U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

DOE Advanced Manufacturing Office 2020 Peer Review

Review Panel Report

September 2020

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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 virtual peer review of its program activities online on June 2–3, 2020. 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, especially given the challenges of the COVID-19 pandemic. On the first afternoon, AMO management presented a high-level view of AMO, followed by presentations on strategy, budget, and analysis that provided beneficial context for the second day of the review.

The review panel commends the Office for incorporating suggestions from the 2019 review to provide additional context and information. Specifically, this includes:

- Budget:
  - Breaking down discretionary vs. directed budgets for specific activities
  - Providing high-level review of AMO budget history in past years (although the presentations for most portfolio areas covered only the past two years).
- R&D Projects Pillar:
  - Providing a targeted presentation on each major portfolio area
  - Discussing the targets being measured
  - Providing information on the future direction of each portfolio (true for some areas only).
- R&D Consortia Pillar:
  - Addressing the panel's questions from 2019 about consortia operations
  - Explaining AMO's interactions with consortia.
- General Comments:
  - Covering additional program planning and budget material
  - Explaining in more detail how AMO works with other EERE offices and other agencies.

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Introduction

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 virtual peer review of its program activities online on June 2-3, 2020. 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.

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.

2020 AMO Program Peer Review Process

The AMO Program Peer Review was held virtually on June 2-3, 2020 due to the COVID pandemic. The meeting was open to the public with registration required; Appendix A provides the agenda for the review. The peer review began on the afternoon of June 2 with welcoming comments, and remarks by EERE Assistant Secretary Daniel Simmons. The rest of the session focused on AMO overview presentations on AMO's mission, vision and goals, success stories, strategic approach and strategic analysis, budget overview and outlook. Also presented were information about the AMO R&D Consortia model and mechanisms for fostering innovation. The session concluded with time for questions for AMO leadership by the review panel.

On June 3, a series of six panel sessions were conducted focusing on individual technical topics, with presentations by AMO Technology Managers and time for reviewer questions at the end of each panel session. After the second panel session, Deputy Assistant Secretary Alex Fitzsimmons provided some additional EERE leadership remarks.

Prior to the meeting, the review panel was provided with information about the upcoming peer review, the AMO Program, and the 2019 Peer Review report. Separate sets of feedback responses were developed for the program and for individual technical topic activities (based on criteria in Appendix B and Appendix C).

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
Paul Bryan	Independent consultant; former Senior Scientist and Program Manager for Biomass/ Bioenergy Programs at the Sandia National Laboratories; former Program Manager of the DOE Biomass Program; and a former Vice President at Chevron
Raghubir Gupta	President, Susteon, Inc.; former Senior Vice President at RTI International; and an adjunct professor at North Carolina State University
James Lyons	Principal, Farmington River Technologies; Chief Technologist for Venture Investment Teams at Capricorn Investment Group and Energy Innovation
Sharon Nolen	Program Manager and Fellow, Global Natural Resource Management at Eastman Chemical Company
Steve Sciamanna	Senior Lecturer 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
John Wall	Advisor to numerous programs and boards; formerly Chief Technical Officer of Cummins Inc.

Appendix E contains the biographies of each panel member.

AMO Overview

AMO's purview covers a broad technology space, which makes effective program planning critical. Reviewers are pleased to hear that AMO management is already working toward creating a more strategically structured program.

The panel had expressed concern during the 2019 review that the relatively long list of strategic goals could make it more challenging for AMO to make a large impact in any one area. AMO has reduced and clarified its goals and now explicitly lists competitiveness, a recommendation from last year's review.

The "constellation" chart from the Multi-Year Program Plan (MYPP), which was presented to the panel, is impressive but somewhat difficult to follow, with its approximately 20 technology areas (including emerging and crosscutting areas). Peer reviewers are still hoping to see an overarching framework/structure that would allow a consistent collection of projects.

Reviewers continue to be 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 reviewers acknowledge AMO's point that its leadership is focused on the future rather than the past, but believe the institutional knowledge gained from retrospective analysis could be beneficial in managing programs and could illustrate that AMO has been responsive to changes in technology, markets, and national priorities. The panel feels that AMO could sharpen its use of foundational knowledge in general to better explain the Office's focus and direction with regard to program planning.

Key recommendations include the following:

- Organize the approximately 20 technology areas from AMO's constellation chart into a higher-level framework (preferably no more than six categories), and illustrate how these categories map to national needs.
    - Show the synergies without defaulting to "everything is connected to everything."
- Develop an "elevator brief" to describe AMO's purpose clearly and succinctly.
- 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.
    - Analyze AMO's efforts that did not meet their stated objectives to determine what went wrong, and disseminate this information to program managers.
        - □ Require a "lessons learned" discussion as part of R&D project closeout.
    - Consider publishing the Impacts report annually.
- Require more emphasis on the market opportunity and "value add" of each R&D activity.
- Examine overall portfolio balance versus AMO's stated objectives.
    - How much of AMO's overall portfolio should focus on existing industries/products vs. emerging ones? On retrofitting existing technologies vs. building efficiency into new ones?
- Consider AMO's unique ability to help create new U.S. industries and jobs.
    - Add domestic job creation as a metric.
- Explore ways to promote spin-off companies, especially for projects or consortia mainly involving universities and national labs; for example, include tasks in R&D funding opportunity announcements (FOAs) that focus on technology-to-market and partnership activities.

- Continue to coordinate closely with other government agencies and DOE programs whose activities overlap with AMO's (e.g., cybersecurity, critical materials) and who may have significant budgets and more expertise.
    - Continue to coordinate with other EERE offices whose missions appear to overlap (e.g., batteries, plastics recycling, water, grid-scale energy storage).
    - Better clarify AMO's role vs. other offices in cross-EERE and -DOE areas (e.g., Grand Challenges).
- Continue to increase stakeholder engagement in AMO program planning activities.

The reviewers encourage AMO to think about how its funding is maintaining the balance of key technical capabilities in the United States, particularly in the national laboratories.

- Do AMO's "listening sessions" with labs include industry participation?
- How does AMO promote collaboration and not competition between national labs?
    - Consider developing a framework to bring them together with their individual strengths.

R&D Portfolio-Level Observations

In 2020, AMO organized its peer review by portfolio topic, with related technical focus areas grouped together. Therefore, activities conducted under AMO's R&D subprogram (or "pillar") were discussed during the same review session as related activities funded under the consortia pillar. This structure allowed reviewers to hear about technically related topics in a more coherent manner. One additional session covered AMO's Technical Partnerships pillar.

Suggestions and recommendations on the topics discussed in the five technical portfolio sessions are presented below. (Technical Partnerships are covered separately.)

Panel #1: Additive Manufacturing, Composites, Sustainable Manufacturing and Circular Economy

- Define more clearly AMO's unique contribution to the area of Additive Manufacturing.
- Consider metrics other than energy to gauge the progress of Additive Manufacturing activities.
- Consider composites other than carbon fiber.
- Make sure to analyze the competitive landscape for composites being developed.
- Be able to show how the capital expenditure (CapEx) reduction component is specifically being addressed for carbon fiber composites.
- Better define how AMO will engage with the Institute for Advanced Composites Manufacturing Innovation after it becomes self-sustaining.
- Look for opportunities to collaborate with DOE's Advanced Research Projects Agency–Energy and National Energy Technology Laboratory programs on carbon fiber R&D.
- Consider pyrolysis of methane as a source of carbon for making carbon fibers.
- Re-examine the definition of "circular economy" to ensure it aligns with industrial interests.
- Have a transparent life-cycle assessment process, and clearly define the terms used.
- Develop a consistent methodology for assessing the capital expenditures for recycling technologies, given that CapEx is particularly important for economic viability of these technologies.
- Coordinate with the Environmental Protection Agency and others to look for broader opportunities to encourage recycling.
- Promote consideration of recycling during the development of any new materials in AMO's portfolio.

Panel #2: Advanced Materials, Materials for Harsh Conditions, Critical Materials, and Energy Storage

- Be able to more clearly define the focus of AMO's work in advanced materials.
    - What are the current industries of focus, and how does this R&D address those sectors' barriers/challenges?
- Look for R&D opportunities to anticipate the failure of coatings (e.g., using sensors or tools).
- Consider looking at materials for heat pumps in addition to heat exchangers.
- Consider looking at wide-range heat transfer fluids, such as those needed to couple the heat produced from solar thermal with another high-temperature process step that can use the heat.

- Examine how the lack of infrastructure for recycling critical materials may impact the technologies AMO is supporting.
- Clarify AMO's explicit role in rare earth materials.
- Be able to justify how the Critical Materials Institute is connected to industry needs, given there is no current U.S. production of these critical materials.
- Develop a technology map for energy storage, and determine how it connects to the strategy of AMO's R&D program in this area.
    - Show clear connections between AMO's energy storage activities and other AMO investments (e.g., critical materials, roll-to-roll manufacturing).
    - Coordinate with other EERE programs (e.g., Vehicle Technologies Office) and other DOE programs (e.g., Office of Electricity, Fossil Energy) to determine current gaps.
- Develop a coherent view on AMO's role in batteries; consider focusing on how to make them rather than advancing battery science.

Panel #3: Energy–Water Nexus and Water Security Grand Challenge, Process Intensification and Chemical Manufacturing, and Roll-to-Roll Manufacturing

- Define AMO's unique role in the energy-water area as well as the market and the technology gaps.
- Sharpen the strategy for AMO's Water Security activities.
    - To avoid overlap with other agencies, DOE offices, and states, explore exactly what water-related activities these entities are doing.
- Show AMO's R&D investments by water source (beyond just seawater).
- Consider options for brine other than disposal.
- Clearly define the market for the Process Intensification technologies being developed.
    - Given there is already massive CapEx in ethylene facilities, make sure there is a market for AMO's modular ethylene production technology.
- Better define AMO's objective in natural gas upgrading/utilization, given other agencies are doing work in this area.
- Define how AMO links its chemical manufacturing R&D projects and the Rapid Advancement in Process Intensification Deployment (RAPID) Institute efforts.
- Disseminate knowledge on roll-to-roll technology to potential users throughout the manufacturing sector, given the widespread potential applications of this technology.

Panel #4: Power Electronics, Combined Heat and Power, Waste Heat Recovery and Process Heating

- Continue brainstorming ways to share the knowledge and best practices developed under the Power America consortium.
    - Clearly define an application map.
    - Publicly share lessons learned on Power America's successes.
- Look into possible high-speed rail applications of technology developed under Power America.

- Make sure there is an industry market for the flexible combined heat and power (CHP) concept AMO is considering.
    - Show the business case and barriers.
- Consider CHP systems even smaller than 20 MW, or that are combined with cooling.
- Explore integration of waste heat recovery with heat pumps.

Panel #5: Smart Manufacturing, Cybersecurity, and High-Performance Computing for Manufacturing

- Ensure there is no overlap between Smart Manufacturing and Cybersecurity efforts.
- Consider expanding the workforce development component of Smart Manufacturing.
    - Investigate opportunities for training on artificial intelligence-oriented systems in order to build up the human capital in these technologies.
    - Explore communicating with universities on the need for new engineers to have programming experience; consider coordinating this activity with the American Society for Engineering Education or the Accreditation Board for Engineering and Technology.
- Ensure any user interfaces developed are accessible to the average operator, not just experts.
- Plan for field testing the long-term performance of new sensors developed under the Smart Manufacturing initiative.
    - Examine what type of measurement and verification (M&V)/quantification models could be built.
- Study the vulnerabilities of Internet of Things (IoT) devices/process controllers, and consider standards development.
- Clarify how energy efficiency goals are supported through Cybersecurity versus Smart Manufacturing activities.
- Provide data on High-Performance Computing activities that have resulted in actual technology transfer.

Other R&D Portfolio Observations

Consortia

- Require consortia to develop better transition plans for operation beyond the five-year DOE funding.
- Look for ways to make the consortia more autonomous.
- Document "lessons learned" from Power America and others whose AMO funding is winding down, and share the results with other consortia.

Portfolio "Snapshot"

As they recommended after the 2019 review, the peer reviewers feel strongly that AMO should evaluate the R&D activities in its portfolio in a standardized way. This would allow AMO to look at the balance of its portfolio versus the characteristics of the industries supported by this portfolio. AMO could then determine how its funding distribution correlates with the industry opportunity using a relatively small number of key metrics, including:

- AMO funding provided for a given topic area
- Potential impact of that area on the U.S. economy
- List of specific targets for the topic area.

At the project level, AMO should look at the following metrics:

- The relative size of the investments in a project
- Specific project targets
- The position of the project on the technology maturity timeline.

Regarding the industry to which the topic area is related, AMO should consider:

- The maturity of the industry
- An indicator of whether the industry is capital- or labor-intensive
- The size of the domestic market and the opportunity for export.

AMO indicated during the review that staff are working to provide information in a quad chart format (including strategic fit, energy impact, and market impact) so every project can be evaluated using the same process. The peer reviewers regard this as a positive development and encourage AMO to think about how to use this information to present AMO's complex and diverse portfolio in a more logical manner.

Technical Partnerships Observations

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

The panel applauds the 50001 Ready initiative as a less costly alternative to achieving International Standards Organization (ISO) 50001 certification. 50001 Ready is an excellent tool whose promotion and maintenance should continue. Likewise, the panel is impressed with the Better Plants program but is concerned that challenging goals (25% energy intensity reduction over 10 years) might deter companies from joining. The work being done by the Industrial Assessment Centers (IACs), particularly the workforce development aspects, is also seen as very beneficial.

The panel has the following suggestions on these Technical Partnership activities:

- Develop and implement strategies for publicizing these voluntary programs and overcoming associated adoption challenges.
- Consider online training where possible.
- Develop a clear strategy for growing/adding companies to the various partnership programs while allowing AMO to maintain the quality of assistance.
- Graphically show IAC data over time to determine how this program is growing—or even whether it is growing.
- As noted in the 2019 peer review report, AMO could use its relationships with companies involved in Technology Partnerships activities (particularly Better Plants and IACs) to gather information about challenges industry faces.

The peer reviewers were particularly impressed with AMO's programs to foster innovation and develop the domestic workforce. Lab-embedded entrepreneur programs, Small Business Innovation Research, and Energy I-Corps are all viewed as strong programs to accomplish these objectives while creating U.S. economic activity. Transferring new technologies and practices to the market should also be an important consideration in everything AMO does.

The reviewers had the following questions about facilitating technology transfer, fostering innovation, and developing the workforce:

- How does AMO (or DOE more generally) follow through on creating and keeping jobs in the United States?
    - Can the federal government make it a requirement for jobs to remain in the United States?
    - Are intellectual property issues handled in a way that ensures jobs are created domestically?
- Has AMO thought of developing a formal process for taking technologies to market?

The following are comments and recommendations on these programs:

- Expand the focus of AMO's workforce development beyond people with advanced degrees or special skills to workers at all levels.
- Look for additional mechanisms to encourage industry to work with the national laboratories.
- Emphasize the workforce development aspect of AMO's institutes, and make sure they aggressively share "lessons learned."

- Coordinate better with state energy offices on AMO's technology transfer programs.
  - Promote leveraging of AMO tools.
  - Expand outreach and information-sharing.
- Consider following the past successful example of AT&T (Bell Labs and Western Electric) to increase the likelihood of success of critical efforts.
  - Strive for "close proximity of researchers to the manufacturing floor" to facilitate access to problems.
  - Ensure a stable source of baseline funding.
  - Use cooperative research and development agreements (CRADAs) between companies and national labs where possible.

Feedback on the Peer Review Process

The panel appreciates the hard work AMO put into preparing for the 2020 review and congratulates AMO for a job well done, particularly in light of the challenges presented by the pandemic. The peer review was well run and organized. Presenters were prepared and communicated their activities effectively.

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

- Highlight commercial successes from the past five years.
- Show AMO historical data of commercialized technologies, with normalized AMO budget comparison over the years.
- Show the percentage of AMO funds that were provided to national labs the past 5–10 years (broken down by individual lab).
- Show AMO R&D project funding by performer (national lab, university, private industry).
- Show how the analysis connects/supports the R&D topics chosen for FOAs and at which technology readiness levels (TRLs).
- Discuss more about the future direction of each portfolio.
- Reduce the amount of detail in the PowerPoint slides.
    - Focus on the strategy, the importance of the activity to the United States, and the activity's potential for technical impact.
    - Cover details, if needed, in project-level reviews.
- Present portfolios according to the stage of research of their activities.
- Task a subcommittee of former/current peer reviewers to advise AMO on presentation templates (information, formats, analysis) for future reviews.
- Provide additional information on consortia.
    - The history of consortia that have been funded by AMO, how long the funding was provided, and how are they doing now
    - Details (as available) on exit plans after direct AMO funding ends
    - A history of funding sources for each consortium (public vs. private)
    - A table/graphic comparing institutes, hubs, and grand challenges to show similarities and differences (TRLs, expected outcomes, etc.).
- Provide a graphic of all AMO staff and expertise.

In terms of logistics, the panel makes the following recommendations:

- Provide presentations further in advance.
- Allow additional time for the panel to ask questions (whether the review is in-person or virtual).

Appendix A: Final Agenda

Plenary Session: Day 1 (Tuesday, June 2)		
12:30 PM	Welcome and Review of Day 1 Agenda	**Melissa Klembara** or **Bob Gemmer**, AMO
12:40 PM	Introduction of EERE Leadership	**Valri Lightner**, AMO Deputy Director
12:45 PM	EERE Leadership Remarks	**Daniel R Simmons**, Assistant Secretary for Energy Efficiency and Renewable Energy
1:15 PM	AMO Overview Mission, Vision, Goals, Success Stories	**Valri Lightner**, AMO Deputy Director
1:45 PM	AMO Strategic Approach	**Diana Bauer**, AMO
2:15 PM	AMO Strategic Analysis (Retrospective, Introspective, and Prospective)	**Joe Cresko**, AMO
2:45-3:15 PM	**BREAK**	
3:15 PM	Budget Overview and Outlook	**Lauren Hall**, AMO
3:30 PM	R&D Consortia Model	**Michael McKittrick**, AMO
3:45 PM	Mechanisms for Fostering Innovation	**Joe Cresko**, AMO
4:00 PM	Q&A for AMO Leadership	**Peer Review Panelists**
5:00 PM	Overview of Technical Tracks to be Discussed on Day 2	**Melissa Klembara** and **Bob Gemmer**, AMO
5:15 PM	**WRAP UP /ADJOURN**	

Plenary Sessions: Day 2 (Wednesday, June 3)		
9:30 AM	Welcome and Review of Day 2 Agenda	**Melissa Klembara** or **Bob Gemmer**, AMO
9:40 AM	AMO Technical Topic Panel #1 • Additive Manufacturing • Composites • Sustainable Manufacturing/Circular Economy	AMO Technology Managers **Blake Marshall** and **Chris Hovanec** **Chad Schell** and **Jeremy Leong** **Chris Hovanec, Kate Peretti,** and **Joe Cresko**
10:40 AM	AMO Technical Topic Panel #2 • Advanced Materials • Materials for Harsh Conditions • Critical Materials • Energy Storage	AMO Technology Managers **Steve Sikirica** and **Tina Kaarsberg** **Steve Sikirica** **Helena Khazdozian** **Brian Valentine, Diana Bauer** and **Joe Cresko**
12:00 PM	Introduction of DAS-EE, Alex Fitzsimmons	**Valri Lightner**, AMO Deputy Director
12:05 PM	Remarks from DAS-EE, Alex Fitzsimmons	**Alex Fitzsimmons**, Deputy Assistant Secretary for Energy Efficiency
12:30 PM	**LUNCH BREAK**	
1:00 PM	AMO Technical Topic Panel #3 • Energy-Water Nexus/Water Security Grand Challenge • Process Intensification/Chemical Manufacturing • Roll-to-Roll Manufacturing	AMO Technology Managers **Melissa Klembara** and **Diana Bauer** **Kate Peretti, Melissa Klembara** and **Jeremy Leong** **Brian Valentine**
2:00 PM	AMO Technical Topic Panel #4 • Power Electronics • Combined Heat and Power • Waste Heat Recovery/Process Heating	AMO Technology Managers **Al Hefner** **Bob Gemmer** **Bob Gemmer** and **Joe Cresko**

3:00 PM	**BREAK**	
3:15 PM	AMO Technical Topic Panel #5 • Smart Manufacturing • Cybersecurity • High Performance Computing for Manufacturing	AMO Technology Managers **Sudarsan Rachuri** **Chad Schell** **Bob Gemmer**
4:15 PM	AMO Technical Topic Panel #6 • Technical Partnerships • Workforce Development/Investing in People • Technology Transfer Mechanisms	AMO Technology Managers **Eli Levine** **Steve Shooter** and **Nebiat Solomon** **Tina Kaarsberg** and **Jeremy Leong**
5:15 PM	Wrap Up/Next Steps on AMO Peer Review	**Melissa Klembara** or **Bob Gemmer**, AMO
5:30 PM	**ADJOURN**	

Appendix B: Evaluation Criteria for Overall AMO Program

Relevance and Strategy

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 activities, addresses the AMO mission.
- Were the program's long-term strategy, strategic approaches, and future direction effectively conveyed?
- Does the program's strategy reflect an understanding of the near and long-term challenges facing industry and other stakeholders?
- Do activities address high impact areas and address appropriate markets and technical barriers?
- Is the program appropriately investing to accelerate development of innovative manufacturing-relevant technologies?

Resources

- Are there adequate resources in terms of dollars for the current mission?
- Overall Assessment of Relevance and Strategy
- What is your overall assessment of relevance and strategy?
- What recommendations do you have for relevance and strategy?

Please explain by commenting below. Provide both strengths and any weaknesses. (Maximum 500 words)

Assessment of Current Portfolio

- Are the activities within the program portfolio contributing to meeting the program's goals and objectives?
- Are the activities within the program portfolio addressing key challenges and reducing barriers?
- Was the rationale for and organization of the funded activities effectively conveyed?
- Does the program portfolio effectively balance priorities and allocates resources appropriately?
- Are there important topic areas that are underrepresented or missing?
- Are the activities within this program portfolio appropriate for AMO's role as a public research and development organization?

Please explain by commenting below. Provide both strengths and any weaknesses. (Maximum 500 words)

Program 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?
- Does the program have operations and oversight procedures in place to ensure efficient direction of office activities?

Resource Management and 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?
- Is the program investing taxpayer funds wisely to drive the greatest impact?

Stakeholder Engagement and Outreach

- How well is the program gathering feedback from stakeholders to inform and improve AMO activities and strategy?
- Is the program providing access to accurate and objective information and data that can help to accelerate development and inform decision-makers?
- How well is the program maximizing the outcomes of AMO-supported activities by effectively disseminating results of activities and evaluating their impacts?
- 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?

Please explain by commenting below. Provide both strengths and any weaknesses. (Maximum 500 words)

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?

Please comment. (Maximum 750 words)

Appendix C: Evaluation Criteria for Individual Technical Topic Activities

1. **Clarity of opportunity and objectives:**
   - 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?

Please comment. (Maximum 300 words)

2. **Alignment and fit with AMO's Mission and Goals:**
   - Does the activity align well to the overall mission and goals of AMO?

Please comment. (Maximum 300 words)

3. **Activity structure and organization:**
   - Is the activity structured so that it is well-suited to address market challenges and barriers, and is there a high likelihood of progress and success?
   - How well is the activity gathering feedback from stakeholders to inform and improve the activity's strategy and implementation?
   - Are there important areas for this topic that are underrepresented or missing?

Please comment. (Maximum 300 words)

4. **Activity progress and outlook:**
   - Is there evidence of progress towards achieving the stated objectives for the activity?
   - Is the current and forward-looking level of effort for the activity appropriate?

Please comment. (Maximum 300 words)

Overall Assessment:

Please provide any additional comments.

Appendix D: Advanced Manufacturing Office Management Response

Members of the AMO 2020 Program Peer Review Panel,

I appreciate your participation and insightful perspective as part of the Advanced Manufacturing Office (AMO) 2020 Peer Review Panel. The expertise you bring as a team including knowledge of the manufacturing sector as it exists today and strategic vision to the technical challenges that manufacturers will face in the future is paramount in aligning AMOs research, development and assistance portfolio towards meaningful technology innovation. The review gives the AMO team the opportunity to receive constructive feedback and to remain focused on energy-related advanced manufacturing technologies and practices that will be adopted by industry to increase energy productivity and drive U.S. economic competitiveness.

The Committee's valuable feedback on opportunities to improve project oversight and analysis will bolster the performance of our R&D portfolio. AMO is committed to implementing program improvements and below highlights a few actions that AMO is undertaking that align with recommendations in the Peer Review Report:

- **Organize technology areas into a higher-level framework.** As presented in the Strategic Approach session, a higher-level framework to organize the AMO activities has been under development. The framework was not available for presentation at the Peer Review and has continued to evolve as presented below including five draft technology area descriptions with alignment to the national needs. Your inputs are welcome.
    - **Advanced Materials Manufacturing:** novel materials with improved properties and their production processes - includes the Plastics Innovation Challenge
    - **Sustainable and Secure Supply Chains:** domestic availability of materials and resources through resilient and secure supply chains - includes critical materials and the Water Security Grand Challenge
    - **Manufacturing Process Innovation:** new manufacturing technologies and improving energy efficiency in existing manufacturing processes and operations
    - **Energy Systems:** systems related to energy conversion, use, storage, technologies for management within industrial facilities, and advancing production processes of these systems - includes the Energy Storage Grand Challenge
    - **Manufacturing Enterprise:** value chains that are nimble, responsive, and adaptive to disruption, change and opportunity; knowledge and transformational tools; and the future manufacturing workforce includes cyber security
- **Identify, communicate, and implement lessons learned.** As presented in the Strategic Analysis session, AMO has been piloting introspective analysis including the composites and process intensification portfolios. The main goal of this pilot is to establish a consistent methodology for evaluating the potential impact of the AMO portfolio. As the methodology is being developed the analysis team is also updating and aligning the methodologies of retrospective, introspective, and prospective analyses to enable consistent tracking of benefits throughout the life of a project and within a technology portfolio of projects. This structured analytical approach will assist AMO in identifying and implementing best practices and lessons learned. Additionally, AMO is developing an annual report for 2020 to highlight successes and communicate them broadly to our stakeholders.
- **Continue to improve the peer review experience for Committee members.** The Committee provided a number of useful suggestions related to the peer review process in 2019 that AMO was not able to fully implement in 2020 due to the COVID-19 pandemic. AMO intends to incorporate these ideas as it plans for the 2021 Peer Review. In addition, AMO will provide more time for Peer Review Panelist questions and engage panelists in developing the agenda and presentation templates for the 2021 Peer Review.

Once more, let me express my deep gratitude to all of you for being members of the Peer Review Panel and for your diligence in reviewing AMO's portfolio and providing useful insights. The results will make the work of AMO more impactful as AMO continues to work with academia, industry, national laboratories, and other stakeholders to solve energy related challenges in manufacturing.

Sincerely,

Valri Lightner
Deputy Director
Advanced Manufacturing Office
Office of Energy Efficiency and Renewable Energy
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 the Department of Energy (DOE), the National Laboratories, the National Institute of Standards and Technology, and state and local governments. For several decades, Ms. Margolis provided technical and strategic planning support to the DOE Advanced Manufacturing Office.

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, 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.

Paul Bryan

Paul Bryan is currently an independent consultant, and is an internationally recognized expert in the field of biofuels and biotechnology with a distinguished career in the chemicals and fuels industry. Dr. Bryan recently served as a senior scientist and program manager for Biomass/Bioenergy Programs at the Sandia National Laboratories. Previously, he was a lecturer in chemical engineering at the University of California, Berkeley. Dr. Bryan also served as program manager for the Department of Energy (DOE) biomass program (now known as the Bio-Energy Technology Office) between 2010 and 2012. He remains active as a DOE Merit and Peer Reviewer, co-chair of the Biomass R&D Board's Technical Advisory Committee, and also serves in other advisory/reviewer roles.

Prior to his time at DOE, he worked for about 15 years for Chevron, most recently as Vice President – Biofuels Technology. Prior to that he founded and managed Chevron's Western Australian Alliance for Advanced Energy Solutions in Perth, Australia, as well as Chevron's Long-Range Research Program in Separations Technology in the United States. Earlier positions included stints as a research engineer with Chevron and Union Carbide, and academic positions at the Massachusetts Institute of Technology (MIT) and Colorado School of Mines. Dr. Bryan has long been active in the American Institute of Chemical Engineers Separations Division originally as a director, then division chair, and since 2003, the Gerhold Award Committee Chair. He holds a bachelor's degree in chemical engineering from Penn State University, as well as a Ph.D. in chemical engineering from the University of California, Berkeley.

Raghubir Gupta

Raghubir Gupta is currently President of Susteon, Inc., a company focused on technology development and commercialization of low-carbon technologies for energy and process industries. With over 30 years of experience in leading technology development and research, Dr. Gupta's technical expertise ranges from coal/biomass gasification, synthesis gas (syngas) cleanup and utilization, syngas conversion into fuels and chemicals including Fischer-Tropsch chemistry, hydrogen production and storage, carbon capture, utilization, and sequestration, desulfurization of hydrocarbon fuels, production of cellulosic biofuels, and industrial water reuse. Previously, he served as the senior vice president of the Energy Technology Division at RTI International where he managed more than $300 million of R&D effort with a team of 50 professionals. Dr. Gupta has presented his research work in a number of national and international conferences, published in a number of reputed journals, including a paper in Science, and holds more than 20 U.S. and foreign patents. Dr. Gupta is an adjunct professor in the Chemical and Biomolecular Engineering Department at North Carolina State University. He obtained his B.A in chemical engineering from the Indian Institute of Technology, and his Ph.D. in chemical engineering from the Illinois Institute of Technology.

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, and became 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. Dr. Lyons is a reviewer for the Department of Energy 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.

Sharon Nolen

Sharon Nolen is the program manager & fellow, global natural resource management at Eastman Chemical Company. During her 31-year career at Eastman, she has 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 reuse 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 the Department of Energy'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 as the 2019 International Energy Manager of the Year by the Association of Energy Engineers.

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 MIT.

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 Department of Energy 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 UC Davis. He is active in a number of roles with the National Academies of Science, Engineering, and Medicine, 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 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.

Appendix F: Acronyms

AMO	Advanced Manufacturing Office
CapEx	Capital expenditure
CHP	Combined heat and power
DAS-EE	Deputy Assistant Secretary for Energy Efficiency
DOE	U.S. Department of Energy
EERE	Office of Energy Efficiency and Renewable Energy
FOA(s)	Funding Opportunity Announcement(s)
GE	General Electric
IAC(s)	Industrial Assessment Center(s)
IoT	Internet of Things
ISO	International Standards Organization
M&V	Measurement and verification
MIT	Massachusetts Institute of Technology
MYPP	Multi-Year Program Plan
Q&A	Questions and answers
R&D	Research and Development
RAPID	Rapid Advancement in Process Intensification Deployment
SAE	Society of Automotive Engineers
TRL(s)	Technology readiness level(s)
UC	University of California
U.S.	United States

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