U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

# Smart Manufacturing Innovation Institute: Overview, Goals and Activities

AMO Industry Day

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**Isaac Chan**

**Advanced Manufacturing Office**

*www.manufacturing.energy.gov*

# Presentation Outline

- Institute and Technology Background
- Goals and Objectives
- Potential Areas of Interest
- Anticipated Technical Volume Requirements and Evaluation Criteria
- Special Considerations and Timeline

Information in this presentation is preliminary and subject to change. The content of the FOA will take precedence over any content included in this presentation.

# Clean Energy Manufacturing (CEM) Innovation Institute Concept

- Support shared RD&D infrastructure with affordable access to reduce cost, risk and technical challenges of scale-up
- Provide capabilities for collaborations in open, pre-competitive work
- Define structures and strategies for a wide range of stakeholder participation, particularly small and medium sized enterprises
- Establish a technical education and workforce development plan to support technology expansion
- Leverage existing private and public sector resources to maximize benefits and speed commercialization
- Become a financially self-sustaining, world-leading innovation hub
- Anticipated federal funding of $70 million over five years matched by at least $70 million in non-federal cost share

# Smart Manufacturing Innovation Institute Background

- DOE-EERE Request for Information on potential CEM institute topics in April 2014
- DOE-EERE Request for Information on specific potential CEM institute topics in September 2014
- Joint DOE-DOD Workshop on specific potential manufacturing institute topics in October 2014
- Advanced Manufacturing Partnership (AMP) Report released October 2014
- DOE Notice of Intent for Smart Manufacturing Institute released December 2014
- Smart Manufacturing Institute Industry Day conducted in February 2015
- Funding Opportunity Announcement (FOA) expected to be released in 2015

# Relationship to the Advanced Manufacturing Partnership (AMP)

- Building on White House-led efforts initiated in 2011, AMP "2.0" is a renewed, cross-sector, national effort to secure US leadership in emerging technologies that will create high-quality manufacturing jobs and enhance America's global competitiveness.
- ***Advanced Sensing, Controls & Platforms for Manufacturing (ASCPM, also referred to as Smart Manufacturing) was established as a high priority AMP Manufacturing Technology Area.***
- An ASCPM work team was formed, with the following objectives:
  - Identify technical gaps and implementation barriers that limit development, scale-up, and adoption of ASCPM technologies.
  - Provide recommendations for addressing the gaps and barriers.
- The ASCPM work team included subject matter experts from industry, academia, and government.
- The AMP report was published in October 2014, along with several Annexes.


REPORT TO THE PRESIDENT

ACCELERATING U.S. ADVANCED MANUFACTURING

Executive Office of the President

President's Council of Advisors on Science and Technology

October 2014

*For more information about AMP, visit http://www.manufacturing.gov/amp.html*

# What Is Smart Manufacturing?

Advanced networked systems that combine sensors, data, models, and algorithms to improve efficiency, process flows, and product quality across interconnected new and legacy equipment – highly interoperable, smart systems for manufacturing.

## Visionary Goals*

- Seamless interoperation of manufacturing automation equipment from different vendors allowing plug-and-play configurations
- Energy use and waste streams per unit output from manufacturing plants are reduced by 20% to 50%
- Deployment cost of sensors fall by an order of magnitude
- Real-time optimization and control to adapt to changes in feedstock, market demands and plant performance

* Based on AMP work team report

## Essential Technologies & Key Features

- Affordable Industrial Data Collection & Management System
  - Resilient Wireless Sensors, Low Cost Networked Sensors
  - Noninvasive Real-time Measurement Solutions
- Standardized IT Platform
  - Data Interoperability
  - Multi-scale Dynamic Modeling & Simulation
- Enterprise Wide Integration: Business Systems, Manufacturing Plants & Suppliers
  - Open Standards
  - Standard Interface
  - Process Models

# Institute and FOA Goals

- Commercial adoption of next generation Smart Manufacturing technologies at the mass-market affordable level
- Contribution of the Institute to the technical field and industrial partners
- Workforce development and education
- Sustainable operation of the Institute beyond federal support

- The next generation Smart Manufacturing technologies developed will enable manufacturing technologies that:
  - Optimize production, quality, and global competitiveness with cost-effective sensing and control retrofits
  - Improve and integrate process, plant, and enterprise-wide efficiencies by reducing energy, materials, and water intensity
  - Better inform business decisions across the manufacturing enterprise and improve supply chain efficiency

Preliminary information subject to change; the FOA will take precedence.

# Institute Objectives

- Evaluation of Institute performance and accomplishments may include objectives and metrics in the following areas:
  - Develop and Validate Enabling Platform Technologies
  - Demonstrate Reduced Energy and Waste
  - Accelerate Time-to-Market for SM-ASCPM Technologies
  - Reduce Cost for Broad Implementation
  - Improve Plant Performance
  - Validate Market Acceptance Across Manufacturing
  - Advance Workforce Development and Education



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# Smart Manufacturing Innovation Institute: FOA Areas of Interest

Areas of interest may include, but are not limited to, the following:

- Advanced sensors
- Control systems and data analytics
- High fidelity and predictive modeling and simulation
- Open software and communication platforms
- Application toolkits
- Testbeds

From DOE Notice of Intent, published December 11, 2014.

Preliminary information subject to change; the FOA will take precedence.

# Potential Area of Interest: Advanced Sensors

- Summary:
  - Develop affordable, low O&M advanced sensors to monitor each stage of manufacturing, including sensors suitable for withstanding high temperature, high-pressure, and chemically reactive/corrosive environments or sensors with embedded knowledge that makes them smarter and easier to integrate into sensor networks employed in manufacturing
  - Suggested TRL/MRL level for activities: 3-5
- Additional background and opportunities:
  - For energy-intensive industries with harsh environments, advanced sensors will be subject to requirements of packaging for survivability, accuracy, low power consumption, connectivity (e.g., wireless communication), ease of manufacturing, and very low installation and maintenance cost
  - More broadly, develop plug-and-play sensors with embedded knowledge that makes them smarter and easier to integrate into wired/wireless sensor networks
  - Develop reliable sensor systems that can measure across many length scales at high bandwidth enabling combined sensor fusion for advanced real-time energy management and process control methodologies



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# Potential Area of Interest: Control Systems and Data Analytics

- Summary:
  - Develop control systems and data analytics, including 1) algorithms for real-time control and performance optimization; 2) sensor network strategies to enable pervasive low cost monitoring and control; and 3) advanced sensor analytics to capture, manipulate, fuse, and display the collected sensor data to provide the operator options for process improvement and control
  - Suggested TRL/MRL level for activities: 4-6
- Additional background and opportunities:
  - Focus on exploiting data collected from large-scale distributed sensor networks, to provide the user near real time situational awareness of the factory, identify process abnormalities, and initiate suitable responses
  - Advanced data compression techniques and development of low cost engineering approaches to deployment of model-predictive control in energy intensive manufacturing processes would be a key innovation
  - Sensor analytics must be interoperable, not only with different sensor types but also with backward capability to existing sensors, while forward looking to integrate cyber security protection and resiliency



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# Potential Area of Interest: High Fidelity Modeling

- Summary:
  - Advance high fidelity predictive modeling and simulation of advanced manufacturing processes and data analytics; accurate and robust mathematical models are needed to simulate advanced manufacturing processes and enable complex control algorithms
  - Suggested TRL/MRL level for activities: 3-6
- Additional background and opportunities:
  - High performance computing has evolved within the science and technology community to provide accurate physics and chemistry based understanding of systems across scale ranging from atoms and molecules to electric power grids and logistic supply chains
  - Deployment of advanced control approaches requires high-fidelity modeling at the level of the unit process, the facility, and the enterprise
  - High-fidelity models can provide insight into energy and material flow in the large systems-of-systems used for manufacturing processes
  - Validate, test, and develop accurate control algorithms and methods



Preliminary information subject to change; the FOA will take precedence.

# Potential Area of Interest: Open Software and Communication Platforms

- Summary:
  - Develop open-architecture, open-standard, and open-source (when possible) software and communication platforms to enable plug-and-play connectivity to ease integration and customization across enabling technology components, different manufacturing requirements, and the latest IT hardware and standards
  - Suggested TRL/MRL level for activities: 4-6
- Additional background and opportunities:
  - Cyber-physical platforms integrate computing and communication capabilities in the sensing and actuation functions of components; public and private applications and data resources need to interconnect to achieve horizontal enterprise views and actions
  - Manufacturing automation relies predominantly on single-vendor monolithic software architectures; these data and information seams are not well-bridged with ad-hoc existing systems and multiple non-interoperable platform technologies
  - As the complexity of platform integration grows there is further need for methods to design and build platform infrastructures that integrate computing and communication capabilities in the sensing and actuation functions of components
  - Platforms will need to ensure that a standard of performance and cyber security is met at a low implementation cost



Preliminary information subject to change; the FOA will take precedence.

# Potential Area of Interest: Application Toolkits

- Summary:
  - Develop application toolkits for workflow design, process monitoring, and big data analysis for factory and enterprise wide real-time decision support
  - Suggested TRL/MRL level for activities: 4-6
- Additional background and opportunities:
  - A manufacturing platform architecture, based on an open-standards, open-source, and open-innovation framework, should enable plug and play connectivity to ease integration and customization across enabling technology components, different manufacturing requirements, and current as well as future-proofed IT hardware and standards, while ensuring that a standard of performance for process control, cyber security, and cyber-resiliency are met
  - End users should be able to develop application toolkits, for workflow design, process modeling, sensor integration and validation, process monitoring, and big data analysis of processes
  - Toolkits could be used across many manufacturing establishments and/or address company specific manufacturing processes

Preliminary information subject to change; the FOA will take precedence.

# Potential Area of Interest: Testbeds

- Summary:
  - Enable availability of testbeds to ensure that technologies are tested in conditions similar to those in the manufacturing environment, including hardware-in-the-loop testing and factory floor testing to reduce risks associated with implementation
  - Suggested TRL/MRL level for activities: 5-7
- Additional background and opportunities:
  - Provide operationally relevant hardware-in-the-loop testbed capabilities for Smart Manufacturing technologies (TRL/MRL 5-6) not commonly available to individual firms (particularly small and medium sized enterprises)
  - Provide opportunities for first-of-kind testing (TRL/MRL 6-7) of Smart Manufacturing as pilot deployment in manufacturing processes through an extended industrial partnership
  - Results of first-of-kind testing can be used to validate models, sensors and controls as well as measure energy and waste saved in processes



Preliminary information subject to change; the FOA will take precedence.

# Anticipated Application Technical Volume and Review Criteria

- Technical Description/Merit, Innovation, and Impact
- Institute Workplan and Commercialization Plan
- Team and Resources
- Operations and Management Plan
- Intellectual Property Management Plan
- Transition Plan

Until the FOA is released, please review the earlier EERE Institute FOA on Composite Materials at https://eere-exchange.energy.gov/ (DE-FOA-0000977: Clean Energy Manufacturing Innovation Institute for Composite Materials and Structures) for additional details on prior technical volume requirements and review criteria

Preliminary information subject to change; the FOA will take precedence.

# Technical Merit, Innovation, and Impact

- Technical merit, including overall approach for the proposed Institute to develop and deploy innovative next generation technologies that meet national needs and FOA goals
- The specific innovation of proposed technology developments, the advantages of proposed technology developments over current and emerging technologies, and the overall impact on advancing the state of the art/technical baseline
- Institute impact by demonstrating potential impact for U.S. manufacturing competitiveness, particularly energy savings/productivity, domestic production capacity, domestic job creation, trade balance and/or GDP, as well as regional economic development
- A summary of how technical education and workforce development activities will be incorporated into the overall Institute plan and operations



Preliminary information subject to change; the FOA will take precedence.

# Institute Workplan and Commercialization Plan

- A clear and concise  approach and workplan, including detailed statement of project objectives, work breakdown structure and task descriptions
- The goals for the overall Institute and major Institute elements, including operations and management, shared RD&D facilities, R&D projects, stakeholder engagement and road-mapping, technical education and workforce development, and commercialization
- Schedule and project management, including milestones to demonstrate success, go/no-go decision points, metrics, and deliverables
- An understanding of the key technical risk areas involved in the proposed work and mitigation strategies
- A market transformation/commercialization plan for initial proposed R&D projects or technical work



Preliminary information subject to change; the FOA will take precedence.

# Team and Resources

- Institute team and participants, including unique qualifications and expertise, and key personnel
- Sufficiency of the existing and proposed facilities and capabilities; and leveraging of existing resources and facilities
- Level of participation by project participants as evidenced by letters of commitment and integration into the workplan
- Level of commitment to support U.S. manufacturing competitiveness
- Reasonableness of budget and spend plan for proposed project and objectives



Preliminary information subject to change; the FOA will take precedence.

# Operations and Management Plan

- Effectiveness of management approach and structure to enable strategic decision-making
- Proposed organization structure to support the Institute objectives and incentivize private sector participation, including participation structure for each level of participation
- Adequacy and quality of plans for strategic planning, roadmapping, selection and prioritization of R&D work, review activities, and performance metrics
- Identification of operational risks, specifically with respect to Intellectual Property management and securing U.S. manufacturing competitiveness



Preliminary information subject to change; the FOA will take precedence.

# Intellectual Property Management Plan and Transition Plan

## Intellectual Property Management Plan

- How the IP management plan will support domestic manufacturing and encourage participation by domestic industry in the Institute
- IP and related governance issues inherent with complex collaborations and/or multi-user facilities

## Transition Plan

- Sustainability plan for the proposed Institute past the award period
- Proposed sources of funding/revenue and the model which will support the Institute operations beyond the award period
- The strategy to keep the Institute relevant to industry



Preliminary information subject to change; the FOA will take precedence.

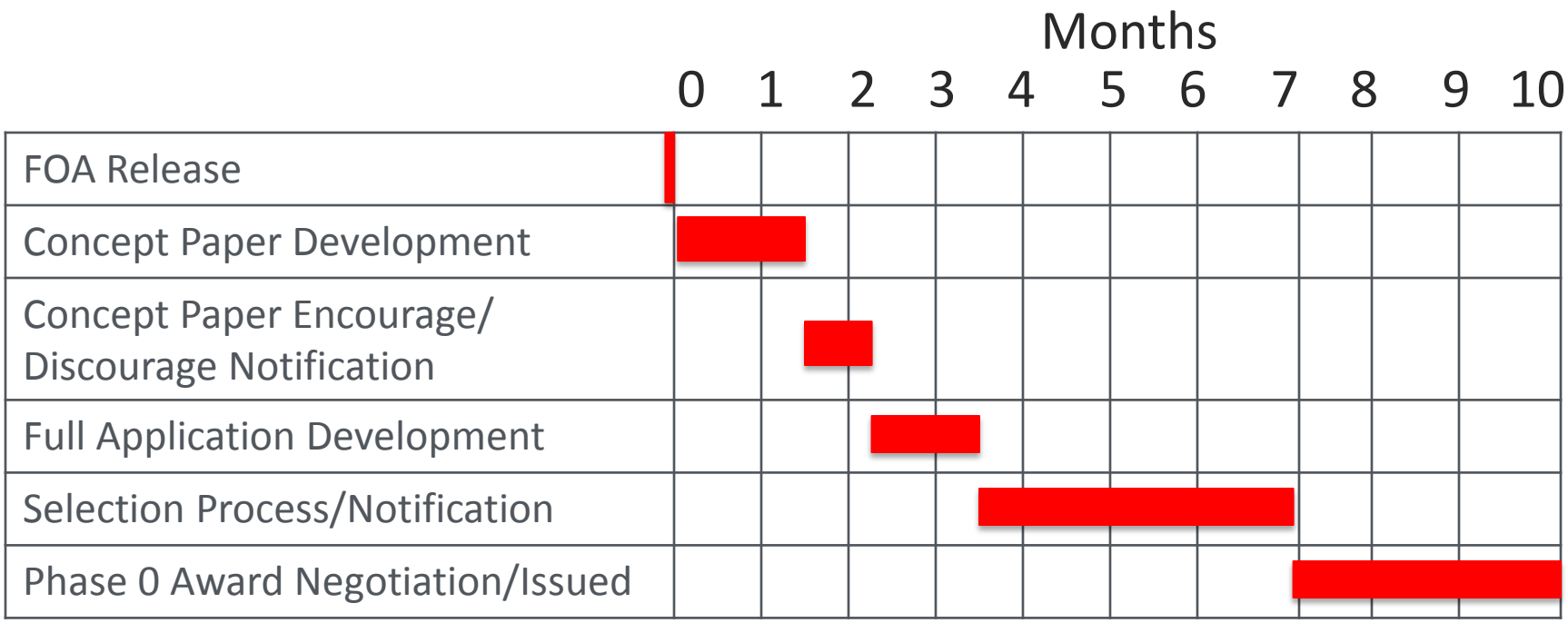
# Special FOA Considerations

- Teaming List will be developed once FOA is released
- Phase 0 award period envisioned:
  - Purpose is to provide resources for the startup phase consisting of formation and organization of the governance structure, initial formation of an industrial partnership as well as finalizing technical development plans
- Active project management:
  - DOE expects to be substantially involved in the Institute award by participating in the following, including but not limited to: observer on management boards; review and approval of projects planned by the organization to reach programmatic goals; review of organization progress based on metrics; and participation in go/no go decision points and peer reviews



Preliminary information subject to change; the FOA will take precedence.

# Approximate FOA Application and Selection Timeline

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# Summary

- The FOA will be a great opportunity to create a center of excellence for Smart Manufacturing
  - Successful partnership between government, academia, and industry
  - Benefits for DOE, the federal government and commercial industry will be substantial
  - Opportunity to network with other Innovative Manufacturing Institutes, including the complementary DOD-led Digital Manufacturing & Design Innovation Institute
  - Provide a technological leap to further U.S. economic and manufacturing competitiveness

# Thank you

- Please submit questions during the break

- Also submit additional or specific questions to Golden as instructed once the FOA is released

# Federal Investment Will Catalyze Smart Manufacturing in the U.S.