REQUEST FOR INFORMATION

U.S. Department of Energy

Office of Energy Efficiency and Renewable Energy
Advanced Manufacturing Office

Request for Information (RFI): Specific Clean Energy Manufacturing Focus Areas Suitable for a Manufacturing Innovation Institute

DE-FOA-0001158

DATE: August 29, 2014

CLOSING DATE: October 3, 2014, 5:00 PM EDT

SUBJECT: Request for Information (RFI) on Specific Clean Energy Manufacturing Focus Areas Suitable for a Manufacturing Innovation Institute

DESCRIPTION: The Advanced Manufacturing Office (AMO) seeks information on mid-Technology Readiness Level (TRL) research and development (R&D) needs, market challenges, supply chain challenges and shared facility needs in addressing advanced manufacturing development challenges impacting clean energy manufacturing. AMO is particularly interested in the challenges associated with advanced manufacturing technology which might be overcome by pre-competitive collaborations conducted via a Clean Energy Manufacturing Innovation Institute. AMO recently completed a broad RFI on this topic area[1]. The intent of this RFI is to narrow the focus of a possible Clean Energy Manufacturing Institute and invite discussion on a set of the following specific focus areas. The Topical/Technical Focus Areas under consideration in this RFI are:

- Advanced Materials Manufacturing (AMM)
- Advanced Sensing, Control, and Platforms for Manufacturing (ASCPM)
- High-Efficiency Modular Chemical Processes (HEMCP)
- High Value Roll-to-Roll Manufacturing (R2R)

[1] Request for Information (RFI): Clean Energy Manufacturing Topics Suitable for a Manufacturing Innovation Institute DE-FOA-0001122, dated 4/17/2014, closed 5/20/2014, http://energy.gov/eere/amo/articles/request-information-rfi-clean-energy-manufacturing-topics-suitable-manufacturing

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For the purposes of this RFI, **clean energy manufacturing** can be broadly considered the making of products and/or product based value-added services such that the environmental impact is reduced in the making, use or disposal of the product made. For the purposes of this RFI, **advanced manufacturing** can broadly be considered the making of products and/or product based value–added services for which technology is either critically enabling or provides a relative competitive advantage in comparison to existing approaches.

BACKGROUND: The Advanced Manufacturing Office (AMO) is a Technology Office within the Department of Energy's (DOE) Office of Energy Efficiency & Renewable Energy (EERE). AMO partners with private and public stakeholders to improve U.S. competitiveness, save energy, create high-quality domestic manufacturing jobs and ensure global leadership in advanced manufacturing and clean energy technologies. AMO invests in cost-shared research, development and demonstration (RD&D) of innovative, next generation manufacturing processes and production technologies that will improve efficiency and reduce emissions, reduce industrial waste and reduce the life-cycle energy consumption of manufactured products. The results of this investment include having manufacturing energy efficiency harnessed as a competitive advantage, and cutting-edge clean energy products competitively manufactured in the United States.

AMO has been an early partner in the Administration's planned National Network of Manufacturing Innovation (NNMI). [2] AMO supports pre-competitive RD&D work in additive manufacturing / 3D printing topics through the interagency, Department of Defense led, pilot institute "America Makes" and through its partner the Manufacturing Demonstration Facility at Oak Ridge National Laboratory.[3, 4] AMO also supports the Critical Materials Institute, a multi-year, multi-participant effort addressing currently identified and future potential critical materials shortage issues.[5] AMO is leading a manufacturing innovation institute for wide band-gap semiconductor power electronics[6], and currently is evaluating applications for the Funding Opportunity Announcement (FOA) for an advanced composites manufacturing innovation institute for clean energy applications.[7] This portfolio of technology development activities supports a broad range of advanced manufacturing issues with significant potential impact on the competitive nature of US domestic clean energy manufacturing. However, there remains a need to further engage the public and private sector for input in identifying issues regarding advanced manufacturing technology areas that might critically benefit from support in an organized manufacturing

[2] National Network for Manufacturing Innovation: A Preliminary Design. National Science and Technology Council. January 2013. http://energy.gov/sites/prod/files/2013/11/f4/nstc_jan2013.pdf

[3] https://www.americamakes.us/

[4] http://energy.gov/eere/amo/oak-ridge-manufacturing-demonstration-facility-mdf

[5] http://energy.gov/eere/amo/critical-materials-hub

[6] http://energy.gov/eere/amo/next-generation-power-electronics-national-manufacturing-innovation-institute

[7] http://energy.gov/eere/amo/articles/clean-energy-manufacturing-innovation-institute-composites-materials-and

innovation institute and to assess the potential of such an institute on domestically competitive clean energy manufacturing.

PURPOSE: The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders on specific issues and topics related to the establishment of Clean Energy Manufacturing Innovation Institutes through specific Topical/Technical Focus Areas described herein. AMO seeks information through this RFI to understand cross-cutting as well as specific manufacturing challenges that if addressed could provide the underlying motivation for the formation of a manufacturing innovation institute, consistent with the mission of the Department of Energy (DOE), the Office of Energy Efficiency and Renewable Energy (EERE) and AMO.

This is solely a request for information and not a Funding Opportunity Announcement (FOA). EERE is not accepting applications.

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Any information obtained as a result of this RFI is intended to be used by the Government on a non-attribution basis for planning and strategy development; this RFI does not constitute a formal solicitation for proposals or abstracts. Your response to this notice will be treated as information only. EERE will review and consider all responses in its formulation of program strategies for the identified materials of interest that are the subject of this request. EERE will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that EERE is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI. Responses to this RFI do not bind EERE to any further actions related to this topic.

PROPRIETARY INFORMATION: Because information received in response to this RFI may be used to structure future programs and FOAs and/or otherwise be made available to the public, **respondents are strongly advised to NOT include any information in their responses that might be considered business sensitive, proprietary, or otherwise confidential.** If, however, a respondent chooses to submit business sensitive, proprietary, or otherwise confidential information, it must be clearly and conspicuously marked as such in the response.

Responses containing confidential, proprietary, or privileged information must be conspicuously marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Federal Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

If your response contains confidential, proprietary, or privileged information, you must include a cover sheet marked as follows identifying the specific pages containing confidential, proprietary, or privileged information:

> **Notice of Restriction on Disclosure and Use of Data:**
>
> Pages [list applicable pages] of this response may contain confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for the purposes described in this RFI DE-FOA-0001122. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source.

In addition, (1) the header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: “Contains Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure” and (2) every line and paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

EVALUATION AND ADMINISTRATION BY FEDERAL AND NON-FEDERAL

PERSONNEL: Federal employees are subject to the non-disclosure requirements of a criminal statute, the Trade Secrets Act, 18 USC 1905. The Government may seek the advice of qualified non-Federal personnel. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The respondents, by submitting their response, consent to EERE providing their response to non-Federal parties. Non-Federal parties given access to responses must be subject to an appropriate obligation of confidentiality prior to being given the access. Submissions may be reviewed by support contractors and private consultants.

REQUEST FOR INFORMATION CATEGORIES AND QUESTIONS:

The four (4) specific topic areas of interest are Advanced Materials Manufacturing, Advanced Sensing, Control, and Platforms for Manufacturing, High-Efficiency Modular Chemical Processes, and High Value Roll-to-Roll Manufacturing. In addition, a single general topic allows broader input from stakeholders on topics not specifically covered. The specific topic areas are described below.

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Advanced Materials Manufacturing

In the Advanced Materials Manufacturing (AMM) topic, we are investigating the potential for both high-throughput computational and experimental tools in a consortium/institute framework for the accelerated development of new materials of critically enabling capability for clean energy applications. This AMM effort would be expected to expand on and complement the Materials Genome Initiative (MGI)[8]. Examples of such capacity include the MIT/Lawrence Berkeley National Lab (LBNL) Materials Project[9], the NSF sponsored Network for Computational Nanotechnology led by Purdue [10] and the NIST sponsored Center for Hierarchical Materials Design (CHiMaD) led by Northwestern[11], which focus on design, development and manufacturing of materials and components, rather than on fundamental materials discovery alone.

An AMM effort would provide a framework to accelerate progress towards applied energy objectives and create strong coordination with Basic Energy Science and current MGI activities. The effort will also complement and leverage activities across government such as MGI activities at the National Institute of Standards and Technology (NIST)[12] which advances measurement science, standards, and technology, yielding new methods, metrologies, and capabilities necessary for accelerated materials development.

[8] http://www.whitehouse.gov/mgi
[9] https://materialsproject.org/
[10] www.nanoHUB.org
[11] http://www.nist.gov/mml/coe-120313.cfm
[12] http://www.nist.gov/mgi/

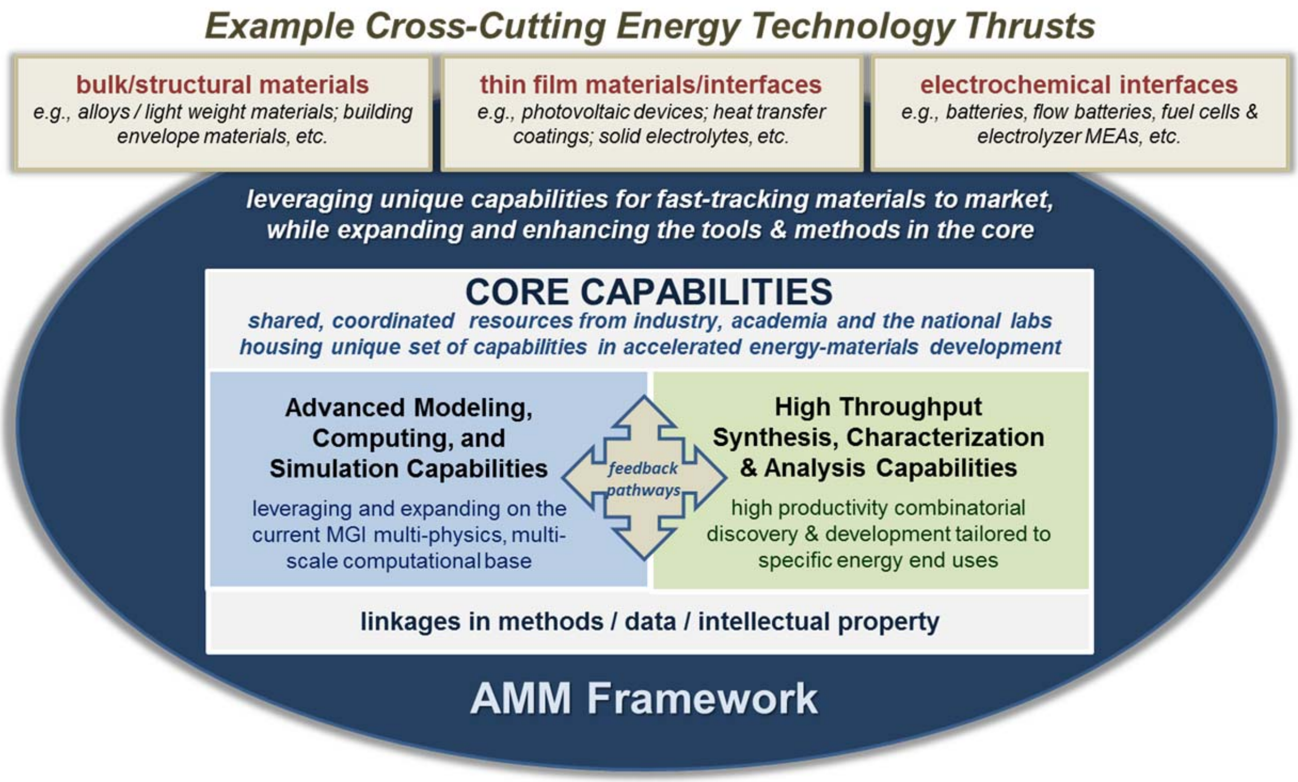

Figure 1. Example Advanced Materials Manufacturing (AMM) Framework: bringing together facilities and expertise in high-throughput computational & experimental methods, materials data, and intellectual property management to support accelerated solutions to targeted materials development challenges in clean energy industries and manufacturing processes.

The following key areas are of interest: Market drivers, applications, metrics, and specific technology areas that would be applicable to AMM accelerated materials development approach. Discussions, relevant to following, are of interest:

- The availability and gaps in computational tools and models that describe the structure, physical and chemical behavior of relevant materials.
- The availability and gaps in high throughput synthesis and characterization tools.
- The availability and gaps in understanding the effects of processing and lifecycle conditions on structure and properties of relevant materials.

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- A consortium or institute framework with the appropriate organizations as well as skilled and experienced computational materials scientists, engineers, and experimentalists, and an appropriate structure to manage and coordinate the effort.

- How best to coordinate and leverage efforts in fundamental science versus applied technology development and engineering.

- Objective, measurable and quantitative metrics for an AMM framework and how such application oriented metrics might drive new or additional manufacturing oriented activities for the MGI.

- Description of practical application of developed MGI tools and associated barriers to applying and using these same tools in the development and technology transfer of materials, processes and products to manufacturing environments.

AMM will accelerate the development of new, high performance materials systems for clean energy applications. The AMM objective would be to complement and expand on current resources in materials R&D for tackling multi-scale, multi-physics materials challenges in key EERE technology thrusts. To achieve this, the AMM framework would build and sustain a broad and powerful application-driven R&D platform that combines state-of-the-art computational capabilities with high-throughput synthesis and characterization tools– all framed within a consortium/institute model equipped with the business and intellectual property management tools needed for fast-tracking the product-to-market process.

The stated goal of the MGI is to "create a new era of policy, resources, and infrastructure that support U.S. institutions in the effort to discover, manufacture, and deploy advanced materials twice as fast, at a fraction of the cost."[13] An AMM approach established about this concept would provide a unique, organized framework of state-of-the-art computational and experimental tools to develop advanced materials that meet specific needs for energy technologies. It is a cross-cutting technology area that applies to multiple industries and many applications, and which has the potential to significantly reduce development time to bring advanced materials to the marketplace.

AMM techniques reduce the cost and improve the performance of clean energy technologies. Cost reductions, for example in overall capital and operating expenditures, are achieved through reduced material cost, reduced manufacturing cost, and a shortened development cycle. Performance improvements are achieved through design of manufacturable materials uniquely suited for the particular clean energy application. Clear definition and aggressive targeting of materials and process level metrics as they impact cost and performance are essential components of the AMM approach.

[13] http://www.whitehouse.gov/mgi

Advanced Sensing, Control and Platforms for Manufacturing

For this RFI, Advanced Sensing, Control and Platforms for Manufacturing (ASCPM), also known as "Smart Manufacturing" is defined as a network data-driven process that combines innovative automation, and advanced sensing and control to integrate manufacturing intelligence in real-time across an entire production operation while minimizing energy and material use. AMO is particularly interested in identifying the R&D needs for the development of affordable, advanced industrial data collection sensors and management systems, industrial community modeling and simulation platforms, and technologies that enable enterprise wide integration to reduce energy consumption and greenhouse gas emissions (GHG) from manufacturing and to support U.S. manufacturing competitiveness.

Within the manufacturing sector, energy intensive manufacturing industries account for nearly 75% of all the energy used (over 20% of national energy use) and offer one of the largest opportunities for potential energy reductions. These industries produce and process basic materials and chemicals that go into many end-use consumer and industrial products. Energy intense industries include primary metals (e.g., steel, aluminum, metal-casting), chemicals/petrochemicals, oil and gas refining, bio-manufacturing (e.g., pulp and paper), and nonmetallic minerals (e.g., glass, cement).

Advanced sensing, control, and platforms for manufacturing enables the cyber and physical connection of diverse systems and increases the collection and analysis of massive amounts data via advanced sensors and high performance computing platforms at the hierarchical levels of the device, process, plant and enterprises. This data creates a high degree and fidelity of manufacturing intelligence that can be used to optimize energy, materials, resources, design of business models, and is applicable in multiple industries and applications, particularly in energy intense industries. The consumer and discrete manufacturing industry has in recent years employed information technology (IT)-based platforms and sensors to individual stages of decision making and production. This Advanced Sensing, Control, and Platforms for Manufacturing (ASCPM) approach could lead to greater energy, material and resource efficiencies at lower costs, while achieving higher productivity and quality. However, these technical advances have been slow to migrate to the energy intensive industries due to differences in manufacturing methods (continuous and high-volume batch processing versus discrete), low turnover rate of capital assets, legacy infrastructure with many disparate IT and process systems installed over decades, low-fidelity of process control models and harsh production environments.

Additional study and focus over a range of ASCPM issues would result in a significant positive impact on the US economy and the overall state of-domestic-manufacturing, while reducing energy consumption and greenhouse gas emissions (GHG) in energy intensive manufacturing industries and creating new business opportunities. It is envisioned that successful development and adoption of smart manufacturing technology (e.g., IT platform, automation, and low-cost advanced sensors) will:

- Optimize production, quality, and global competitiveness with cost-effective sensing and control retrofits.
- Improvement and integration of process, plant and enterprise-wide efficiencies by reducing energy, materials, and water intensity.
- Better inform business decisions across the manufacturing enterprise.
- Improve supply chain efficiency.
- Increase safety and quality.

Organizations such as the Advanced Manufacturing Partnership (AMP 2.0)[14] are supporting ASCPM technology development, systematically identifying challenges such as interconnectivity and interoperability, real-time communication, cyber security, and scalability. In this RFI, we are interested in technologies that may be derived from or aligned with on-going efforts, but applied specifically to the challenges of energy related efficiency and productivity in manufacturing.

High-Efficiency Modular Chemical Processes

High-Efficiency Modular Chemical Processes (HEMCP), often referred to as Process Intensification, aims to provide an open-source platform that catalyzes a revolution in chemical processing from large-scale, fixed asset chemical plants to small-scale, high-efficiency, deployable, plug-and-play reactors and separation equipment that leverage U.S. manufacturing capabilities and enable more innovative and environmentally friendly processing.

The current paradigm in continuous process technology relies on economies of scale to achieve efficient and economic operation. The result is that the construction of economically competitive chemical plants typically requires huge capital expenditures and therefore has a high degree of capital risk. As a consequence, the adoption of new technology is extremely risky and innovation is often stifled. Moreover, such centralized processes are ill-suited for adapting to rapidly changing market demands and cannot be re-deployed closer to new resources or markets.

[14] http://www.manufacturing.gov/amp.html

HEMCP approaches represent a paradigm shift from classical economies of scale to economies of mass production that achieve cost reductions through well-known mass-manufacturing experience learning curves. The shift to small-scale is motivated by the following: 1) technologies for automating processes exist today that were previously unavailable—enabling massively parallel operation and undercutting the savings that could previously only be achieved through economies of scale; 2) mass production of many small standardized units can achieve capital cost savings comparable or superior to economies of scale (e.g., ~ $30/kW mass-produced auto engines versus ~ $1000/kW large-scale power plants); 3) small-scale enables unprecedented flexibility to adapt product output to changing market demand and to locate manufacturing processes closer to resources and/or markets; 4) self-contained, modular units can be deployed in remote regions, allowing the economic utilization of currently inaccessible domestic assets; and 5) continuous learning through production numbers will support the rapid integration of technological innovation.

The fundamental technical challenge in scaling down processes is maintaining high efficiency at comparable capital cost per unit output. Large-scale processes rely on near isothermal operation as an approach to high efficiency. This challenge will be addressed in HEMCP through better thermal integration; reduced or combined process steps; and the implementation of novel process intensification technologies, such as catalytic membrane reactors, micro-channel heat exchangers, centrifugal reactors, low-thermal budget process energetic and other integrated reaction-separation technologies.

Rather than prescribing a particular industry or application, it is envisioned that HEMCP will provide a cross-cutting platform across multiple industries and applications, Table 1. Similarly, the proposed concept intends to provide a platform that allows for the incorporation of a wide-range of novel reactor and separation engineering, manufacturing, and automation innovations, Figure 2.

Table 1. HEMCP cross-cutting industries and applications.

Industry	Applications
Oil & Gas	• Well-head gas separation (N_2, CO_2, C_{2+}, SO_2, Ar, H_2O) • Helium recovery and refining • Gas to liquid (fuels and chemicals) conversion • Hydro-fracturing water recycling • Fractional distillation • Natural gas pipeline processing
Mining & Refining	• Water recycling • Solvent recycling • Metals extraction processes

Chemicals	• Olefin production • Ammonia production • Chemical intermediates production • Specialty chemicals and polymers production • Pharmaceutical chemical production
Waste & Recycling	• Metal recycling • Electronics recycling • Water and sewage treatment • Desalination
Biofuels	• Gasification • Alcohol separations
Power Generation	• Air separation • Hydrogen generation • Gasification • Carbon capture

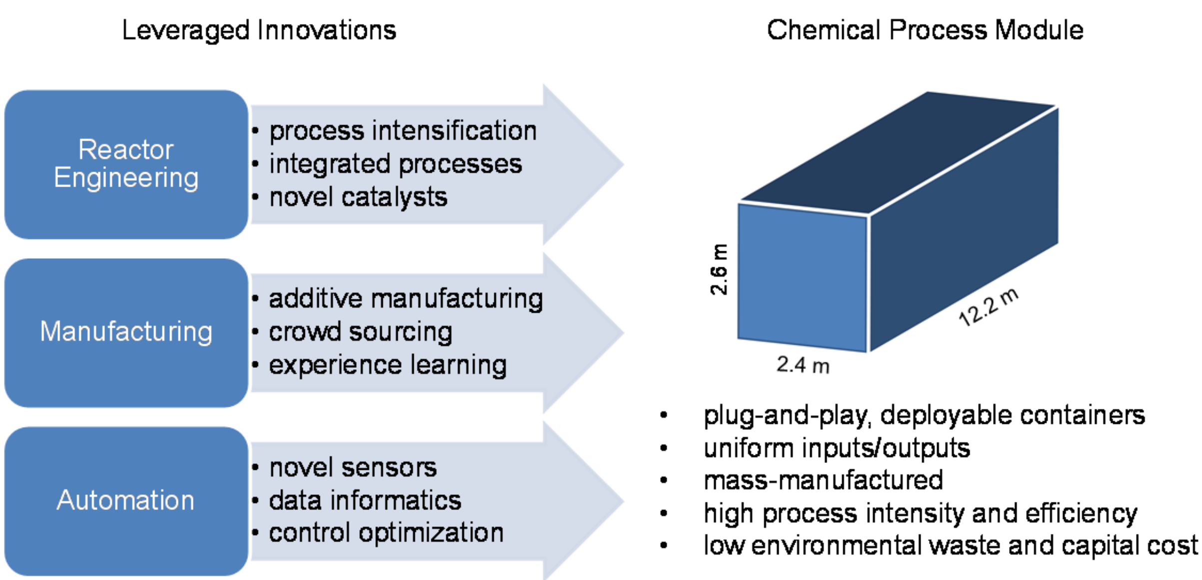

Figure 2. HEMCP concept of chemical process module and leveraged innovations.

The proposed objectives of HEMCP include:

(1) Design of 'plug-and-play' modular continuous process technology at industrial scale for commercial applications, capable of widespread implementation throughout the U.S. industrial sector;

(2) Creation of a backbone platform for modular continuous processes for the validation of new/enhanced reactor and separation technologies, new automation technology, and components fabricated through advanced manufacturing techniques; and

(3) Establishment and dissemination of open-source design methodologies and guidelines for modular, container-based production units, applying process intensification concepts and innovative decision tools.

High Value Roll-to-Roll Manufacturing

High Value Roll-to-Roll Manufacturing (R2R) is used to support a wide range of products in applications which span many clean energy sectors. The R2R technique is considered to be high throughput and high value-added two-dimensional (2D) process methods that involve deposition of material(s) over large areas onto moving webs or carriers or other continuous substrates. The successive deposition steps of heterogeneous materials build a final construction which support these deposited materials in a functional finished structure.[15] Current technologies which typify roll to roll processes include; tape casting, slot-die coating, screen printing, reel to reel vacuum deposition/coating, and R2R lithography.[16]

The current challenge for R2R is the development of energy efficient, low environmental impact, ultra-low cost R2R equipment, process and production capabilities to manufacture high quality clean energy products and applications for energy saving applications. Current and future generation products that could potentially be supported by R2R now and in the future include chemical separation membranes, chemical and moisture barrier films, micro-electronics such as flexible microelectronics[17, 18] made of thin- and thick-film membranes[19] with reduced energy consumption, electro-chromic window films for energy-efficient building construction, reflective and anti-reflective coatings, photovoltaics (PV)[20] in solar panels as a sustainable energy source for

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[15] Watts, Michael PC. "Advances in roll to roll processing." Impattern Solutions, Austin, TX, http://www. impattern. com/Download/RollToRollProcessing. pdf (2007).
[16] Onoda, George Jr., and L. Hench, Ceramic Processing Before Firing, John Wiley and Sons, New York, pp.426-428, 1978
[17] Schwartz, Evan and Chris Ober, MSE 542: Flexible Electronics, Cornell University, May 11, 2006
[18] A. Gregg, et al, "Roll-to-Roll Manufacturing of Flexible Displays", In Flexible Flat Panel Displays, ed. G.P. Crawford, Wiley, 2005, pp. 410-445
[19] Topfer, Morton L., Thick-Film Microelectronics, Fabrication, Design and Application, Microelectronics Series, Van Nostrand Reinhold Company, New York, 1971
[20] Hamers, Edward and Jaap Struijk, SE-POWERFOIL, Roll-to-Roll manufacturing for high efficient multi-junction thin film

agricultural and building applications, fuel cells such as polymer electrolyte membrane (PEM) and solid oxide (SOFC), advanced generation solid-state batteries electrodes and systems for energy storage and other electronic devices and sensors (pressure, position, temperature, gas, etc.) which can be embedded within a matrix substrate using multilayer R2R technology.

All of these products present a huge potential for industry to invest in R2R. In addition, R2R can be a much more environmentally benign and energy-efficient process as compared to wafer-based or vacuum-based manufacturing. Energy savings can be realized not only from the R2R but from the products produced by R2R which will have an enduring economic benefit over the next 20 years, such as using this technology to embed sensors within products and other major infrastructure to provide current state-of-condition and predict any potential faults, serving to dramatically impact the domestic economy.

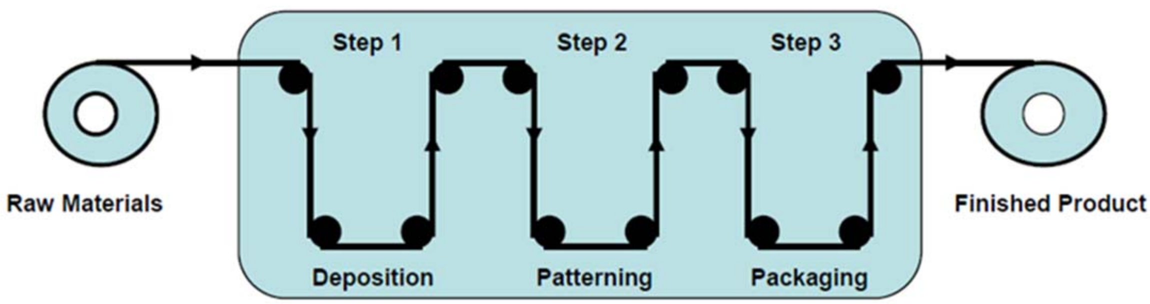

Figure 3. Idealized Roll-to-Roll manufacturing process flow[21]

The thin-film transistor industry has done cost analyses that show R2R can be 80% less expensive than batch processing per unit area of product.[22] In most cases, industry has analyzed the market and built business cases to develop the specific technologies to meet market demands. Further investments would require prototype manufacturing and testing the end products to determine if the R2R is satisfactory to meet material specifications. An R2R Institute could provide a prototyping capability at a shared cost to allow businesses to launch the end product before investing if full production facilities.

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silicon flexible photovoltaic modules, Oct 1, 2006

[21] A. Gregg, et al, "Roll-to-Roll Manufacturing of Flexible Displays", In Flexible Flat Panel Displays, ed. G.P. Crawford, Wiley, 2005, pp. 410-445

[22] Randlph, M.A., Commercial Assessment of Roll to Roll Manufacturing of Electronic Displays, MSE Thesis, MIT, September 2006

Other Emerging Topics in Manufacturing for Energy

The Advanced Manufacturing Office (AMO) of the Department of Energy has previously issued a Request For Information (RFI) on "Clean Energy Manufacturing Topics Suitable for a Manufacturing Innovation Institute" (DE-FOA-0001122). The purpose of the earlier RFI was to seek information on mid-Technology Readiness Level (TRL) research and development (R&D) needs, market challenges, supply chain challenges and shared facility needs in addressing advanced manufacturing development challenges impacting clean energy manufacturing. While in this RFI the AMO seeks information on four specific topical issues, there remains broad interest in identifying topics suitable for the potential formation of a Manufacturing Innovation Institute. As a result, respondents are encouraged to provide information on any emergent topic manufacturing relevant to energy not otherwise listed.

ISSUES, QUESTIONS AND INTERESTS FOR EACH TOPICAL AREA

1. AMO frames the formation of new programs around the consideration, analysis and assessment of five key issues: the consideration of Impact of the program if successful; the potential Additionality of investment in the program topic relative to existing public and private investment by others; the potential for Openness of a topic or technology community addressing a topic to new approaches, ideas or inputs; the need for investment in the topical area as a Proper Role of Government; and the potential for Enduring Economic Benefit of the topical area after a proposed program is complete.

   For all responders addressing any of the topic areas, please comment on the five key issues relative to your area of interest. More detailed questions about each issue are provided below to frame your response:

   a) Impact: What is the advanced manufacturing development challenge to be solved? If solved, how would this development challenge affect clean energy technology? If solved, what organizations or groups will care in the public and/or private sectors? What would be the potential quantitative impacts on energy efficiency, life-cycle energy benefits, greenhouse gas reductions (GHG) and/or related environmental impacts in manufacturing or use?
   b) Additionality: Who supported the fundamental low-TRL research and development and why wouldn't they support mid-TRL advanced manufacturing development? Who else might co-fund this mid-TRL advanced manufacturing development? How might AMO support best catalyze co-funding of mid-TRL investment? What key knowledge or capability is missing, unknown or uncertain, which prevents private sector manufacturing of this technology today without further public sector investment?

c) Openness: Can this mid-TRL advanced manufacturing development challenge be stated more broadly, without loss of potential impact? Is there a fertile low-TRL scientific base which is ready to address this advanced manufacturing development challenge? What broad set of public and private sector stakeholders need to be engaged in addressing this advanced manufacturing development challenge and how would they be best engaged?

d) Proper Role of Government: Why specifically would addressing this advanced manufacturing development challenge through an institute be in the public sector national interest now? What are the potential market failures and why wouldn't the private sector address this manufacturing development challenge by itself in the absence of public sector investment? Is there a pathway for public sector and AMO support to end and what metrics would provide short-term indicators of success along this pathway? Are there supply chain issues where multiple organizations would need to simultaneously change technology approaches or practices for this clean energy technology to be manufactured? What non-technology development issues need to be addressed (workforce development, unique facility construction, user knowledge dissemination, etc.) for this clean energy technology to be adopted?

e) Enduring Economic Benefit: Is there large potential for follow-on funding and what are the potential stage-gate metrics to be achieved before that follow-on support could be harnessed? Is industry currently trying to address a solution to this mid-TRL challenge and what achievements or limitations have they met? Would this mid-TRL advanced manufacturing challenge impact more than one clean energy (or non-clean energy) application?

2. For all responders addressing any of the topic areas, please answer the following questions relative to your area of interest:

a) What do you think are the two/three most important R&D areas with technology development and/or application needs in the Technology Readiness Level/ Manufacturing Readiness Level (TRL/MRL) 4-7 and why?

b) What are the most significant obstacles and/or challenges one faces to invest in or adopt this technology, such as: high capital cost of laboratory equipment and instrumentation, investment to maintain a dedicated staff, lack of applications for this technology, lack of knowledge, or other "Cons" (please identify)? Please explain your choices.

c) What are the top three industries/applications (pros) most likely to benefit from adoption of the technology and to what extent must the market adopt the technology to be considered successful and why?

d) What are the appropriate objectives and/or metrics that would be most effective for gauging the performance and effectiveness for each of the top three applications identified, and why?

e) For the technology areas you identified as the most important, which would be more effectively addressed through a shared use R&D public private partnership (P-P-P) facility, as defined under the "NNMI Design Concept" capable of precompetitive and protected work? Which would be more effectively addressed through individual, independent R&D projects and plant site testing or should the technology, instead be left to the private sector to develop and advance? Please explain your answers.

f) What is the long-term value for this type investment for the US domestic industry?

g) Describe the envisioned model to use to establish a Clean Energy Manufacturing Innovation Institute in one of the technology areas of interest. What is the proper mix and role of industry, academia, national laboratories, and non-profits? Please provide sufficient detail (e.g. streamlined processes, accessibility, opportunities for small businesses, etc.) and roles for each participant. Include a discussion regarding long-term sustainment. What are the roles of all stakeholders?

h) How could concerns over intellectual property (IP) management be addressed in a multi-stakeholder institute? How will commercial competitiveness be balanced with the expectation for open-access information?

i) Do you have access to the skilled practitioners, technicians, engineers and scientists, etc. that are or will be required to implement the technology? What training and workforce development activities could be envisioned through an institute?

j) How should the activities, results, and work products of any institute be communicated to the broader stakeholder community? What mechanisms or approaches could be used to obtain relevant and timely feedback from industry stakeholders on market drivers, applications and technical requirements, resulting from these communications?

k) Please describe how the value of the technology area being addressed is reflected in the cost of the final product or value proposition for a new technology in your market. (CM, OEM, End Users)

l) Please provide topics and a list of potential stakeholders for an AMM workshop that will be organized by DOE to further develop the proposed approach.

m) Please identify the role of your institution or business with respect to the technology area of interest, such as being a technology developer, original equipment manufacturer (OEM), end user, service organization, or other (please identify).

n) Please provide any other feedback that would be relevant to the planning and implementation of the technology of interest.

3. For responders addressing Advanced Materials Manufacturing (AMM) please answer the following questions related to materials problems or challenges:

a) What are some examples in which an accelerated material design/AMM approach has benefited your company/organization and are there examples in which you have an application-driven problem but do not have the material genome data set required that could be utilized to address relevant high impact problems?

b) What core infrastructure components would be required for a central facility to support an AMM-based approach to your materials challenges? Please explain your choices.
c) What are your perspectives regarding a central facility for capabilities/tools versus a distributed model leveraging or expanding upon existing capabilities?
d) What is the availability of advanced computing tools relevant for your application or problem? Are these tools easily accessible by your institution? Please list specific relevant capabilities and institutions.
e) Are there gaps in the computational tools or models that need to be addressed? For example, do you have the required fundamental models relating composition, phases and phase transformations, surface energies, thermo-physical properties, defects, diffusion and precipitation, deformation and microstructure, solidification and heat treatment, and a wide range of mechanical properties and behaviors? Which areas need more development?
f) Are the required high throughput synthesis and characterization tools available for the materials problem(s) of interest to your institution? What additional development work or validation, if any, needs to be done? Please list specific relevant capabilities and institutions.
g) Please comment on the best way to coordinate with current MGI efforts. What are the pros and cons of existing efforts and where are there gaps that may be addressed with the proposed approach by DOE's applied energy offices?
h) There are multiple U.S. institutions developing fundamental material data, property data, advanced materials computational tools, high throughput characterization methods, and deep knowledge about the relationships between composition, processing, structure, and properties. What framework would you propose to unite and curate these resources, in a way that preserves intellectual property and maximizes the benefits of the MGI for U.S. industrial competitiveness? How would AMM fit into this framework?

4. For responders addressing Advanced Sensing, Control, and Platforms for Manufacturing (ASCPM), please answer the following questions:

   a) Define Data Collection and Management Systems R&D Needs for ASCMP in applications relevant to energy, such as: Low-cost, reliable, survivable sensors for harsh environments, Energy harvesting wireless sensors, Information fusing algorithms, Structural health monitoring sensors, Self-healing sensor networks and control, or others (please identify).
   b) What performance characteristics for data collection and management systems are most important? Please explain your choices.

c) Define Modeling and Simulation Platform R&D Needs for Energy Intensive Industries regarding community modeling and simulation platforms for systems to help achieve the goal of increasing U.S. manufacturing competitiveness in these industries, regarding: Standardized IT platforms, Designing components to cyber security standards, High performance computing solutions (e.g., modeling), Retrofitting the current, installed base of serviceable IT investment, Integration of process control systems with planning and scheduling, Optimized co-design of process and sensing/control strategy, or Others (please identify).
d) Concerning Enterprise Wide Integration R&D Needs for Energy Intensive Industries, what open platform software and hardware is required to integrate and transfer data between enterprises, to integrate product and manufacturing process models, or other (please identify)? Also, what performance characteristics for enterprise wide integration are most important? Please explain your choices.
e) What do you consider to be the greatest operational benefits of adopting ASCPM technologies in energy intensive industries: Energy savings/increased efficiency, other production cost savings (fewer product defects), productivity improvement, safer operations, greater integration with suppliers, increased customer satisfaction, or other (please identify)? Please explain your choices.

5. For respondents addressing the High-Efficiency Modular Chemical Processes (HEMCP), please answer the following questions:

a) What is the motivation and value of developing field-deployable chemical reactors and/or small scale modular chemical process reactors and the value to evolve the ability to provide "plug and play" type operation?
b) What can be uniquely accomplished in creating a platform for small-scale modular reactors through a Clean Energy Manufacturing Innovation Institute that cannot be achieved through a normal funding solicitation?
c) Is achieving high efficiency at small-scale feasible? If so, how? Are there examples of where this is done today?
d) How can the economics of mass-producing a small-scale process module be estimated? How accurate are these estimates? What is an appropriate contingency factor?
e) How can industry engagement be insured?
f) What are the key skillsets (machine design, process modelling, etc.), equipment, tools, capabilities, etc. that are required for the successful execution of HEMCP? In what topical areas? Why?

6. For responders addressing High Value Roll-to-Roll Manufacturing (R2R), please answer the following questions.

a) What volume of production is required to justify use of R2R technologies in any respective business sector?
b) What are the competing technologies which are cost competitive to R2R and at what capacity level?
c) What quality systems are envisioned to meet the needs of a high capacity R2R processing? Would these systems be adaptable to multiple industrial sectors or applicable to a singular technology area?
d) Should the technology development initially focus more on high-cost, low-volume products or low-cost, high-volume products?
e) What are the metrological needs by respective industrial sectors when manufacturing with R2R? How do these needs differ between differing technologies and applications?
f) What deficiencies today exist in R2R process equipment, such as alignment, registration, web speed control, surfaces, rollers, etc.?

7. Future AMO technology investments for innovative, next generation materials, manufacturing processes, and production technologies must improve efficiency and reduce emissions, reduce industrial waste, and reduce the life-cycle energy consumption of manufactured products. AMO uses metrics to evaluate the progress of technology investments. Please provide specific metrics to assess clean energy technology development for the above four (4) topic areas. Also, please comment on the suitability of the following metrics for assessing clean energy technology development for the above four (4) topic areas:

Advanced Materials Manufacturing

a) Provide examples resulting from AMM technologies that reduce the overall weight of an electric vehicle by 30%, demonstrate born qualified materials which operate at 800 degrees Celsius and 5000 psi for advanced power systems, or demonstrate fuel cells MEAs with a power density of 1 W/cm^2 at rated power, at a cost of \$9/kW and a durability of 5000 hours for automotive and 60,000 hours for stationary applications;
b) Demonstrate a 50% time reduction in application-specific development, qualification and deployment of materials-dependent clean energy technologies;
c) Success gaged by ability to achieve DOE technology-specific cost targets in the accelerated time frame, with return-on-investment based on life-cycle savings >5:1;

Advanced Sensors, Control, and Platforms for Manufacturing

d) Provide examples of open platform software and hardware that integrates and transfers data between small, medium and/or large enterprises;
e) Demonstrate a 25% reduction in costs for core manufacturing processes in five years with a plan to achieve 50% reduction in costs in ten years by applying advanced data analysis, modeling, and simulation;
f) Provide examples of dashboard performance tools that monitor key performance indicators across the enterprise to manage dynamic production, use, and storage of essential resources, e.g., energy, water, air;

High-Efficiency Modular Chemical Process

g) Demonstrate at least three modular processes that, when compared with current large-scale industrial processes, have 1000x less capital cost ($) at cost parity per unit output [$/(kg/s)], 70 m^3 modular unit volume (8' x 8' x 40'), comparable efficiency (kg/kJ), and 20% lower emissions/environmental waste (kg/kg);

High Value Roll-to-Roll Manufacturing

h) Demonstrate microelectronics manufacturing throughput in excess of 100,000mm^2/min using concurrent dual-side deposition/processing without web reroll/rework needed;
i) Demonstrate a reduction of material costs by >5%/year through product design and fabrication of smaller scale devices, kerfless cutting techniques and quality enhancements; and
j) Demonstrate an increased capacity /productivity by over 25% in five years due to introduction of greater efficiency, high volume, and "smart" processing.

REQUEST FOR INFORMATION RESPONSE GUIDELINES:

Responses to this RFI must be submitted electronically to AMOGolden@ee.doe.gov with a subject line "Response to RFI" no later than 5:00pm (EDT) on October 3, 2014. Any late responses will not be reviewed.

Responses must be provided as a Microsoft Word document (.docx or .doc) of no more than 8 pages in length, 12 point font, 1 inch margins as an attachment to an email. It is recommended that attachments with file sizes exceeding 25MB be compressed (i.e., zipped) to ensure message delivery. Submission of existing commercial documentation and product literature is NOT an acceptable response. Only electronic responses will be accepted.

Please identify your answers by responding to a specific question or topic if possible. Respondents may answer as many or as few questions as they wish.

EERE will not respond to individual submissions or publish publicly a compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed.

Respondents are requested to provide the following information at the start of their response to this RFI:

- Company / institution name;
- Company / institution contact;
- Contact's address, phone number, and e-mail address; and
- Relevant Industry: Primary metals (e.g. steel, aluminum, metal-casting), chemicals/petrochemicals, petroleum refining, bio-manufacturing (e.g. pulp and paper), and nonmetallic minerals (e.g. glass, cement), IT-provider, systems integrator, university, not-for-profit research institution, state or local government, or other (please identify).