U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

DOE Advanced Manufacturing Office 2019 Peer Review

Review Panel Report

December 2019

Department of Energy

Washington, DC 20585

July 15, 2019

Dear Stakeholders,

The U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy's (EERE) Advanced Manufacturing Office (AMO) recently conducted a peer review of the technology research and development (R&D) and technical partnerships supported by our office. I want to thank the entire peer review team and research participants. The strength and breadth of their industry knowledge is highly valued and will help us evaluate and strengthen our portfolio.

This year, Clay Nesler, Vice President of Global Energy and Sustainability from Johnson Controls, shared his industry perspective on the value of AMO. The Assistant Secretary for EERE, Daniel Simmons, spoke about his top three priorities for EERE – energy affordability, energy integration, and energy storage – and the advancements that have made the manufacturing sector more energy-productive.

In an effort to improve our peer review process, we made a point to better outline our priorities and strategic goals, provide more validation of current R&D projects, and highlight updates we've made to our Multi-Year Program Plan. We also discussed ways to enhance project level techno-economic analysis – an action recommended in our 2018 AMO Peer Review Report. In the future, we will continue to improve how we talk about our programs and strategic goals.

Manufacturing is vital to the U.S. economy. Strategic investments in early-stage R&D – in partnership with industry, national laboratories, and universities – is critical to increasing U.S. competitiveness and driving manufacturing productivity. As we look ahead, our programs and projects will continue to support the Administration's key priorities and drive innovative technologies.

Again, thank you for your participation. Your partnership with AMO is invaluable to the work we do.

Sincerely,

Valri Lightner
Deputy Director
Advanced Manufacturing Office
Office of Energy Efficiency and Renewable Energy
Department of Energy

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Executive Summary

The U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) requires each of its programs to conduct periodic peer reviews to enhance EERE program planning. The EERE Advanced Manufacturing Office (AMO) held a peer review of its program activities in Crystal City, Virginia, on June 10–12, 2019. An independent panel of experts provided AMO with feedback on how well the program's portfolio aligns with its overarching goals, identified possible course correction and new direction, and shared information. To the extent possible, the peer review process followed the guidelines set forth in EERE 810: Peer Review Guidance (June 2016) and the EERE Peer Review Guide (2004). The panel's findings are summarized in this report.

Review panel members agree that AMO did an excellent job planning, organizing, and conducting the meeting. On the first day, AMO management gave presentations to the review panel, who described them as "outstanding" and noted that they provided beneficial context for the rest of the review process. The review panel also commends the Office for incorporating suggestions from previous reviews to provide reviewers with additional context and information. As for implementing 2018 peer reviewer feedback to program activities, the panel applauds AMO for strengthening the program's analytical foundation and the methodology used to select and evaluate projects. The panel is pleased to hear that AMO is actively engaged in creating a more strategically structured program, which should enable the Office to make a larger impact in key opportunity areas.

As noted in the two most recent AMO Program Peer Review reports, the AMO vision, mission, and strategic goals are solid. The 2019 review panel approves of AMO's three-pillar structure: Research and Development (R&D) Projects, R&D Consortia, and Technical Partnerships. Reviewers indicate that program activities are aimed at the right subject matter to achieve the objectives described in the Office's Multi-Year Program Plan (MYPP).

During the review, the panel was asked to evaluate AMO's R&D Projects portfolio (the first pillar). To this end, approximately 80 percent of currently funded R&D projects sent representatives to present on project scope, progress, and achievements. The reviewers are generally impressed with the projects' quality and innovation. The second AMO pillar—R&D Consortia—was described as achieving significant progress and appears to have strong leadership and industrial support. The work of the Technical Partnerships pillar is seen as very valuable to industry, particularly the workforce development efforts that will increase the pool of talent available to the manufacturing energy field.

Reviewers are impressed with AMO's strategic analysis, particularly the introspective and prospective activities. The analyses are robust and provide critical foundational knowledge in guiding strategic planning efforts. The panel commends the strategic analysis team's plan to expand analysis of program impacts to provide consistent, transparent analysis and show how AMO's activities connect to its targets and success indicators.

The panel also identified potential opportunities to strengthen program planning and implementation. Key recommendations include the following:

- Perform more retrospective analysis to identify, communicate, and implement lessons learned.
- Identify AMO's biggest successes and best practices and explain the reasons behind the successes.
- Develop an "elevator brief" to describe clearly and succinctly what AMO is trying to do.
- Attempt to organize the approximately 20 technology areas (from AMO's constellation chart) into a higher-level framework; re-evaluate the areas on a regular basis.
- Require every program to estimate energy impacts, as well as projected economic impacts, for the program sub-areas.
- Require more emphasis on the market opportunity and "value add" of each R&D activity.

- Limit the number of awards that are single-product development and that may possibly benefit only the performer's organization.
- Expand engagement with industry outside of R&D projects; use a rotating panel of outside experts when updating the MYPP.
- Coordinate more closely with other agencies and programs whose activities overlap with AMO's (e.g., cyber-security, critical materials) and who may have significant budgets and more expertise.

Introduction

TThe U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) requires each of its programs to conduct periodic peer reviews to enhance EERE program planning. The EERE Advanced Manufacturing Office (AMO) held a peer review of its program activities in Crystal City, Virginia, on June 10–12, 2019. An independent panel of experts provided feedback to AMO on how well its portfolio aligns with the program's overarching goals, identified possible course correction and new direction, and shared information. To the extent possible, the peer review process followed the guidelines set forth in EERE 810: Peer Review Guidance (June 2016) and the EERE Peer Review Guide (2004). The panel's findings are summarized in this report.

EERE Peer Review Requirements

The EERE Peer Review Guide sets forth a number of guidelines for program and project peer reviews. EERE requires all programs to conduct a peer review, on average, every two years. Program reviews should consider budget, output generated, management structure and complexity, stakeholder participation, and information needed to support management decisions. Activities reviewed should typically cover 80%–90% of the program's funding, supporting business analysis, and management programs.

EERE peer review guidelines also require a minimum of three reviewers for each discrete program element or smallest unit that is assessed. Each reviewer should be independent, competent, and objective, selected by a transparent, credible process that involves external parties. The collective reviewer expertise must cover the program element's subject matter.

After the review, the peer review panel is expected to produce a report of the peer review findings and submit it to AMO management. The panel obtains management's feedback on the draft, including actions to be taken. The report is then finalized and submitted to senior EERE management, associated staff and researchers involved with the research and development (R&D) programs or projects, and all persons involved in the review. The final report is to be made available publicly.

2019 AMO Program Peer Review Process

The AMO Program Peer Review was held on June 10-12, 2019 in Arlington, VA. The peer review began on June 10 with a half-day closed session between the review panel and AMO management, which provided valuable context for the subsequent program review. Acting Director Valri Lightner presented on AMO's mission and goals, strategy and structure, success indicators, and budget/funding. The panel also heard presentations on AMO's strategic analysis activities, active project management, and an overview of R&D consortia and technology partnership activities.

The rest of the review meeting was open to the public; Appendix A provides the agenda for this portion of the review. On the morning of June 11, the review panel attended a plenary session that began with welcoming comments, followed by a presentation by one of the Better Plants partners and a presentation of AMO strategic analysis efforts. EERE Assistant Secretary Daniel Simmons then provided some remarks on EERE priorities. The AMO Acting Director concluded the plenary session with a brief overview of AMO, including recent competitive funding opportunities. On June 11 (afternoon) and June 12, presentations were provided in three separate tracks, one for each of the three AMO pillars: R&D Projects, R&D Consortia, and Technical Partnerships. Each project was presented by the principal investigator, and AMO staff presented on R&D Consortia and Technical Partnerships activities; a question-and-answer session followed each presentation. On the afternoon of June 11, a poster session was held to exhibit several of the R&D projects and analysis activities that were not presented individually.

Prior to the meeting, the review panel was provided with information about the upcoming peer review, the AMO Program, and the 2018 Peer Review report. An online evaluation tool allowed reviewers to comment on strengths and weaknesses and provide recommendations for each activity during the review meeting. Separate sets of feedback responses were developed for the program and for individual activities (based on criteria in Appendix B and Appendix C); the observations on individual activities have been provided to AMO separately.

As part of the peer review process, AMO management is provided an opportunity to respond to the peer review findings. Appendix D provides AMO management's response.

Review Panel Membership

Name	Position
Nancy Margolis	Chair of the Visiting Committee of the Mechanical Engineering Department, University of Maryland at College Park; formerly President of Energetics Incorporated
James Lyons	Principal, Farmington River Technologies; Chief Technologist for Venture Investment Teams at Capricorn Investment Group and Energy Innovation
Steve Sciamanna	Teaches in the Product Development Masters Program at the Department of Chemical Engineering at the University of California, Berkeley; previously had an extensive career at Chevron
Mike Simpson	On detail from the National Institute of Standards and Technology (NIST) Manufacturing Extension Partnership; currently serving as the Executive Director for the Concrete Masonry Checkoff Program, NIST
John Wall	Advisor to numerous programs and boards; formerly Chief Technical Officer of Cummins Inc.
Lee Buchanan	Venture Partner, Paladin Capital Group; also serves as a director for multiple organizations
Jim Lancaster	Senior Director of the National Materials and Manufacturing Board at the National Academies of Science, Engineering, and Medicine (NASEM); Director of NASEM's Board on Physics and Astronomy
Sam Licata	Consultant; previously Director of Corporate Manufacturing Integration at Cummins Inc.
Sharon Nolen	Manager, Global Natural Resource Management at Eastman Chemical Company
Kelly Perl	Economist in the Office of Energy Consumption and Efficiency Analysis (OECEA) at the U.S. Energy Information Administration
Shri Ramaswamy	Professor in the Department of Bioproducts and Biosystems Engineering at the University of Minnesota
Michael Socks	Senior Energy Consultant at the non-profit Vermont Energy Investment Corporation
James Wolf	Independent consultant specializing in the energy and environmental fields

Appendix E contains the biographies of each panel member.

AMO Strategic Goals

The peer review panel approves of AMO's mission statement and found it appropriate. The panel has concern that the relatively long list of strategic goals could make it more challenging for AMO to make a large impact in any one area. Specific comments on the goals include the following:

- The goals related to energy efficiency and productivity, life-cycle energy and resource impacts, and market transition appear to be the most important.
- Every project selected for funding should be able to address at least one of these three important goal areas.
- Some new parts of the program are listed explicitly in the goals, but others are not:
    - Critical materials, high-performance computing, and cybersecurity are important to the current administration and are listed as goals.
- U.S. manufacturing competitiveness should be considered as a goal.
- The downside to having technology transition as a goal is that projects that benefit only a single U.S. company could be justified because they address this goal.

The peer reviewers understand that major portions of the program are directed by Congressional budget language. If permitted, AMO could think about options for integrating these activities into its existing goal structure to create a more cohesive program.

Each portfolio itself should have clear objectives, and AMO's Multi-Year Program Plan (MYPP) could include an overarching five-year goal for each portfolio, describing what AMO wants to accomplish in that area. The peer reviewers also recommend that AMO develop an "elevator brief" to describe clearly and succinctly what the program is trying to do, which would help AMO staff explain a program that—because of the nature of the manufacturing sector—is an order of magnitude more complex than any other DOE EERE program.

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AMO Program Planning

AMO's purview covers a broad technology space, which makes effective program planning critical. Following are some of the questions AMO management must address during planning:

- Are the right things being emphasized?
- Should AMO be doing more or less in a particular area?
- What topics are missing?
- Where is the appropriate role for government?
- When is "enough, enough" in terms of investment in a particular area?

The planning process is complicated by changes in administration and AMO program leadership, both of which can lead to changing priorities. Reviewers are pleased to hear that AMO management is already working toward creating a more strategically structured program.

A major program planning tool used by AMO is the MYPP, which is updated annually. It is the panel's understanding that the MYPP identifies potential work areas but does not delineate a process for choosing those areas or selecting projects to fund. Although the MYPP chapters have technical targets that align with AMO's energy targets, it is not entirely clear what the impacts on a particular manufacturing sector will be if the targets are achieved.

The "constellation" chart from the MYPP (presented to the panel) is impressive but somewhat difficult to follow, with its approximately 20 technology areas (including emerging and crosscutting areas). Many of the panel members believe that 20 areas are too many, questioning how AMO can be strategic and achieve meaningful results with such a large and diverse group of topics. Other reviewers suggest AMO keep all of the areas but organize them into a higher-level framework. All reviewers agree that, while all of the technology areas might be important, they are not equally important at any particular time. Therefore, AMO management should continue to regularly evaluate each topic's current relative importance.

Specific questions for AMO to consider when doing program planning include the following:

- Is the MYPP a true strategy document?
- What is AMO's strategy for the next 5–10 years?
- How does the current R&D portfolio align with the areas identified in the MYPP?
- How does the current program align with the overarching goals of reducing energy intensity in manufacturing and reducing life-cycle energy and resource impacts?
- In what areas should AMO continue efforts, and is AMO doing enough in those areas?
- What are other governments focusing on for R&D; and what are their industry or technology priorities?
- What is AMO's impact on any particular sector? What is the chance of success?

The panel has the following suggestions and recommendations:

- To narrow down AMO's areas of focus, put some distance between the MYPP and the Quadrennial Technology Review, as some content in the latter may no longer be up to date.
- If all 20 areas are retained, organize them into a smaller number of categories and describe some as opportunity areas. The current (smaller) staff can probably bring comprehensive focus to about eight areas.
- Update the priority areas regularly.

- Consider issuing funding opportunity announcements (FOAs) that cover no more than four opportunity areas, with specific goals in each area.
    - For example, pick high-conductivity materials (e.g., wire); set some specific goals for conductivity, ductility, and cost; and publish those goals at the time the FOA is released.
    - Performance goals should be among the criteria for selection to ensure AMO funds will make a significant contribution to the opportunity area.
- Require each program area to state expected energy savings, recognizing that some topics (e.g., cybersecurity) will have difficulty doing this.

The panel is providing the following input on the technology areas themselves:

- The following topics could be evaluated and considered for inclusion:
    - Industrial robotics
    - Data analytics and machine learning for manufacturing
    - Power consumption of data centers
    - Power consumption of microelectronics fabrication.
- The budget for additive manufacturing seems disproportionally high:
    - The focus of AMO R&D in this area is on the reliability of the systems, and the connection to energy savings is not entirely clear.
- The justification for the consortium on wide bandgap activities raises concerns:
    - The market/business case is unclear.
    - The work seems to be addressing cost and reliability, but it is not clear how that translates to energy savings.
    - The educational benefits (generating interns), rather than energy savings, seems to be one of the most touted benefits of the R&D projects.
- AMO should consider finding more projects applicable to energy-intensive industries and other high-opportunity areas (e.g., process heating, waste heat recovery), given the overall energy consumption in these areas and the size of the potential savings opportunities:
    - Process heating R&D represented just 4% of the budget in 2019 and waste heat recovery activities had no budget at all.
    - Based on the budget pie chart presented, most R&D appears focused on non-energy-intensive manufacturing industries.
    - As an example, some new directions in smelting/refining and carbon-cured cement/concrete have arisen and could be explored.
- Energy alternatives for process industries will be critical in a low-carbon world. AMO is encouraged to explore this area more.

The panel found AMO management's presentations to be highly informative, providing good context for evaluating the overall program. For the 2020 review, the panel has recommendations for additional program information that could be included and how it could be displayed:

- When presenting AMO budget data, include two pie charts—one for discretionary budget and one for directed activities ("critical directed programs")—and divide these into R&D Projects, R&D Consortia, and Technical Partnerships.
- Provide more history (multiple years) on the budget breakdown.
- Devise a way to display the potential impacts in the United States for the different investment areas.
- Create a chart for each of the three pillars describing the opportunity size of different projects to help the panel to determine whether benefits are proportional to investment costs.

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AMO Pillar-Level Observations

The review panel believes the AMO three-pillar structure is an effective means of organizing the type of work the Office supports to achieve its mission. Below are reviewers' thoughts on the individual pillars.

R&D Projects

To help the peer review panel evaluate the AMO program overall, brief presentations were given on about four-fifths of AMO's R&D projects. Reviewers were able to provide feedback on specific projects using an online tool. For the most part, the peer reviewers are very impressed with the quality of the R&D projects. The template used to present the information is deemed excellent, with adequate information to assess the projects. General comments include the following:

- Given the number of projects, AMO appears to be understaffed.
- Some projects do not seem to address energy or life-cycle resource goals, so it is unclear how AMO measures their impacts.
- Some of the smaller projects may not be able to make an impact in the larger technology areas that involve numerous industries.
- Some reviewers would prefer to see presentations from a greater number of recently awarded projects.
- As noted in AMO Program Planning section, certain topics that are particularly relevant today (e.g., robotics, Blockchain for supply chain) appear to be underrepresented.
- Some projects require more consideration of the technology's long-term economics:
    - AMO should consider the potential for a product to sell at high volume as part of its selection process.
    - More weight should be given to the technology transition criterion during the selection process; some presentations had only a token discussion of market demand or value proposition, even as the project was ending.
- It is unclear what happens to a project if the market wanes or the economics are unfavorable.

Suggestions and recommendations include the following:

- Classify R&D that reduces the energy intensity in one of two ways:
    - Improve a product that lowers energy or carbon intensity; replace existing products or develop a revolutionary new application (e.g., an electric car with a >300 mile range).
    - Reduce the process energy intensity of a manufacturing process.
- Reduce the number of awards for single-product development that benefits only the performer's organization; ensure that any selected project will have broad benefit to the industry.
- For every project, include an opening slide that discusses market, opportunity, and value add.
- Include a presentation by each AMO portfolio manager about his or her "pie slice" (activity area) in future peer reviews:
    - The targets being measured (including a retrospective look for completed R&D)
    - The actions being taken based on measurements
    - The future direction of each portfolio.

At the 2020 review, the review panel would be very interested in hearing more about FOA selection criteria and the criteria for go/no-go decisions.

R&D Consortia

The review panel is impressed by many of the activities being conducted by the R&D consortia and would be interested in knowing more about their set-up and operation in future reviews. Specific questions included the following:

- What is the process behind the selection of the consortia topics?
- Do the consortia drive research? Or do technologies drive the consortia that are created?
- What is each consortium's plan for beyond-DOE funding when the five-year term ends?
- What direction, beyond topic and location, is given to the institutes?
- Can the connection between consortia activities and energy savings be articulated more specifically (e.g., what are the energy savings associated with using additive manufacturing for producing turbine blades?).

Based on previous experience (e.g., SEMATECH), consortia are easy to start and challenging to wean from dedicated financial assistance. The accomplishments of Power America are impressive; unfortunately, the consortia members will likely lower their participation as AMO financial backing is reduced. Decisions should be made well in advance about how to transition those consortia with time-limited funding from AMO to a different funding source/model. In general, after consulting with other manufacturing institutes associated with Manufacturing USA, these consortia should be required to provide better transition plans for beyond the five-year DOE funding. AMO could also consider establishing standards for the organizations running consortia so these large efforts can be managed more effectively.

Specific recommendations when preparing consortia presentations for future reviews include the following:

- Describe how AMO engages consortia and how the consortia are being held accountable.
- Provide an understanding of why specific topics are chosen.
- Develop a separate presentation template for consortia (describing more of how they are managed) for future peer reviews.

Technical Partnerships

The Technical Partnerships pillar is an important part of AMO, according to the reviewers, who are very impressed by the activities and achievements.

The panel applauds the 50001 Ready initiative. Achieving ISO 50001 certification entails a great deal of effort and expense, so 50001 Ready is an excellent tool whose promotion and maintenance should continue. Widening the scale of ISO 50001 adoption may require incentives and may need to involve other branches of federal and state governments and utilities.

Likewise, the panel is impressed with the Better Plants program but is concerned that challenging goals (25% energy intensity reduction goal over 10 years) might deter companies from joining. The panel has the following suggestions:

- Develop better standards for how the improvements are calculated and reported.
- Consider setting different goals for different industries.

The work being done by the Industrial Assessment Centers (IACs), particularly the workforce development aspects, is seen as very beneficial. The panel notes the manufacturing sector's difficulty in finding students to work in the

energy field who do not require sponsorship. Given the high demand for energy specialists, AMO might consider expanding the IAC program to community colleges.

The panel is impressed by the Combined Heat and Power (CHP) activity and encourages AMO to keep promoting CHP, including efforts to educate the general public. Specific comments include the following:

- The proposed CHP–renewable solution is interesting, but buy-in and adoption of small-to-medium CHP (which would require coordination with utilities) may not be feasible.
- The Technical Assistance Partnerships (TAPs) could be empowered to do more than just promote CHP solutions.
- The TAPs should consider coordinating with the IACs, if they are not already.

Other comments from the panel on the Technology Partnerships pillar include the following:

- AMO should continue engaging industries beyond those involved with AMO R&D activities as much as possible.
- AMO could use its relationships with companies to gather information about challenges industry faces. That knowledge could inform the program and help shape and direct R&D opportunities.
- Efforts by the pillar have resulted in some excellent software tools, and the updating activity should prove beneficial.
- The Technologist in Residence activity is a solid endeavor. AMO should look for additional mechanisms to encourage industry to work with the national laboratories.

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General Comments and Recommendations

The peer review team is impressed with the strategic analysis AMO is performing to 1) help identify the areas of maximum opportunity for achieving the program's goals and 2) measure the potential impact of the program's activities. The reviewers applaud AMO for making significant improvements from the 2018 peer review presentation on strategic analysis:

- AMO is being more systematic about impacts, both current and prospective.
- AMO is establishing a formal process to assess and communicate the progress and contribution of projects to strategic goals and success indicators.

AMO's strategic analysis team members also indicate they will be expanding their analysis of program impacts to provide consistent, transparent analysis and show how AMO's activities connect to its targets and success indicators. Eventually the new methodology, processes and procedures (MP&P) approach can also be used to improve funding opportunity analyses and, ideally, improve the project selection process.

The peer review team suggest that:

- High-level analysis (retrospective, introspective, prospective) should be trickled down to activities at lower levels (both portfolio and project).
- All programs should have projected energy impacts for their different sub-areas, as well as projected economic impacts.
- Basic project performance metrics should be rolled up into higher-level program measures.
- The MP&P analysis should focus initially on R&D projects rather than consortia activities (as currently planned).
- Each activity should have an associated statement of the market need being addressed (e.g., reducing costs by 20%).

Reviewers have interest in understanding how the results of the various analyses feed into AMO's decision-making process, particularly at the portfolio level. Some reviewers question why the amount of funding for a particular program is often decided before an FOA is released and proposals are received.

The reviewers are interested in knowing more about retrospective analysis, which was not discussed in as much depth as introspective and prospective analysis. Because the past helps predict the future, tracking R&D results and identifying trends could be an important driver in determining the future composition of the AMO portfolio. More emphasis on retrospective analysis to identify, communicate, and implement lessons learned would be beneficial to AMO management. The panel has the following specific questions about retrospective analysis:

- How robust is the technology tracking conducted by Pacific Northwest National Laboratory, and at what level is it conducted?
- Why is the Impacts report (published annually in the past) no longer public?
- Are there data on the progress AMO has made toward goals over the past five or ten years?

Regarding retrospective analysis, the panel recommends that AMO identify its biggest successes and best practices and explain the reasons behind the success. Feedback in the form of lessons learned and best practices should be part of a project's final deliverable. The panel recognizes that AMO staff do not have this information readily available, particularly knowledge of key successes from the past five years. The panel suggests AMO prepare a "brag sheet" and present a track record of successes at the 2020 review. In addition to the successes, the panel recommends that AMO identify its biggest failures, including reasons why the projects failed, to help identify any systematic reasons for failure.

The panel recognizes that it can be difficult to define success, i.e., how an activity is determined to be a success and what would have happened if AMO had not funded the project. AMO may not want to advertise disappointing results but should actively advertise successes.

According to reviewers, AMO could benefit from increased stakeholder engagement. They specifically note updates to the MYPP, which should consider input from a panel of outside experts who rotate each year. Having outside experts would ensure industry input into AMO's planning processes.

The panel also recommends that AMO coordinate better with other agencies and programs whose activities overlap with AMO's (e.g., cybersecurity and critical materials) and who may have significant budgets and more expertise. AMO should also coordinate with other EERE offices whose missions appear to overlap; for example, AMO could work with the Vehicle Technologies Office on materials R&D.

Feedback on the Peer Review Process

Those panel members who participated in previous reviews agree that the 2019 review was much improved in terms of context provided and the content of the various presentations. The closed session with AMO management on the first day was particularly useful to the reviewers. The panel appreciates the hard work AMO put into preparing for the 2019 review and congratulated AMO for a job well done.

Specific comments include the following:

- The peer review was well run and organized.
- Presenters were prepared and communicated their activities effectively.
- The programmatic background was very helpful.
- The structure of the presentations was excellent.
- Information was presented fairly quickly and easily.
- AMO did a better job presenting program vs. project information compared to the 2018 review.
- The 2018 review report called for AMO to do a better job of evaluating proposals and projects, and for more techno-economic analysis used in proposals and early-stage research. Returning peer reviewers see significant improvement in this regard. AMO is being more systematic about impacts, both current and prospective, and is establishing a formal process to assess/communicate the progress and contribution of projects to strategic goals and success indicators.
- The 2018 report asked for more validation of current R&D projects. In response, AMO is developing a new MP&P methodology to provide consistent, transparent analysis and show how it connects to AMO's targets and success indicators. AMO will collect more basic, fundamental data for every R&D project.

Recommendations for 2020

In addition to recommendations already noted in the report, the panel suggests the following changes to future peer reviews:

- Identify which activities are directed and which are discretionary.
- Briefly discuss the MYPP and the portfolio-level grouping of projects.
- Provide more information about AMO work processes.
- Allow more time on the first day for AMO staff presentations.
- Have each AMO portfolio manager present on his or her "pie slice."
- Cover additional program planning and budget material during the closed session:
  - The overall project pipeline, including technology readiness levels
  - The cascade of mission/vision → goals → portfolio
  - The spend trend across multiple years for technology areas (not just fiscal years 2018 and 2019).
- Consider including a graphic in each presentation that highlights where the activity falls within the overall program.
- Revise the second slide of the presentation template for R&D projects to include information on potential applications/markets, benefits, and value add/creation.
- Develop a separate presentation template for consortia describing more about how they are managed.

Appendix A: Final Agenda

June 11-12, 2019

DoubleTree Crystal City
300 Army Navy Drive
Arlington, VA 22203
Phone: (703) 416-4100

Plenary Session: Crystal Ballroom		
Day 1 (Tuesday, June 11)		
7:30 AM	**REGISTRATION FOR ATTENDEES**	
8:30 AM	Welcome	**Bob Gemmer/Valri Lightner** AMO
8:35 AM	Invited Presentation Better Plants Partner Story	**Clay Nesler** **VP Global Sustainability and Industry Initiatives** Johnson Controls
9:05 AM	AMO Strategic Planning Activities	**Joe Cresko** AMO
9:35 AM	Introduction of Daniel Simmons, Assistant Secretary, EERE	**Valri Lightner** AMO
9:45 AM	Remarks	**Daniel Simmons, Assistant Secretary** EERE
10:00 AM	AMO Overview	**Valri Lightner** AMO
10:20 AM	**BREAK AND TRANSITION TO TRACKS**	

Crystal Ballroom A		
Day 1 (Tuesday, June 11)		
10:35 AM	Introduction: Materials for Harsh Service Conditions	**Steve Sikirica**, AMO
10:40 AM	Boride-Carbon Hybrid Technology to Produce Ultra-Wear and Corrosion Resistant Surfaces for Applications in Harsh Conditions	**Nina Baule** Fraunhofer USA, Inc.
11:00 AM	Ultra-High Temperature Thermal Barrier Coating Development and Validation	**Brent Cottom and Dave Voss** Solar Turbines Inc.
11:20 AM	Novel Corrosion and Wear Resistant Coatings Using Innovative Cold Plasma Jet Surface Treatment to Enable Improved Bonding Performance of Dissimilar Material Joints Subject to Harsh Environmental Exposure	**Ivan Shchelkanov** Starfire Industries LLC
11:40 AM	Low Cost Ceramic-Matrix Composites for Harsh Environment Heat Exchanger Applications	**Rajiv Ranjan** UTRC
Noon	**LUNCH**	
1:00 PM	Introduction: Clean Energy Manufacturing Institutes	**Mike McKittrick**, AMO
1:05 PM	Reducing Embodied Energy and Decreasing Emissions Institute (REMADE)	**Nabil Nasr** SMI Alliance
1:45 PM	PowerAmerica WBG Manufacturing Institute	**Victor Veliadis** North Carolina State University
2:25 PM	**BREAK**	
2:45 PM	Integrated Electric Drive with HV2 Modular Electric Machine and SiC Based Power Converters	**Longya Xu** Ohio State University

Crystal Ballroom A *(continued)*		
3:05 PM	Grid Application Development, Testbed and Analysis for MV SiC (GADTAMS)	**Barry Mather** NREL
3:25 PM	Introduction: Traineeships in Power Electronics	**Al Hefner**, AMO
3:30 PM	DOE Traineeship in WBG Power Electronics Engineering	**Rolando Burgos** Virginia Tech
3:50 PM	DOE Traineeship in WBG Power Electronics Engineering	**Leon Tolbert** University of Tennessee
4:15 PM	Clean Energy Smart Manufacturing Innovation Institute (CESMII)	**John Dyck** UCLA
4:55 PM	**END OF TRACK – Poster Session to begin at 5:00PM in the Lincoln Ballroom**	

Day 2 (Wednesday, June 12)		
8:30 AM	Introduction: Roll to Roll	**Brian Valentine**, AMO
8:35 AM	Roll to Roll (R2R) Consortium	Claus Daniel ORNL
9:20 AM	Development of Roll-to-Roll Simultaneous Multilayer Deposition Methods for Solid-state Electrochemical Devices Using Highly Particulate Loaded Aqueous Inks	**Jeff Peet** Saint Gobain
9:40 AM	High-Temperature Membrane for In-Situ Process-Water Removal	**Balu Balachandran** ANL
10:00 AM	**BREAK**	
10:20 AM	Introduction: Technical Partnerships	**Andre DeFontaine**, AMO
10:25 AM	AMO Energy System Tools Modernization	**Tom Wenning** ORNL
10:45 AM	Technologist in Residence	**Eli Levine**, AMO
11:05 AM	Better Plants	**Eli Levine**, AMO
11:25 AM	ISO 50001 Portfolio	**Pete Langlois and Paul Scheihing**, AMO
11:45 AM	**LUNCH**	
1:00 PM	Introduction: Process Intensification and Clean Energy Manufacturing Institutes	**Melissa Klembara**, AMO
1:05 PM	Rapid Advancement in Process Intensification Deployment Institute (RAPID)	**Bill Grieco** AIChE
1:45 PM	Improved Catalyst Selectivity and Longevity Using Atomic Layer Deposition	**Christopher Marshall** ANL
2:05 PM	Rational Design Platform for Transition Metal Catalyzed Electrochemical Synthesis	**Juergen Biener** LLNL
2:25 PM	Introduction: Composites	**Chad Schell**, AMO
2:30 PM	Institute for Advanced Composite Manufacturing Innovation (IACMII)	**John Hopkins** CCSC
3:10 PM	**BREAK**	
3:30 PM	Energy Efficient Thermoplastic Composite Manufacturing	**Marc Matsen** Boeing
3:50 PM	Carbon Fiber Test Facility	**Merlin Theodore** ORNL
4:10 PM	Amorphous and Nanocomposite Magnets for High Efficiency, High Speed Motor Designs	**Michael McHenry** Carnegie Mellon University
4:30 PM	High-Silicon Steel Strip by Single-Step Shear Deformation Processing	**Kevin Trumble** Purdue University
4:50 PM	**ADJOURN**	

Crystal Ballroom B		
Day 1 (Tuesday, June 11)		
10:35 AM	Introduction: Power Electronics	**Al Hefner**, AMO
10:40 AM	Medium Voltage Integrated Drive and Motor	**Suratkal Shenoy and Octavio Solis** Calnetix Technologies, LLC
11:00 AM	Fully Integrated High Speed Megawatt Class Motor and High Frequency Variable Speed Drive	**J. Curtiss Fox** Clemson University
11:20 AM	Integrated 10kV SiC VSD and High-Speed MW Motor for Gas Compression Systems	**Geraldo Nojima** Eaton Corporation
11:40 AM	SiC Enabled High-Frequency Medium Voltage Drive for High-Speed Motors	**Ravi Raju** General Electric
Noon	**LUNCH**	
1:00 PM	Introduction: Critical Materials and Additive Manufacturing	**Blake Marshall**, AMO
1:05 PM	Science-Based Acceleration of the Full Value Stream for Metal Additive Manufacturing: Expedited Powder Development and Additive Manufacturing Deployment	**Emma White** Ames Laboratory
1:25 PM	Advanced Manufacturing of Alpha Double Prime Iron Nitride (ADPIN): An Innovative Rare Earth Element (REE) Free Ultra-High Performance Permanent Magnet for Clean Energy Applications	**David Matthiesen** FeNix Magnetics, Inc.
1:45 PM	Infrastructure Scale Additive Manufacturing	**Brian Post** ORNL
2:05 PM	Full Scale Engine Demonstration of Additively Manufactured High Gamma Prime Turbine Blades	**Ryan Dehoff** ORNL
2:25 PM	**BREAK**	
2:45 PM	Manufacturing Demonstration Facility	**Bill Peter** ORNL
3:30 PM	Advanced Turbine Airfoils for Efficient CHP Systems	**Doug Straub** NETL
3:50 PM	Development of Improved Combined Heat and Power (CHP) Systems utilizing Thermodynamic Modeling and Additive Manufacturing (AM) Components	**Anand Kulkarni** Siemens
4:15 PM	Organic Rankine Cycle Integration and Optimization for High Efficiency CHP Genset Systems	**John Fox** ElectraTherm Inc.
4:35 PM	Modifications to Solar Titan 130 Combustion System for Efficient, High Turndown Operation	**Jacob Delimont** Southwest Research Institute
4:55 PM	**END OF TRACK – Poster Session to begin at 5:00PM in the Lincoln Ballroom**	

Day 2 (Wednesday, June 12)		
8:30 AM	Introduction: Process Heating	**Joe Cresko**, AMO
8:35 AM	A Direct Process for Wire Production from Sulfide Concentrates	**Antoine Allanore** MIT
8:55 AM	Low-temperature Electrochemical Activation of Ethane for Co-production of Chemicals/Fuels and Hydrogen	**Dong Ding** INL
9:15 AM	Introduction: Advanced Materials Manufacturing	**Bob Gemmer and Tina Kaarsberg**, AMO
9:20 AM	High Performance Computing for Manufacturing (HPC4Mfg)	**Robin Miles** LLNL
9:40 AM	The Radical Atom: Mechanosynthetic 3D Printing of an Atomically Precise SPM Tip	**Adam Stieg** UCLA
10:00 AM	**BREAK**	
10:20 AM	Atomically Precise Manufacturing for 2D-Designed Materials	**James Owen** Zyvex Labs, LLC

Crystal Ballroom B *(continued)*		
10:40 AM	A Platform Technology for High-throughput Atomically Precise Manufacturing: Mechatronics at the Atomic Scale	**Reza Moheimani** UT Dallas
11:00 AM	DNA Strand Displacement driven Molecular Additive Manufacturing (DSD-MAM)	**William Shih** Dana-Farber Cancer Institute
11:20 AM	Developing Nanometer Scale, Atomically Precise Metallo-Catalysts with Molecular Lego	**Christian Schafmeister** Temple University
11:40 AM	**LUNCH**	
1:00 PM	Carbon Conductors for Lightweight Motors and Generators	**Matteo Pasquali** Rice University
1:20 PM	Nanometal-Interconnected Carbon Conductors for Advanced Electric Machines	**Cory Cress** U.S. Naval Research Laboratory
1:40 PM	Polydopamine/PTFE Composite Coating for Large-Scale Journal Bearings in Next Generation Electric Machines	**Samuel Beckford** Surftec
2:05 PM	Advanced Manufacturing of High Performance Superconductor Wires for Next Generation Electric Machines	**Venkat Selvamanickam** University of Houston
2:30 PM	Processes for 2G HTS Wire Manufacturing	**Ken Pfeiffer** Superconductor Technologies Inc.
2:50 PM	Enhanced 2G HTS Wire for Electric Motor Applications	**Martin Rupich** American Superconductor
3:10 PM	**BREAK**	
3:30 PM	Introduction: Smart Manufacturing & Cybersecurity	**Sudarsan Rachuri**, AMO
3:35 PM	An open-source framework for the computational analysis and design of autothermal chemical processes	**Shankar Subramaniam** Iowa State University
3:55 PM	Industrial Base Cybersecurity Initiative	**Rich Taylor** LANL
4:15 PM	Traineeship: Enhanced Preparation for Intelligent Cybermanufacturing Systems	**Christopher Saldana** Georgia Tech
4:35 PM	**ADJOURN**	

Washington Room		
Day 1 (Tuesday, June 11)		
10:35 AM	Introduction: Consortia	**Mike McKittrick**, AMO
10:40 AM	Critical Materials Institute	**Chris Haase** CMI
11:20 AM	Combined Heat and Power (CHP) Deployment	**Tarla Toomer**, AMO **Bruce Hedman**, CHP Deployment Program
11:40 AM	CHP Technical Assistance Partnerships (TAPs)	**Isaac Panzarella**, Director Southeast CHP TAP **Patti Garland**, CHP TAP Coordinator
Noon	**LUNCH**	
1:00 PM	Introduction: CHP R&D	**Bob Gemmer**, AMO
1:05 PM	Converter-Interfaced CHP Plant for Improved Grid-Integration, Flexibility, and Resiliency	**Ibrahima Ndiaye** GE Global Research
1:25 PM	High Speed Medium Voltage CHP System with Advanced Grid Support	**J. Curtiss Fox** Clemson University
1:45 PM	SiC Based Modular Transformer-less MW-Scale Power Conditioning System and Control for Flexible CHP System	**Shiqi Ji** University of Tennessee
2:05 PM	High-Efficiency Modular SiC-based Power-Converter for Flexible-CHP Systems with Stability-Enhanced Grid-Support Functions	**Rolando Burgos** Virginia Tech
2:25 PM	**BREAK**	
2:45 PM	Introduction: Advanced Materials Manufacturing	**Steve Sikirica**, AMO

Washington Room *(continued)*		
2:50 PM	Lifetime Energy Savings Via Advanced Manufacturing of Low Density Steels for Transportation Applications	**Kelcey Garza** AK Steel Corporation
3:10 PM	Carbon-Free Iron for a Sustainable Future	**Richard Bradshaw** Boston Metal
3:30 PM	Flash® Processed Steel for Automotive Applications	**Gary Cola** SFP Works (Flash Steelworks, Inc.)
3:55 PM	Aggregation and Structuring of Materials and Chemicals Data from Diverse Sources	**Chris Tassone** SLAC
4:15 PM	High Performance Electrical and Thermal Conductors	**Balu Balachandran** ANL
4:35 PM	Fabrication of Advanced Nanocarbon-Metal Composites for Improved Energy Efficiency	**Lourdes Salamanca-Riba** University of Maryland
4:55 PM	**END OF TRACK – Poster Session to begin at 5:00PM in the Lincoln Ballroom**	

Day 2 (Wednesday, June 12)		
8:30 AM	Introduction: Electric Machines	**Steve Sikirica**, AMO
8:35 AM	Motor System Market Assessment	**Paul Sheaffer** LBNL
8:55 AM	Highly Efficient Conical Air Gap Axial Motor Using Soft Magnetic Composites and Grain-Oriented Electrical Steel	**Paul Knauer and Alan Crapo** Regal-Beloit Corporation
9:20 AM	Metal (Cu, Al) CNT Composite Wires for Energy Efficient Motors	**Quanfang Chen** University of Central Florida
9:40 AM	Cost-effective Conductor, Cable, and Coils for High Field Rotating Electric Machines	**Lance Cooley** Florida State University
10:00 AM	**BREAK**	
10:20 AM	Si-Al-Cr-Mn Alloy for High Specific Resistivity	**Erik Pavlina** AK Steel Corporation
10:40 AM	Designing New Economical and Scalable High Performance Aluminum Alloys for Overhead Electric Transmission Conductors	**Nhon Vo** NanoAL
11:00 AM	Introduction: Waste Heat Recovery	**Bob Gemmer and Brian Valentine**, AMO
11:05 AM	Turbocompression Cooling System for Ultra Low Temperature Waste Heat Recovery	**Todd Bandhauer** Colorado State University
11:25 AM	Roll-to-Roll Manufactured Hybrid Metal-Polymer Heat Exchangers with Anti-Fouling and Self-Monitoring for Waste Heat Recovery	**Sanjiv Sinha** University of Illinois
11:45 AM	**LUNCH**	
1:00 PM	High Efficiency Waste Heat Harvesting Using Novel Thermal Oscillators	**Michael Loewenberg** University of Pennsylvania
1:20 PM	Simulation Based Design and Optimization of Waste Heat Recovery Systems	**Kyle Benne**, NREL **Michael Wetter**, LBNL
1:40 PM	Introduction: Workforce Development/Technical Partnerships	**John Smegal**, AMO
1:45 PM	Traineeship: Advanced Manufacturing for Energy Systems	**Ugur Pasagullari** University of Connecticut
2:05 PM	Industrial Assessment Centers	**Bhaskaran Gopalakrishnan** West Virginia University
2:25 PM	Introduction: Process Intensification	**Dickson Ozokwelu**, AMO
2:30 PM	Development of Oxy-Esterification for Natural Gas Upgrading at the Wellhead	**Zili Wu** ORNL
2:50 PM	Advanced Catalysts for Low Temperature Heavy Crude Upgrading	**Jay Gaillard** SRNL
3:10 PM	**BREAK**	

Washington Room *(continued)*		
3:30 PM	Dynamics at the Interface for Advancing Efficient Manufacturing: Developing New Methods to Understand Catalysts for Ethylene Production	**Rebecca Fushimi** INL
3:50 PM	Integrated Hydrogen Combustion with Energy-Efficient Ethylene Production	**Elena Chung** EcoCatalytic Technologies
4:10 PM	Low-Pressure Electrolytic Ammonia Production	**Ted Aulich** EERC
4:30 PM	**ADJOURN**	

Peer Review – Poster Session
Tuesday, June 11, 5 – 7PM

#	Topic Area	Poster Title	Presenter
1	Composites	Innovative High-Feed Rate Additive Manufacturing Using Sustainable Nano- Micro- Cellulose-Reinforced Thermoplastic Composites	Soydan Ozcan Bill Peter
2	High Performance Computing for Manufacturing	Development and Validation of Simulation Capability for the High Capacity Production of Carbon Fiber	Srdjan Simunovic
3	Advanced Materials Manufacturing	Melt Processing of Covetic Materials	Paul Jablonski
4	Advanced Materials Manufacturing	SBIR: In-Line Quality and Process Control in Solar and Fuel Cell Manufacturing	Sergei Ostapenko
5	Energy/Water	SBIR: Photothermal Solar Cell	Youssef Habib
6	R2R	AMM-R2R - Applied Materials Genome Initiative - From Ideal Materials to Real-World Devices	Vince Battaglia
7	Materials for Harsh Service Conditions	Wear-Resistant Surface Technologies for Low-leakage NG Compressors	Ali Erdemir
8	Analysis	Sustainable Manufacturing - Opportunities, Trends and Technoeconomic Analysis	William Morrow
9*	Analysis	Sustainable Manufacturing – Application and Analysis of Circular Economy Strategies, parts 1 and 2	Nwike Iloeje
10	Workforce Development	Lab Embedded Entrepreneurship Program: Cyclotron Road	Ilan Gur
11	Workforce Development	Lab Embedded Entrepreneurship Program: Chain Reaction Innovation	John Carlisle
12	Workforce Development	Lab Embedded Entrepreneurship Program: Innovation Crossroads	Dan Miller
13	High Performance Computing for Manufacturing	Making Semiconductor Devices Cool Through HPC Ab Initio Simulations	Lin-Wang Wang
14	Additive Manufacturing	Development of a High Throughput Laser System for Soft Magnetic Materials to Revolutionize Motor Technology	Alex Plotkowski
15	Additive Manufacturing	Stabilization of High Energy Lithium-ion Cathodes using Nanocomposite Coatings	Anil Mane
16	Advanced Materials Manufacturing	SBIR: Transition Metal Blocking Microporous Polymer Separators for Energy-Dense and Long-Lived Li-ion Batteries	Peter Frischmann
17	Energy/Water	SBIR: Solar Thermal Assisted Vacuum Freezing Desalination of Seawater at the Triple Point	Fangyu Cao
18	Additive Manufacturing	Accelerating Qualification of Additively Manufactured Metal Parts	Ibo Matthews
19	Additive Manufacturing	Powder Synthesis and Alloy Design for Additive Manufacturing	Iver Anderson
20	Roll to Roll Manufacturing	AMM-R2R - Roll-to-Roll Manufacturing Science and Applications: Accelerate R2R Materials Manufacture for Energy Storage and Generation	Mike Ulsh

#	Topic Area	Poster Title	Presenter
21	Roll to Roll Manufacturing	AMM-R2R - Roll-to-Roll Manufacturing Science and Applications: From Ideal Materials to Real-World Devices	Gregory Krumdick
22	High Performance Computing for Manufacturing	Developing High Performance Computing Model of Vapor Transition through Advanced Membranes for Applications in 7AC Liquid Desiccant Air Conditioners	Jason Woods
23	High Performance Computing for Manufacturing	HPC to Enable Next Generation Low Temperature Waste Heat Recovery	Prashant Jain
24*	Analysis	The Implications of Advanced Manufacturing in Connected Economy: Moving Towards a Smart, Sustainable and Productive Economy, parts 1 and 2 (Data Metrics and Smart Manufacturing Case Studies)	Sujit Das
25*	Analysis	Manufacturing Water Use Characteristics and Opportunities for Increased Resilience, parts 1 and 2	James McCall
26	Analysis	AMO Introspective Performance Assessment Methodology with Verification and Validation of R&D Projects	Debbie Sandor
27	Combined Heat and Power/ Technical Partnerships	Integration of Thermal Energy Storage with a Combined Heat and Power System	Dileep Singh
28	Combined Heat and Power/ Technical Partnerships	CHP & the REopt Lite Web Tool	Patricia Garland Kate Anderson
29	Combined Heat and Power/ Technical Partnerships	CHP for Resiliency Accelerator: Critical Infrastructure Planning and Resources Tools	Anne Hampson
30	Combined Heat and Power/ Technical Partnerships	CHP E-Catalog and Accelerator	Bruce Hedman
31	Combined Heat and Power/ Technical Partnerships	CHP IGATE-E Deployment Tool	John Story
32	Analysis	Geospatial Combined Heat and Power Opportunity Consideration for Combined Heat and Power Grid Connection	Samantha Reese
33	Process Intensification	SBIR: Oxygen Separation with Dual Phase Nano-Composite Membrane	Don Karnes
34	Energy/Water	SBIR: Ionic Membrane Based Desalination System	Bamdad Bahar

**Note: 4'x8' posters.*

Appendix B: Evaluation Criteria for Program Overall Activity

Relevance and Approach

Mission

- How well does the AMO Program fit within the EERE mission and the overall DOE mission?
- Is the justification for a federal program clear and compelling?

Approach

- Assess how well the overall AMO Program approach, including goals and programs, addresses the AMO mission.
- Do activities address high impact areas and address appropriate markets and technical barriers?

Resources

- Are there adequate resources in terms of dollars for the current mission?
- Is the allocation of resources reasonable?

Overall Assessment of Relevance

- What is your overall assessment of relevance and approach?
- What recommendations do you have on relevance and approach?

Management

Execution

- Are the activities likely to result in high quality products and outcomes? How can their impact be improved?
- How can AMO improve the way its new technologies are received and used by target audiences/stakeholders?

Resource Leveraging

- How well is the program coordinating with and learning from other EERE, DOE, and federal activities?
- What other resources could be used or leveraged to meet AMO goals?

Overall Assessment of Management

- What is the panel's overall assessment of the organization and management of the AMO Program?
- What recommendations does the panel have on program management?

Overall Program Assessment

- What are the best aspects of the AMO Program? What area needs the most improvement?
- What is the panel's overall assessment of the program?
- What recommendations does the panel have for the program?

Appendix C: Evaluation Criteria for Individual Activities

R&D Projects

As you listen to the presentation on the R&D Project, please give consideration to the following guidelines as you formulate your comments.

1. Alignment and fit to the Advanced Manufacturing Office's Mission and Goals

Does the project align well to the overall mission and goals of AMO and does it address relevant technical targets as outlined in the MYPP? Is what they are trying to do challenging and appropriate for the AMO Program.

2. Clarity of presentation on technical merit and innovation

Does the project have a high level of scientific and technical merit, a high degree of innovation, and will it be compatible with current or future U.S. manufacturing operations?

3. Project accomplishments and progress towards goals

Are the accomplishments to date noteworthy (on-going projects only)? Is the project structured so that there is high likelihood of success and is there evidence of progress towards achieving its stated goals?

4. Technology transition plan

Is there evidence of a sound approach for transitioning the technology towards the market?

Please provide your observations on the presentation.

R&D Consortia

As you listen to the presentation on the R&D Consortium, please give consideration to the following guidelines as you formulate your comments.

1. Alignment and fit to the Advanced Manufacturing Office's Mission and Goals

Does the Hub/Facility/Institute align well to the overall mission and goals of AMO and does it address relevant technical targets as outlined in the MYPP? Is what they are trying to do challenging and appropriate for the AMO Program.

2. Clarity of presentation on technical merit and innovation

Does the Hub/Facility/Institute have a high level of scientific and technical merit, a high degree of innovation, and will it be compatible with current or future U.S. manufacturing operations?

3. Consortium accomplishments and progress towards goals

Are the accomplishments to date noteworthy? Is there evidence of progress towards achieving the stated goals, including specific performance indicators for the Hub/Facility/Institute?

4. Technology transition plan

Is there evidence of a sound approach for transitioning technology towards the market and addressing market barriers?

Please provide your observations on the presentation.

Technical Partnerships Activities

As you listen to the presentation on the Technology Partnerships Activity, please give consideration to the following guidelines as you formulate your comments.

1. Clarity of presentation on goals

Does the activity have a high level of merit, a high degree of relevance, and is it be compatible with current or future U.S. manufacturing operations?

2. Alignment and fit to the Advanced Manufacturing Office's Mission and Goals

Does the activity align well to the overall mission and goals of AMO and does it address relevant targets as outlined in the MYPP?

3. Activity organization

Is the activity structured so that it is well suited to address market challenges and barriers, and is there a high likelihood of success?

4. Activity progress

Is there evidence of progress towards achieving the stated goals, including performance indicators, for the activity?

Please provide your observations on the presentation.

Appendix D: Advanced Manufacturing Office Management Response

Dear Members of the AMO 2019 Program Peer Review Panel,

All of us at the Advanced Manufacturing Office sincerely appreciate the time and expertise you contributed to our 2019 Peer Review. This rigorous review process helps AMO maintain a productive and cost-effective R&D portfolio that stimulates meaningful technology innovation. The review gives our project performers and partners the opportunity to reflect on progress, evaluate other approaches, and receive constructive feedback to ensure projects are on track for success. The resulting innovations in manufacturing and energy are essential to support the continued economic prosperity of industries and communities across our Nation.

I appreciate your comments related to AMO's strategy. As you know, AMO's strategy on R&D investments needs to responsive to congressional direction and administration priorities. Also, AMO's portfolio covers a fairly unique and powerful combination of discovery-driven process, material, and technology research combined with needs-driven research, for example, in water or critical materials.

Over the past several months, AMO has initiated a series of activities related to office strategy and integration that address a number of recommendations offered by the panel. Staff teams from across the office have developed white papers addressing technical topics of focus for 2020's R&D investments. These teams are combining and reconfiguring their results to develop a series of broad workshops for the spring of 2020 to identify R&D needs for fiscal year 2021 and beyond that also link to partnerships and technical assistance. AMO is also hosting a series of listening sessions with individual DOE National Laboratories to explore R&D needs to support the future of manufacturing. In addition, AMO is formalizing connections between its verification and validation analysis and its R&D investments, as well as reinstituting its collection and communication of success stories. Specifically, this collection of activities addresses the following recommendations of the panel:

- Revisit strategic planning framework for technology areas;
- Conduct periodic evaluation of investment levels for existing activity areas and potential inclusion of new technology opportunities;
- Continue to expand types of analysis conducted;
- Improve communication of program successes and impacts; and
- Increase engagement with stakeholders and coordination with other programs.

AMO looks forward to reporting on these efforts at the 2020 Peer Review. The office is refreshing its approach to Peer Review in a number of ways that will help address some of the 2019 Peer Reviewers' feedback. Specifically:

- An extended Peer Review meeting (3 days) and better organized technical tracks to cover the breadth and scope of AMO's portfolio;
- A fourth day closed session for Peer Reviewers to provide AMO staff with initial feedback on the overall portfolio and specific technical tracks;
- A minimum half day plenary session to explain AMO's vision for advanced manufacturing and how the portfolio lines up with that vision;
- Two to two-and-a-half days of multiple and parallel technical tracks with dedicated expert peer review panels;
- AMO Technology Managers will provide context for the projects discussed in each technical track and explain how those activities connect back to AMO's vision for advanced manufacturing as well as what progress has been made since the last peer review;

- A plenary session with industry, university, national laboratory, and other experts in advanced manufacturing technology and policy; and
- More networking opportunities.

Once more, let me express my deep gratitude to all members of the panel for their diligence in reviewing AMO's portfolio and providing useful insights. The results will assist AMO as it continues to work with academic, industry, lab, and other stakeholders to solve high-impact R&D challenges in manufacturing. Thanks also to our partners for participating in the successful 2019 Peer Review.

Sincerely,

Valri Lightner
Deputy Director, Advanced Manufacturing Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Appendix E: Review Panel Member Biographies

Nancy Margolis (Chair)

Nancy Margolis joined Energetics Incorporated as an engineer in 1984 and served as the company's president from 2010 until her retirement in 2017. At Energetics, Ms. Margolis managed top-flight teams tackling some of today's biggest energy and technology challenges for clients at DOE, the national laboratories, the National Institute of Standards and Technology (NIST), and state and local governments. For several decades, Ms. Margolis provided technical and strategic planning support to the Advanced Manufacturing Office and its predecessor organizations.

Prior to joining Energetics, Ms. Margolis worked at ARINC Corporation, focusing on power plant reliability. She also worked as a chemist for Bethlehem Steel Corporation in the late 1970s. She holds a B.A. in chemistry from Johns Hopkins University and an M.S. in mechanical engineering from the University of Maryland at College Park, where she currently serves as chair of the visiting committee of the mechanical engineering department. In 2017, she was awarded the Glenn L. Martin Medal from the A. James Clark School of Engineering at the University of Maryland.

James (Jim) Lyons

James (Jim) Lyons entered the venture capital business in 2008 after a 30-year technology career at General Electric. Dr. Lyons is currently the principal at the Farmington River Technologies consulting firm and also serves as chief technologist for the venture investment teams at the Capricorn Investment Group and Energy Innovation, focused on the creation and growth of clean/renewable energy companies. Formerly, Dr. Lyons was chief engineer for electrical technologies at General Electric (GE) Research, serving as technology leader and mentor for a 250-member global team. He was a leading advocate for renewables within GE and corporate champion behind the formation of GE Wind Energy in 2002, which quickly grew to $8 billion in annual revenues.

In 2000, Dr. Lyons was the technology leader during the creation of GE's Digital Energy business unit. While at GE, he served on the board of directors of Powerex, the Electric Drive Trade Association, and the U.S. Offshore Wind Collaborative, as well as becoming a principal company spokesperson for renewable energy. In 2006, Dr. Lyons was co-chair of the American Wind Energy Conference, initiating the American Wind Energy Association–DOE 20% wind energy roadmap. He has led many additional technology and business initiatives, e.g., waste gasification, electric vehicles, advanced batteries, power electronics, solid-state lighting, solar photovoltaics, rural electrification, and nuclear fusion. He currently serves in a variety of technical board assignments, including Curent ERC, Servato, Encell, Sunpreme, Kinestral, and Norwegian Crystals. Dr. Lyons is a reviewer for DOE and the National Science Foundation. He holds 40 patents and has a B.S. in electrical engineering from Rensselaer Polytechnic Institute, an M.S. in electrical engineering from Virginia Polytechnic Institute, and a Ph.D. from Cornell University.

Steve Sciamanna

Steve Sciamanna currently teaches in the product development masters' program in the department of chemical engineering at the University of California (UC), Berkeley. Previously, he had an extensive career at Chevron, focusing on process engineering and product development. In his last position as a consulting engineer/scientist, he provided techno-economic assessments for projects such as bioenergy and gas-to-liquids. Previous positions included program manager/leader of the technology development and deployment effort for a heavy oil upgrading process and R&D manager for MolecularDiamond Technologies, a unit of Chevron Technology Ventures, leading the basic and applied R&D programs. Those efforts were focused on the product and application development of diamondoid-based materials.

Dr. Sciamanna has also managed a Chevron analytical lab-service group; developed and commercialized internal and external technologies; assessed international upstream facilities for acquisition; managed and grew the process engineering group for Tengizchevroil in Tengiz, Kazakhstan; took a Russian-developed crude oil treating process from concept to commercialization; supported many small and large capital projects; and conducted separations

science and engineering R&D in the areas of mineral, environmental, and gas processing. Dr. Sciamanna received his B.S. and Ph.D. degrees in chemical engineering from UC Berkeley and an M.S. degree from the Massachusetts Institute of Technology (MIT).

Michael Simpson

Michael Simpson is currently on detail from the Manufacturing Extension Partnership (MEP) to the U.S. Department of Commerce's (DOC's) NIST program office, as the executive director for the Concrete Masonry Checkoff Program. This is a new program being established within DOC's Office of Economic Affairs, for the purpose of research and promotions development for the concrete masonry product (CMP) industry. The executive director is responsible for conducting a referendum of the CMP membership, establishing an industry board, and coordinating research and promotions activities for the industry. Prior to his current assignment, Mr. Simpson supported NIST's Advanced Manufacturing Office as the competition chair for the first Manufacturing USA Institute funded by the DOC. As a result of this effort, the Manufacturing USA Institute at the University of Delaware, known as NIIMBL, was established. The National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) is a public–private partnership dedicated to advancing biopharmaceutical manufacturing innovation and workforce development. Following the completion of the Concrete Masonry Checkoff Program, Mr. Simpson will return to NIST's MEP as a member of the management team.

Since joining MEP in 1994, Mr. Simpson has led several divisions, including system operations, national programs, information systems, and center operations. During his career, he also was an engineering and information technology consultant to the nuclear power industry, and he served as an officer on board the nuclear submarine USS John Adams. Mr. Simpson received an MBA in the management of innovation, science and technology from George Washington University and a B.S. in chemical engineering from the Pennsylvania State University.

John Wall

John Wall has more than 40 years of industry experience in internal combustion engine technology, fuels and emissions, and global engineering organization development. Most recently, Dr. Wall served as chief technical officer of Cummins Inc., the world's largest independent manufacturer of diesel engines and related technologies, from which he retired in 2015. As he progressed from research and product engineering into engineering leadership, Dr. Wall remained directly involved in the most critical technology programs for low emissions, powertrain efficiency, and alternative fuels. He also led the growth of Cummins' technical organization from 1,000 engineers, mostly centered in the United States, to more than 6,000 engineers globally, establishing new technical centers in India and China. Prior to joining Cummins in 1986, he led diesel and aviation fuels research for Chevron, where his team was first to discover the important contribution of fuel sulfur to diesel particulate emissions.

Dr. Wall is currently an advisor to the DOE Joint BioEnergy Institute and Co-Optima Program, the Cyclotron Road energy incubator at Lawrence Berkeley National Laboratory, the International Council of Clean Transportation, and the Institute of Transportation Studies at the UC Davis. He is active in a number of roles with the National Academies of Science, Engineering, and Medicine (NASEM), including the Board on Energy and Environmental Systems and the Board on Science, Technology and Economic Policy, and is chair of the board of directors of Achates Power. He has been recognized for his technical contributions by election to the National Academy of Engineering and as a fellow of the Society of Automotive Engineers (SAE). He has received the SAE Horning Memorial Award and Arch T. Colwell Merit Award for research in the area of diesel fuel effects on emissions, the SAE Franz F. Pischinger Powertrain Innovation Award, the American Society of Mechanical Engineers (ASME) Soichiro Honda Medal for significant engineering contributions in the field of personal transportation, the California Air Resources Board Haagen–Smit Clean Air Award, and the U.S. Environmental Protection Agency's Thomas W. Zosel Individual Achievement Award for career accomplishments in diesel emission control. Dr. Wall studied mechanical engineering at MIT, where he received his S.B. and S.M. degrees from the mechanical engineering honors program in 1975 and his Sc.D. in 1978.

H. Lee Buchanan III

Lee Buchanan is currently a venture partner in Paladin Capital Group in Washington, DC. He is also a director of Tektronix, Lucent-Alcatel Government Solutions, TestMart Corp., Advantage Federal Corp., and the Robotics Technology Consortium. Prior to joining Paladin, Dr. Buchanan was vice president of advanced concepts for EDO Corporation, a $1 billion producer of intelligence, electronic warfare, sonar, and weapons systems for the U.S. military; executive vice president of Perceptis, a holding company for producers of wireless data collection and intelligence systems; and president and chief executive officer of QualStream.

Dr. Buchanan has also had a significant career with the U.S. government, serving as Assistant Secretary of the Navy, the most senior executive for research, development, and acquisition for the U.S. Navy and the U.S. Marine Corps; deputy director and acting director of the Defense Advanced Research Projects Agency; division manager for Titan Corporation; senior research physicist at the Lawrence Livermore National Laboratory; and naval aviator. Dr. Buchanan holds a Ph.D. in applied physics from the University of California and B.S. and M.S. degrees in electrical engineering from Vanderbilt University.

Jim Lancaster

Jim Lancaster is senior director of the National Materials and Manufacturing Board at NASEM and the director of NASEM's Board on Physics and Astronomy (BPA). In these positions, he has worked on a number of projects in the areas of materials and manufacturing, including the recently released Strategic Long-Term Participation by DoD in Its Manufacturing USA Institutes (2019) and Frontiers of Materials Research: A Decadal Survey (2019), as well as a number of workshop proceedings including Globalization of Defense Materials and Manufacturing: Proceedings of a Workshop (2018) and Limited Affordable Low-Volume Manufacturing: Summary of a Workshop (2014). Prior to joining the staff at NASEM, Dr. Lancaster served on the faculty of Rice University, where he taught introductory physics to science and engineering students, and as a staff researcher, where he participated in experimental investigations of the interactions of highly excited atoms with electromagnetic pulses and surfaces. During his time at Rice, Dr. Lancaster received both the Wilson Prize for outstanding doctoral thesis in physics and astronomy, and the American Physical Society teaching award for his work as instructor of undergraduates. He is the co-author of over 25 peer-reviewed articles and is a member of the American Physical Society.

In addition to M.A. and Ph.D. degrees in physics from Rice University, Dr. Lancaster holds a B.A. degree in economics from Rice University and a J.D. degree from the University of Texas. Prior to entering the field of physics, Dr. Lancaster practiced law for over 12 years, specializing in the financial structuring and restructuring of businesses.

Salvatore Licata

Salvatore (Sam) Licata is an engineering and business administration professional with 49 years of experience in manufacturing engineering, providing new process development, quality systems development, manufacturing support, manufacturing planning, and manufacturing operations leadership. Mr. Licata is currently operating a small consulting company to provide manufacturing engineering and manufacturing operations advice and guidance, after retiring from Cummins Inc., where he most recently served as director of corporate manufacturing integration. In addition to plant manufacturing and corporate manufacturing positions within Cummins, he provided worldwide industrial and manufacturing engineering guidance, counsel and support to Cummins and its joint venture operations in Brazil, China, England, India, Italy, Japan, and Mexico, in addition to North American engine plants. He interfaced with these entities across manufacturing processes in all engine families, including 3000 HP to 53 HP engines worldwide, as well as all engine-related products (turbochargers, fuel systems, generators, and filters) designed and manufactured by Cummins. His earlier experience encompassed machine tool design, computer numerical control (CNC) machining, robotics, metal forming, and welding with the Lamb Corporation and the Ansul Company.

Mr. Licata has been registered as a professional engineer and a member of the Society of Manufacturing Engineers and ASME. He has also served on technical advisory committees in manufacturing engineering for Purdue University and the University of Michigan. He holds a bachelor of mechanical engineering from the University of Detroit Mercy and an MBA from Saint Bonaventure University.

Sharon Nolen

Sharon Nolen is the manager of global natural resource management at Eastman Chemical Company. During her 30-year career at Eastman, she held leadership positions in a variety of divisions—process engineering, plant engineering, corporate quality, information technology, and utilities—before assuming leadership of the Worldwide Energy Program in 2010. Her role has expanded to include water conservation and renewable energy. Under her leadership, Eastman has been recognized by the U.S. Environmental Protection Agency for eight consecutive years as an ENERGY STAR® Partner of the Year. Ms. Nolen is Eastman's representative for DOE's Better Buildings, Better Plants Challenge program. She holds a B.S. in chemical engineering from Tennessee Tech University and has completed the University of Tennessee's Executive Development Program. She is a professional engineer and a Certified Energy Manager® and was recognized with the 2018 Industrial Energy Technology Conference Energy Award.

Kelly Perl

Kelly Perl is an economist in the Office of Energy Consumption and Efficiency Analysis (OECEA) at the U.S. Energy Information Administration. She works on industrial sector energy consumption and the impact of technology on energy consumption in manufacturing and non-manufacturing industries. OECEA's work appears in EIA's Annual Energy Outlook, International Energy Outlook, and Today in Energy articles. Before joining EIA in August 2011, Dr. Perl worked at the Federal Energy Regulatory Commission and in private industry as an electricity expert. She holds a Ph.D. in economics from Princeton University and an AB in economics from UC Berkeley.

Shri Ramaswamy

Shri Ramaswamy is currently a professor in the department of bioproducts and biosystems engineering at the University of Minnesota. He served as the department head from 2003–2017. In his over 24 years at the University of Minnesota, his primary emphasis has been on industrial research, process and product development, and manufacturing process engineering; focus areas include pulp and paper, tissue, towel and consumer products, and chemical applications technology. Additionally, his process and product engineering research and education efforts have focused on bio-based products including bio-based materials, chemicals, fuels, and energy. More recently, his interests encompass integrated biorefining, sustainable use of renewable resources, enhancement of the environment for the 21st century bioeconomy, and environmental sustainability.

Prior to arriving at the University of Minnesota, Dr. Ramaswamy was a senior project leader at Scott Paper and a research engineer at Hercules Inc. He is a fellow in both the Technical Association of Pulp and Paper Industry and the American Institute of Chemical Engineers (AIChE), and he has received the AIChE Andrew Chase award for outstanding contributions to forest bioproducts. Dr. Ramaswamy holds a Ph.D. in paper science and engineering from the State University of New York (SUNY) in Syracuse, an M.S. in chemical engineering from Syracuse University, a M.S. in paper science and engineering from SUNY-Syracuse, and a B.S. in physics and pulp and paper engineering from the University of Roorkee (Indian Institute of Technology).

Michael Socks

Michael Socks is currently a senior energy consultant at the non-profit Vermont Energy Investment Corporation (VEIC). In his 15 years with VEIC, he has served industrial clients through VEIC's energy efficiency utility program known as Efficiency Vermont. He promotes cost-effective, energy-efficient technologies and practices in new construction, existing buildings, and manufacturing process improvements. Most recently, Mr. Socks has served as the technical lead for strategic energy management pilot programs on behalf of Efficiency Vermont and the New York State Energy Research & Development Authority (NYSERDA) and assisted in the adoption of energy management programs and methods compliant with ISO 50001 Energy Management System and Superior Energy Performance™ standards. Previously, he was a graduate research assistant at the University of Massachusetts Industrial Assessment Center, a project engineer for the Midwest Fluid Power Company, and a part-time community college instructor. Mr. Socks holds a B.S. in mechanical engineering from the University of Michigan–Ann Arbor and an M.S. in mechanical engineering from the University of Massachusetts–Amherst. He is a licensed professional engineer, a Certified Energy Manager® (Association of Energy Engineers®), and a Certified Practitioner of Energy Management Systems (Institute for Energy Management Professionals, Inc.).

James Wolf

Since 1997, James Wolf has been an independent consultant specializing in the energy and environmental fields. He designs programs, prepares strategic plans, and conducts evaluations. He has consulted with many foundations, businesses, and others over the past decade concerning energy and climate change issues. He has extensive international experience including work in China, India, and Europe. He also served as co-chair of a National Research Council committee evaluating DOE's energy efficiency and fossil energy programs and has participated in several panels evaluating other DOE programs. Prior to independent consulting, he was the vice president of energy and environmental markets at Honeywell, Inc. He has also served on the board of directors of the International Institute for Energy Conservation. Mr. Wolf holds a J.D. from Harvard Law School.

Appendix F: Acronyms

AIChE	American Institute of Chemical Engineers
AMO	Advanced Manufacturing Office
ASME	American Society of Mechanical Engineers
CMP	Concrete Masonry Product
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
EERE	Office of Energy Efficiency and Renewable Energy
EIA	U.S. Energy Information Administration
FOA	Funding Opportunity Announcement
GE	General Electric
IAC	Industrial Assessment Center
MEP	Manufacturing Extension Partnership
MIT	Massachusetts Institute of Technology
MP&P	Methodology, Processes and Procedures
MYPP	Multi-Year Program Plan
NASEM	National Academies of Science, Engineering, and Medicine
NIIMBL	National Institute for Innovation in Manufacturing Biopharmaceuticals
NIST	National Institute of Standards and Technology
OECEA	Office of Energy Consumption and Efficiency Analysis
R&D	Research and Development
SEMATECH	Semiconductor Manufacturing Technology
SUNY	State University of New York
TAP	Technical Assistance Program
UC	University of California
VEIC	Vermont Energy Investment Corporation

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