepreneur-friendly society, the deepest and most sophisticated capital markets in the world, robust IP protection mechanisms, and low cost natural gas.

As the AEMC Partnership continues its first year, the Council and EERE will develop and drive a positive, honest, and easily communicable narrative regarding the opportunities in both manufacturing and energy that will raise awareness with stakeholders. The Council and EERE will collect information on the leverage points in the U.S. innovation ecosystem to focus a PPP on a bottleneck in the technology development cycle. Target areas mentioned by dialogue participants include scaling-up innovative technologies, creating shared infrastructure to facilitate scale-up; bridging small and large companies, and creating high technology and high-value products. Participants have also mentioned a need for workforce development that is driven by the private sector. Future dialogues will also discuss organizational issues such as governance structure, financing options, and agreements for issues including intellectual property management.

The Council and EERE are hosting dialogues spanning across the United States—tapping into the knowledge and experience of the best local, national, and global leaders.

- The Council and EERE will partner with the University of Toledo for the second AEMC Partnership dialogue on June 20, 2013 in Toledo, Ohio. University of Toledo has played an important role in transitioning Northwest Ohio's glass-making economy for clean energy manufacturing by working with silicon-based and other materials-focused industries in the region—a transition the AEMC Partnership hopes to support in other regions. Today, these collaborations inform the acceleration of Toledo's evolution from the "glass city" to a thriving cluster of solar energy research and manufacturing.
- The Council and EERE will partner with General Electric for the third AEMC Partnership dialogue on August 13, 2013 in Niskayuna, New York. General Electric has a 130-year tradition of innovation including public and private collaborations to address challenges in clean energy and advanced manufacturing with expertise in multinational markets. General Electric's expertise in creating innovative products that are competitive in global markets is a strength the AEMC Partnership hopes to replicate in other companies.

Dr. Mark Peters, Deputy Laboratory Director for Programs, Argonne National Laboratory; Mr. John Mizroch, Senior Fellow, Council on Competitiveness; Major General Matthew Caulfield, Chairman and Chief Executive Officer, Hire Quality, Inc., Dr. Tomás Díaz de la Rubia, Director, Deloitte Consulting LLP; the Honorable Deborah L. Wince-Smith, President & CEO, Council on Competitiveness; Dr. Montgomery "Monty" Alger, Senior Vice President for Research and Development, Myriant Corporation; Dr. J. Stephen Rottler, Vice President, California Laboratory and Vice President, Energy, Climate, and Infrastructure Security, Sandia National Laboratories; and the Honorable Alexander "Andy" A. Karsner, Chairman and Chief Executive Officer, Manifest Energy, LLC

- The Council and EERE will partner with Applied Materials to co-host a fourth dialogue on October 17, 2013 in Santa Clara, California. Santa Clara, is a part of the San Francisco Bay Area—a region that leads the United States in sustainable energy and "clean tech" development,[13] is world-renowned for its strength in technology innovation exemplified by the success of Silicon Valley,[14] and has the highest concentration of Fortune 500 companies in the United States in 2012.[15]

13 Clean Edge. 2013 U.S. Clean Tech Leadership Index. June 2013. Accessed July 8, 2013. Available at: http://www.cleanedge.com/sites/default/files/CTLI-2013-Report.pdf?attachment=true

14 http://www.forbes.com/sites/gregsatell/2013/07/08/what-makes-silicon-valley-unique/ Posted: July 8, 2013, Accessed, July 8, 2013. Available at: http://www.forbes.com/sites/gregsatell/2013/07/08/what-makes-silicon-valley-unique/

15 CNN Money, The Fortune 500 List: 2012. Accessed: July 8, 2013. Available at: http://money.cnn.com/magazines/fortune/fortune500/2012/states/CA.html

The first year of the AEMC Partnership with culminate in a major Washington, D.C.-based, energy and manufacturing summit on December 12, 2013.

According to Dr. Danielson, there is a massive opportunity at the nexus of energy and manufacturing. He sees and believes he will continue to see trillions of dollars of manufacturing value-add invested at the junction of energy and manufacturing. Dr. Danielson no longer asks whether the marketplace will innovate to more efficient manufacturing processes. The questions have become:

- When will the global community get there?
- When the global community develops more efficient manufacturing, will the United States be the leader?
- Will the United States have its fair share of the manufacturing value-add?

As stated by Ms. Wince-Smith, the time to act is now. The AEMC Partnership must work to explore and define next-generation innovation opportunities that will remove technology development bottlenecks and result in non-linear advances in clean energy development and manufacturing.

National greatness is homemade. It's a homemade material. It's not exotic. It's not imported, but it's produced and reared on the soil that it ennobles.

O.M. Roberts

Council on Competitiveness

Council Membership

GENERAL MEMBERSHIP

Dr. Michael F. Adams
The University of Georgia

Mr. Joseph A. Alutto
The Ohio State University

Dr. Joseph E. Aoun
Northeastern University

Mr. J. David Armstrong, Jr.
Broward College

Mr. Neil Z. Auerbach
Hudson Clean Energy Partners

Dr. James F. Barker
Clemson University

The Honorable Sandy K. Baruah
Detroit Regional Chamber

Dr. Mark P. Becker
Georgia State University

Ms. Stephanie W. Bergeron
Walsh College

Mr. George Blankenship
Lincoln Electric, North America

Dr. Joel Bloom
New Jersey Institute of Technology

Dr. Lee C. Bollinger
Columbia University

Mr. Terry Boston
PJM Interconnection

Dr. Richard H. Brodhead
Duke University

Dr. Robert A. Brown
Boston University

Mr. Goodloe E. Byron
Potomac Energy Fund

Mr. Steve Cardona
Nzyme2HC, LLC

Dr. Robert L. Caret
University of Massachussetts

Dr. Curtis R. Carlson
SRI International

Dr. Roy A. Church
Lorain County Community College

Dr. James P. Clements
West Virginia University

Dr. Mary Sue Coleman
University of Michigan

The Honorable Mitchell E. Daniels, Jr.
Purdue University

Dr. William W. Destler
Rochester Institute of Technology

Mr. Ernest J. Dianastasis
CAI

Mr. Daniel R. DiMicco
Nucor Corporation

Dr. Joseph A. DiPietro
The University of Tennessee

Dr. Nicholas B. Dirks
University of California, Berkeley

Dr. Charlene M. Dukes
Prince George's Community College

Dr. Robert A. Easter
University of Illinois

Dr. Carol L. Folt
The University of North Carolina at Chapel Hill

Mr. Kenneth C. Frazier
Merck & Co., Inc.

Mr. John A. Fry
Drexel University

Dr. Judy L. Genshaft
University of South Florida

Dr. R. Barbara Gitenstein
The College of New Jersey

Mr. Gregory E. Glaros
SYNEXXUS, Inc.

Mr. Robert B. Graybill
Nimbis Services, Inc.

Mr. Robert Greifeld
The NASDAQ OMX Group, Inc.

Dr. Amy Gutmann
University of Pennsylvania

Mr. Peter T. Halpin
World Resources Company

Dr. Philip J. Hanlon
Dartmouth College

Dr. Patrick T. Harker
University of Delaware

Ms. Marillyn A. Hewson
Lockheed Martin Corporation

Dr. John C. Hitt
University of Central Florida

Mr. John D. Hofmeister
JKH Group

Mr. Jeffrey R. Immelt
General Electric Company

Dr. Lloyd A. Jacobs
University of Toledo

Ms. Madeleine S. Jacobs
American Chemical Society

Fr. John I. Jenkins
University of Notre Dame

Mr. Jeffrey A. Joerres
ManpowerGroup

Dr. John P. Johnson
Embry-Riddle Aeronautical University

Dr. Robert E. Johnson
Becker College

Dr. Lester A. Lefton
Kent State University

Dr. J. Bernard Machen
University of Florida

Mr. Bill Mahoney
SCRA

Dr. Sally Mason
University of Iowa

Dr. David Maxwell
Drake University

Dr. Jane D. McAuliffe
Bryn Mawr College

Mr. Sean McGarvey
Building and Construction Trades Department, AFL-CIO

Mr. Mark McGough
Ioxus, Inc.

Dr. Michael A. McRobbie
Indiana University

Dr. Carolyn Meyers
Jackson State University

Mr. Paul Michaels
Mars, Incorporated

Dr. Richard K. Miller
Franklin W. Olin College of Engineering

Dr. H. Keith Moo-Young
Washington State University, Tri-Cities

Dr. Martin J. Murphy, Jr.
CEO Roundtable on Cancer

Dr. Mark G. Mykityshyn
Tangible Software, Inc.

Mr. Mark A. Nordenberg
University of Pittsburgh

Mr. Keith D. Nosbusch
Rockwell Automation, Inc.

Dr. Santa J. Ono
University of Cincinnati

Dr. Eduardo J. Padrón
Miami Dade College

Dr. Daniel S. Papp
Kennesaw State University

Dr. David W. Pershing
University of Utah

Dr. G. P. "Bud" Peterson
Georgia Institute of Technology

Dr. William C. Powers, Jr.
The University of Texas at Austin

Mr. Stuart Rabinowitz
Hofstra University

Dr. Edward Ray
Oregon State University

Dr. L. Rafael Reif
Massachusetts Institute of Technology

Mr. Ralph Resnick
National Center for Defense Manufacturing and Machining

Mr. Rory Riggs
Balfour, LLC

Mr. Thomas W. Ross
The University of North Carolina

Mr. Douglas Rothwell
Business Leaders for Michigan

VADM John R. Ryan
Center for Creative Leadership

Mr. E. Scott Santi
Illinois Tool Works Inc.

Dr. Leonard A. Schlesinger
Babson College

Dr. David E. Shaw
D. E. Shaw Research

Mr. Scott D. Sheffield
Pioneer Natural Resources Company

Dr. David J. Skorton
Cornell University

Mr. Frederick W. Smith
FedEx Corporation

Mr. Jack Stack
SRC Holdings Corporation

Ms. Susan S. Stautberg
PartnerCom Corporation

Dr. Charles W. Steger
Virginia Polytechnic Institute and State University

Dr. Elisa Stephens
Academy of Art University

Mr. Edward Stolper
California Institute of Technology

Dr. Erik Straser
Mohr Davidow Ventures

Dr. Elizabeth Stroble
Webster University

Dr. Teresa Sullivan
University of Virginia

The Honorable Subra Suresh
Carnegie Mellon University

Dr. Satish K. Tripathi
State University of New York at Buffalo

Dr. Thomas M. Uhlman
New Venture Partners LLC

Dr. Steve L. VanAusdle
Walla Walla Community College

Mr. Frederick H. Waddell
Northern Trust Corporation

Dr. Jeffrey Wadsworth
Battelle Memorial Institute

Mr. Joseph L. Welch
ITC Holdings Corp.

Mr. Keith E. Williams
Underwriters Laboratories Inc.

Dr. Heather Wilson
South Dakota School of Mines & Technology

Mr. Rick E. Winningham
Theravance, Inc.

Dr. W. Randolph Woodson
North Carolina State University

Dr. Mark S. Wrighton
Washington University in St. Louis

Mr. Paul A. Yarossi
HNTB Holdings Ltd

National Affiliates and Council Staff

INTERNATIONAL AFFILIATE
Ms. Amy Ericson
Alstom Inc.

NATIONAL LABORATORY PARTNERS
Dr. Penrose C. "Parney" Albright
Lawrence Livermore National Laboratory

Dr. Eric D. Isaacs
Argonne National Laboratory

Dr. Michael Kluse
Pacific Northwest National Laboratory

Dr. Thomas E. Mason
Oak Ridge National Laboratory

NATIONAL AFFILIATES

Mr. Marc Apter
IEEE–USA

Ms. Rebecca O. Bagley
NorTech

Mr. James C. Barrood
Rothman Institute of Entrepreneurship

Ms. Leslie C. Berlowitz
American Academy of Arts and Sciences

Dr. Walter G. Bumphus
American Association of Community Colleges

Ms. Cathleen A. Campbell
U.S. Civilian Research & Development Foundation

Mr. C. Michael Cassidy
Georgia Research Alliance, Inc.

Mr. Jeffrey Finkle
International Economic Development Council

Mr. Richard Grefé
AIGA

Mr. Dominik Knoll
World Trade Center of New Orleans

Mr. Jack E. Kosakowski
Junior Achievement USA

Dr. Alan I. Leshner
American Association for Advancement of Science

Dr. Paul C. Maxwell
The Bi-National Sustainability Laboratory

Mr. Jack E. Middleton
SMC3

LTC Harrison A. Page
Oak Ridge Associated Universities

Dr. Hunter R. Rawlings
Association of American Universities

Dr. Carol G. Schneider
Association of American Colleges & Universities

Dr. David Vogan, Jr.
American Mathematical Society

Mr. Steven G. Zylstra
Arizona Technology Council

DISTINGUISHED & SENIOR FELLOWS
The Honorable Erich Bloch

The Honorable Daniel S. Goldin

The Honorable Bart J. Gordon

The Honorable Alexander A. Karsner

The Honorable Alan P. Larson

Mr. Edward J. McElroy

Mr. John F. Mizroch

Ms. Michelle Moore

The Honorable Thomas Ridge

Dr. Anthony J. Tether

SENIOR ADVISOR
Ms. Jennifer S. Bond

STAFF
Mr. William C. Bates
Executive Vice President and Chief of Staff
Treasurer and Secretary to the Board

Mr. Chad Evans
Executive Vice President

Dr. Walter Kirchner
Chief Technologist

Dr. Cynthia R. McIntyre
Senior Vice President

Ms. Cathy Tripodi
Senior Vice President

Ms. Lisa Hanna
Vice President

Ms. Patricia A. Hennig
Controller

Mr. Mohamed N. Khan
Vice President

Ms. Deborah Koolbeck
Vice President

Mr. Christopher Mustain
Vice President

Ms. Marcy S. Jones
Assistant to the President and Office Manager

Mr. Zachary Schafer
Senior Policy Director

Dr. Clara Smith
Senior Policy Director

Mr. Michael Bush
Policy Director

Mr. Gourang Wakade
Director, Membership & Strategic Development

Mr. Thomas Trueblood
Database Administrator

Mr. Michael Anthony
Program Manager

Mr. Mark Karkenny
Program Manager

Mr. Aaron S. Malofsky
Program Manager

Ms. Marie Plishka
Program Manager

About the Council on Competitiveness

WHO WE ARE

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

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

Council on Competitiveness

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

HOW WE OPERATE

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

The Council achieves its mission by:

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

Compete.

Council on Competitiveness

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