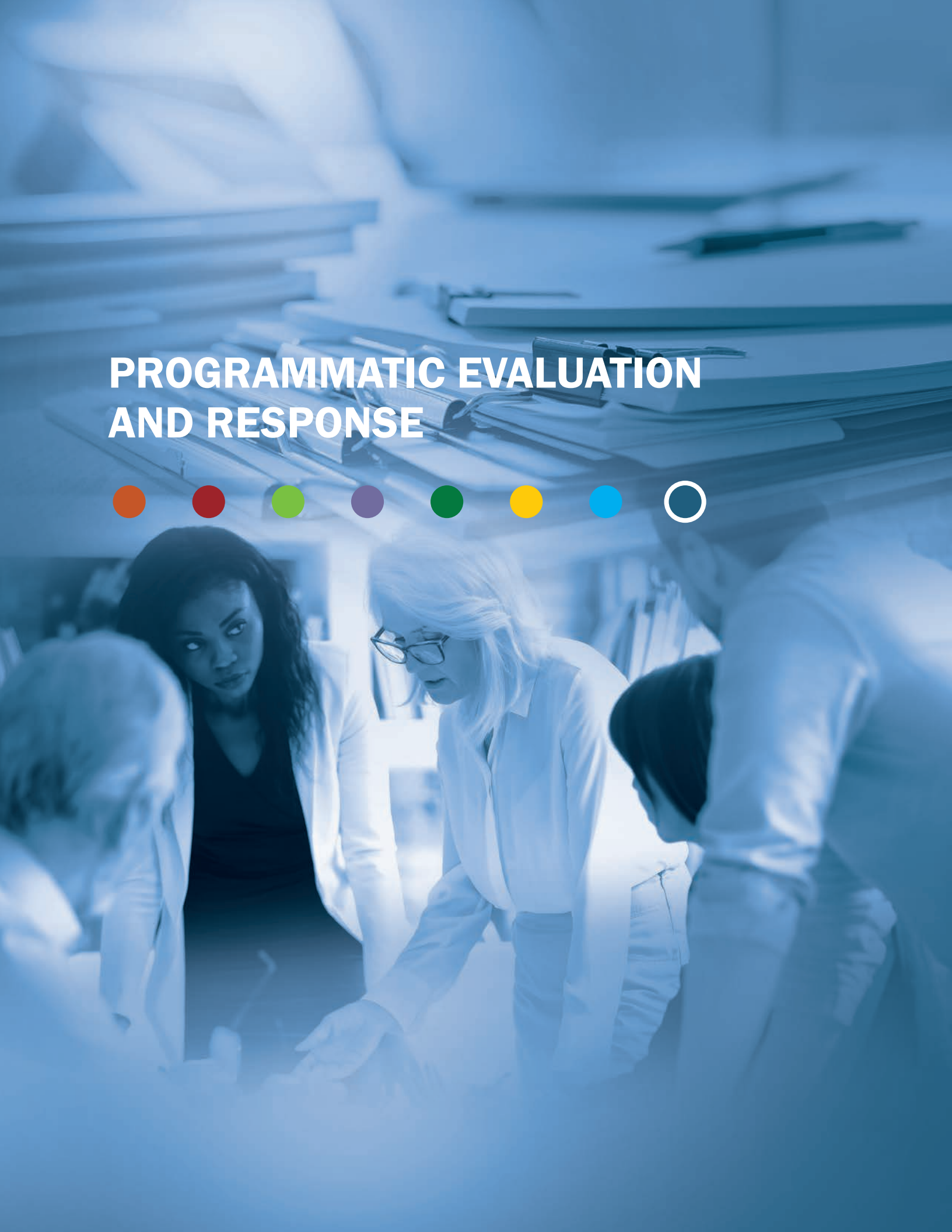
PROGRAMMATIC EVALUATION AND RESPONSE



BIOENERGY TECHNOLOGIES OFFICE PROGRAMMATIC EVALUATION

Prepared by the Bioenergy Technologies Office 2019 Peer Review Steering Committee

The Steering Committee was tasked with observing the technology peer review process performed by the technical review panels and with reviewing the Bioenergy Technologies Office (BETO) project portfolio for relevance in developing transformative and revolutionary bioenergy technologies to enable sustainable, domestically produced biofuels, bioproducts, and biopower.

The Steering Committee based its review of the BETO project portfolio on information collected from several resources: plenary presentations that provided the overall context and goals for the portfolio technology areas; direct observations of the different technology area reviews; a closed-door session involving the lead reviewers and discussions between the Steering Committee and BETO management; a review of the BETO *Strategic Plan for a Thriving And Sustainable Bioeconomy* and the draft *Multi-Year Plan* (MYP) for 2019; and supplemental information detailing the breakdown of the types of projects in the portfolio, who is performing the work, and barriers being addressed. We attempted to keep our evaluation focused on issues pertaining to the portfolio and not duplicate comments from the individual technology reviewers detailed elsewhere in this report.

The members of the Steering Committee thank BETO for the opportunity to review the progress and direction of the program portfolio. We are unanimous in our appreciation of the depth of thought and expertise shown by the BETO staff in the program management and incorporation of independent advisor feedback, including the 2017 Steering Committee, and in the development of the multiyear and strategic plans.

The Steering Committee members express their condolences to the family of Don Stevens. Stevens was a member of the 2019 Steering Committee, and he was profoundly impactful during his short time with us. Stevens and his insights will be missed in the bio-industry community.

PEER REVIEW OBSERVATIONS

Based on our observations during the Project Peer Review, the project technology review sessions were performed reasonably similarly and fairly across the portfolio and allowed enough time for questions from the review panel; however, minimal time was allowed for audience questions. We noted that the quick pace of the review process did not allow enough time for all reviewers to record their evaluations and suggestions in the review tool. We recommend that BETO allow additional time between individual project reviews for the audience to ask questions and provide time for the reviewers to complete their entries. Also, guidance on slide limits should be given to principal investigator presenters to help ensure that presentations fit into allocated time slots and allow enough time for questions. Reviewers voiced their appreciation for receiving project presentations ahead of time so that they could be better prepared for the review. Reviewers also favored slide content that focused more on the technical approach, data, lessons learned, and results instead of aspects of project management. The preference toward more results-oriented information could be a result of BETO's direction toward more projects with lower technical readiness levels (TRLs) that are focused on research. As discussed in the following sections, however, we believe that the project management information should be enhanced, particularly regarding progress and relevance.

Some review panels had trouble distinguishing between similar projects. It would be helpful to reviewers for similar projects within a technology area to be grouped together and for any complementary relationship or key differences between them to be explained by the BETO lead technology manager. Generally, the panel reviewers were excellent, very knowledgeable, and offered many thoughtful questions. Recognizing that many of the reviewers are taking time away from other commitments, we recommend that BETO consider reducing the significant demand on the reviewers that occurs when preparing for the peer review, during the week of the review, and when preparing feedback after the review by enlisting additional reviewers or downselecting which projects are fully reviewed.

The closed-door program review session was a very useful and informative open exchange between the BETO team and the Steering Committee. It provided a critical forum for frank discussion and nuanced discussion that would not otherwise be possible during the peer review or in conjunction with another public meeting or conference. It worked well as a stand-alone meeting. BETO technology managers comprehensively and satisfactorily addressed the recommendations made in the review panel summary reports and encouraged the Steering Committee to provide feedback in an open and nonprescriptive way.

LEVERAGING KNOWLEDGE AND COLLABORATION

Based on the amount of work being managed and the expertise and commitment of the BETO staff we observed, it is clear to us that BETO has an exceptional group of people who have a tremendous amount of knowledge and dedication toward advancing the bioeconomy. To supplement the BETO expertise, BETO has been implementing consortia comprising industry advisory boards (IABs) and national laboratories that are dedicated to specific technology areas. The consortia comprise experts who can meet several times per year to discuss progress on projects.

BETO is active in understanding domestic and international markets and drivers for bio-based commodities, in promoting collaborative efforts to harmonize domestic and international codes and standards and regulations for alternative fuels, and in fostering responsible sustainability practices and metrics. On a project level, we identified several individual projects that brought in international resources to help with specific technical issues. We believe it is appropriate that the individual projects identify and collaborate with international experts and for BETO's international role to be focused on understanding markets and regulations to aid in directing U.S. bio-industry efforts. On a domestic level, it was clear that BETO works closely with other relevant agencies, such as the U.S. Department of Agriculture, National Science Foundation, and the U.S. Environmental Protection Agency (EPA). An example of this is the initiative taken by BETO, with EPA, to develop and approve an analytical pathway to cellulosic ethanol renewable identification numbers for starch ethanol plant residuals. BETO has a strong history of developing standardized methods that have been widely accepted. BETO has shown to be a leader for federal interagency collaboration and coordination on bioenergy and bioproducts research. BETO played a strong role in the development of the Biomass Research and Development (BR&D) Board's *Bioeconomy Initiative: Implementation Framework*, which is now guiding and coordinating research at BETO and among numerous other key federal agencies and offices. BETO has also demonstrated strong collaboration with other U.S. Department of Energy (DOE) offices within the Office of Energy Efficiency and Renewable Energy (EERE), Office of Fossil Energy, and Office of Science. The Steering Committee recommends that BETO continue to communicate and showcase its intra- and interagency work at future peer reviews.

COMMERCIAL RELEVANCE AND MARKET TRENDS

In 2018 and early 2019, several firsts occurred, and some bold announcements were made. Expanded and distributed electricity generation and vehicle electrification are some of the energy transitions anticipated in the coming decades, and they demonstrate a growing movement away from coal- and petroleum-based liquid fuels, whether or not the specific commitments are fully realized. Such trends are likely to impact the BETO portfolio, but other end-use areas, such as air and marine transportation, might require different approaches to reduce their carbon footprint, including bioenergy. A few of the milestones and trends we noted include:

- BETO supported a major milestone in sustainable jet fuel for commercial aviation: the first commercial flight (a Virgin Airlines Boeing 747 from Orlando, Florida, to London, England) using fuel from recycled waste carbon.
- Increasing numbers of U.S. states have pledged to become carbon neutral or carbon free and are codifying a commitment to renewable energy sources. Action at the state level to remove greenhouse gas emissions from the electric grid is becoming increasingly common.

- Such policies have the potential to reshape local/state energy sectors with wind and solar but also technologies employing carbon capture and reuse, sequestration, or storage.
- Major automakers—such as the Volkswagen Group, Toyota, Nissan, and Honda—have committed to achieving 90%–100% carbon neutrality by 2050, in large part by producing only battery electric and/or fuel cell electric vehicles (EVs). Volvo announced that every vehicle produced from 2019 and beyond will involve some level of electrification, and the company has set a goal for 50% of sales volume to be fully electric vehicles by 2025. Some countries—such as India, France, the United Kingdom, and Norway—are making bold statements about transitioning from internal combustion to fully EVs. BETO's programmatic expansion to include more diverse biomass sources, bioenergy alternatives, and diverse end-use markets is consistent with current trends, including increased electrification of the light-duty vehicle fleet. It will be important that energy generation and energy storage from clean and renewable sources matches increased demand.
- New applications of algae and lignin are exciting and have the long-term potential to increase the profitability and sustainability of technologies formerly focused only on bioenergy generation. Although new markets and products take time to establish, these are technology areas where BETO has taken a lead in recent years. In the lignin area, a diverse group of projects is addressing the use of lignin in composite form and as isolated components.

Recycling and reuse of plastics continues to have popular support, and both local and national governments are introducing policy initiatives, such as various restrictions on single-use plastics. New solutions are needed, and the background technology that BETO brings is well positioned to contribute to this difficult problem.

BETO has an important role in translating renewable energy technologies in relation to incumbent technologies for policymakers and the public. The transformative work being funded by BETO should be championed in the public forum. BETO has the "basic data" and expertise to infuse the advanced fuel conversation with fact-based comparisons of life cycle assessments, economics, job creation, and sustainability as an economic opportunity for rural America to participate in generating domestic energy security. BETO-supported technologies and approaches can generate income for farmers, provide an outlet for forest residues (fire-prone states are ramping up their forest management practices), and diversify municipal waste disposal options.

DIVERSE PORTFOLIO

As part of the review process, the Steering Committee was asked to review the mix of projects in the BETO portfolio. During the 2013, 2015, and 2017 peer reviews, the number of projects reviewed was between 190 and 277, representing total DOE investments of between $400 million and $1.6 billion, depending on the review cycle. The 2019 Project Peer Review included 447 projects across five technology areas, representing a combined DOE investment of nearly $860 million. This is an extraordinary number of projects, and the increase in 2019 was a result of the inclusion of projects not previously reviewed or presented in poster sessions, including related projects that are not managed by BETO, as well as the recent emphasis of BETO to focus on smaller research-and-development (R&D) projects instead of larger demonstration or pioneer projects.

The 2019 project breakdown by participant included:

- 13 projects conducted by research institutions (representing 3% of the portfolio)
- 58 by academic institutions (representing 13% of the portfolio)
- 84 by industrial companies (representing 19% of the portfolio)
- 292 by national laboratories (representing 65% of the portfolio).

Additionally, there were 333 annual operating plan (AOP) projects led by the national laboratories and managed by BETO. The AOP projects addressed 55 of BETO's 59 identified barriers. The four barriers not addressed were (1) investigation into the productivity and robustness of energy crops, (2) characterization of energy crop production, (3) development of selective harvesting machines, and (4) development of algal harvesting technologies. In addition, the AOP projects addressed 25 of the 33 BETO milestones listed in the draft 2019 MYP. There are another 55 projects not directly related to any single milestone but are considered to be enabling, analysis, or emerging technology projects. It was apparent to us, however, that at least some technical barriers not being addressed by the AOPs are addressed through BETO's Fiscal Year 2019 funding opportunity announcement (FOA) process, but the full analysis of the most recent FOA projects was not yet available at the time of our review. In addition to the projects presented, we reviewed the draft 2019 MYP and found it to be an excellent resource to aid in understanding the focus of BETO, development of the technical pathways, and programmatic milestones.

We reviewed the number of projects and planned spending for the identified technical barriers. In general, we believe the research supports the key areas in a biomass-to-bioenergy supply chain. Barriers with the least number of projects and planned spending are appropriately on the low end of priorities. Additionally, the two technical barriers with the most projects (82 total) are appropriately focused on increasing the product and coproduct yields from biological and catalytic processes. These two technical barrier descriptions are broad and contain many different topic areas. We believe that the large focus on these areas is appropriate; however, we found that our brief exposure, the number of projects, and the variety of technologies employed made it difficult to grasp the full scope of BETO's portfolio and to offer a further opinion on BETO's priorities in overcoming technical barriers.

We recognized a consistent theme from the preceding and current peer review panels inquiring into how BETO measures progress and how is it reported; how projects are chosen to be funded; which issues justify parallel efforts; where efforts are being unnecessarily duplicated; how work is being leveraged among participants; and whether the assumptions across the different projects are consistent in reporting costs, product values, risks, market sizes, environmental benefits, and progress. Past and present panels have recommended that BETO incorporate standard measurement and reporting tools for all portfolio projects, such as the use of Work Breakdown Structures (WBS), techno-economic analysis (TEA) models, and Gantt charts. It is clear to us that BETO incorporates a WBS for its projects and for the technical barriers that are being addressed. BETO has required the projects to incorporate TEA, as noted in the 2013 review process and earlier. The 2015 review process noted that major improvements had been made in the rigor and depth of the TEA since 2013 and were increasingly integrated into the decision-making process. The 2017 review process did not raise a concern; however, some 2019 review panels noted that the use of TEA models by individual projects were inconsistent or missing, leading to potentially erroneous conclusions regarding potential commercial applicability. We believe that during the 2019 review process a significant factor toward the inconsistent or misuse of the TEA model could be attributed to the recent BETO emphases on projects with lower technology risk, where comprehensive economic models are less applicable.

We appreciate the past panels recommending the use of very useful tools, such as TEA models; however, given the diversity of projects located in a variety of environments, such as universities and national laboratories, it is not unexpected that the rigor and assumptions used in the models continue to be inconsistent. In addition, it is not obvious to us that TEA or Gantt charts should be used equally among all projects in the portfolio. Instead, we recommend that BETO focus on the panel questions we mentioned—such as how progress is measured, the criteria for making choices, and consistency in assumptions (to name a few)—and that the BETO project managers and researchers in individual technology areas should determine the best way to communicate to stakeholders and technical reviewers.

Given the vast complexity of the BETO portfolio, we would like BETO to consider what they want the program and peer review process to accomplish. It appears to us that the current methodology of reviewing the portfolio every 2 years, using temporary panel members, is not optimally effective in evaluating the technical

aspects, relevance, or progress of the projects currently in the portfolio or understanding the historical effort BETO has accomplished. We suggest that BETO consider using the IABs (which can meet several times per year, if appropriate) to evaluate the program and project objectives and that BETO might want to use the biannual peer review process for communication purposes and to review a smaller and more focused set of barriers.

CLOSING OUT OLD AND NEW ISSUES

In the latter part of the last century, private and public researchers performed transformative research into addressing some important bio-industry technical challenges. Because of changing world events and changing of emphasis on both private and public efforts in the U.S. bioenergy realm, some past subject matter experts are no longer available or are not being used as a resource. Consequently, we have seen some repeating of past work by both the private and public communities and a reidentification of previously identified technical barriers.

BETO and the bioenergy industry are at a unique point in history that is experiencing renewed interest and investment in renewable energy, fuels, and products. This investment has resulted in developing a new generation of subject matter experts in renewable fuels and chemicals that are proficient in developing new technologies, assessing risk, and performing project management, and the experts have accumulated a working knowledge of lessons learned and deficiencies in the technologies and equipment that must be overcome.

We recognize that one of BETO's primary focuses has been to identify and mitigate technical barriers that have been identified through the multitude of projects BETO has participated in developing. We also recognize that BETO, through coordination with some national laboratories, has been active in publishing commercially relevant results. It also appears to us, however, that some technical barriers and potential solutions identified around equipment choice and how the equipment choice affects a facility's technical and financial performance might not be well communicated to the industry at large in all cases. It is our experience that we continue to see private industries encounter equipment issues (notably around solids handling in the areas of bale deconstruction and solids cleaning, transporting, and feeding) that were identified decades ago and were not fully addressed at that time, in addition to new issues BETO has identified. We understand that in some cases BETO might be hindered from publishing private industry results because of concerns about intellectual property protection; however, we recommend that BETO make a concentrated effort to find commercially applicable solutions for these lingering issues that have hindered the industry while we have the subject matter experts, vendors, and companies with the knowledge to solve these issues and not need to rediscover and readdress them again in the future.

BETO GOALS AND COMMERCIAL SUCCESS

BETO has long recognized the benefits of producing valuable coproducts to improve the economic viability of a biorefinery and to provide an incentive for private industry to develop these projects. We appreciate that BETO's stated strategic goal in the draft 2019 MYP "is to enable use of America's abundant biomass and waste resources for advanced biofuels, bioproducts, and biopower. …" We believe that to achieve this strategic goal, a bioeconomy must exist that creates an environment that motivates investment in the industry. We recommend that BETO broaden its focus to include higher value products—not only as byproducts but as primary products. The production of higher value bioproducts reduces the economic investment risk and provides funding for solving technical risks (availability, scale-up, yields, and reduction in operation-and-maintenance [O&M] costs), which can be applied to the fuel production pathway when economics dictate. This approach can be seen in the oil refinery and chemical business.

During the project reviews, we noted two items which we believe BETO could apply from the oil refinery business. The first item is the value and focus on products. We appreciate DOE's mandate and focus on fuel production and the strides BETO has made in promoting coproduct production. However, as demonstrated in the oil refining business, a biorefinery with the ability to divert, or further convert, the reactants in the

feedstock from fuel to valuable products can be a key element in its economic viability. We believe the current limitation set on BETO to focus on fuels and only make byproducts with the more difficult to convert elements of the feedstock unnecessarily hinders the potential commercial success of these efforts.

The second item we believe BETO could apply from the oil refinery business revolves around the quality of feedstock the biorefineries should be willing to take. We noted that there was discussion from some project presenters and peer reviewers regarding the need to require (in particular, from farmers delivering stover) a certain feedstock quality to make processing the stover easier for the biorefinery. For example, the presence of rocks and grit is hard on the front-end stover deconstruction equipment and fouls facility equipment. The oil refining business faced a similar issue and determined that low-price feedstock is key. Such low-price feedstock might have a low degree of American Petroleum Institute gravity or be high in sulfur. Feedstock costs comprise a significant portion of the product selling price. Refiners made the necessary improvements to the refineries to accept and process heavy and contaminated feedstocks. The biorefinery should ultimately be designed to do the same and take and use low-priced feedstocks. For example, these feedstocks could be distressed fats or recycled oils and greases (which are currently used in some biorefineries), second-pass field residues, or overwintered material. We believe that efforts to avoid cheaper, dirty feedstock is a shortcut to solving equipment processing issues that will be reflected in the future economic viability of the facility.

The draft 2019 MYP also describes BETO's performance goals to verify models showing the production of hydrocarbon biofuels that achieve a mature modeled minimum fuel selling price (MFSP) of $3/gallons gasoline equivalent (GGE) with a minimum 60% reduction in emissions relative to petroleum-derived fuels by the year 2022 and $2.5/GGE with a minimum 60% reduction in emissions relative to petroleum-derived fuels by the year 2030. Based on our suggestion that BETO place increased emphasis on the production of more valuable coproducts, the target price for fuels becomes less important to the development of a viable bio-industry. We suggest that BETO consider that a more appropriate goal would be verifying models showing an economically viable commercial bio-facility that produces biofuels and bioproducts.

SUMMARY

The members of the Steering Committee thank BETO for the opportunity to review the progress and direction of the program portfolio. We recognize that BETO comprises an exceptional group of subject matter experts, visionaries, and leaders who are executing an extraordinary program. We appreciate BETO's use of consortia comprising IABs and national laboratories that are dedicated to specific technology areas. We believe BETO has an important role in translating renewable energy technologies in relation to incumbent technologies for policymakers and the public.

In our role as the Steering Committee, we reviewed the number of projects and planned spending for the identified technical barriers. In general, we believe that the barriers with the lowest number of projects and planned spending are appropriately on the low end of priorities. Additionally, the two technical barriers with the most projects are appropriately focused on increasing the product and coproduct yields from the biological and catalytic processes. These two technical barrier descriptions are large and contain many different topic areas; however, given the number of projects and the variety of technologies employed, we found it difficult to grasp the full scope of BETO's portfolio to develop a detailed opinion on BETO's priorities in overcoming technical barriers beyond the cursory findings of the technical review panels. Given the complexity of the BETO portfolio, we would like BETO to consider what is it they want the program and peer review process to accomplish. It appears to us that the current methodology of reviewing the entire portfolio every 2 years using temporary panel members is not effective in evaluating the technical aspects, relevance, or progress of the projects currently in the portfolio or understanding the historical effort BETO has accomplished. We suggest that BETO consider using the IABs to evaluate the program and project objectives and to develop criteria for communicating the measurement means, status of progress, and decision-making.

We recommend that BETO make a concentrated effort to find commercially applicable solutions for the known lingering issues that have commercially hindered the industry while we have access to the subject

matter experts, vendors, and companies with the knowledge to solve these issues and not need to rediscover and readdress them in the future.

We recommend that BETO broaden its focus to include higher value products—not only as byproducts but as primary products—to reduce the economic investment risk and provide funding for solving technical risks that can be applied to the fuel production pathway when economics dictate.

Sincerely,

The 2019 Steering Committee

BETO PROGRAMMATIC RESPONSE

Prepared by BETO Leadership

INTRODUCTION

BETO leadership would thanks the Steering Committee for its work, technical support, and critical insights throughout the implementation of the 2019 Project Peer Review and Program Management Review. BETO appreciates all the feedback provided and is encouraged by the Steering Committee's support for many of BETO's current research activities and plans for future directions as well as the Steering Committee's appreciation for the strength and dedication of the BETO staff.

This section represents BETO's response to the Steering Committee's final report. In the coming years, BETO will work with the program and technology managers to implement several of the recommendations and address many of the Steering Committee's concerns. BETO will consider these in managing its portfolio based on systematically prioritizing R&D in technology opportunities across a range of emerging scientific breakthroughs and TRLs.

Steering Committee Recommendations Overview

The Steering Committee provided several recommendations covering a broad spectrum of areas, from portfolio scope and focus to the peer review process and implementation. BETO appreciates the Steering Committee's acknowledgement of BETO's international and federal intra and interagency engagement and plans to apply the Steering Committee's recommendation that BETO showcase this work in the future. Further, BETO appreciates the Steering Committee's robust support of BETO's new R&D directions exploring plastics and recycling improvements.

Peer Review Recommendations

The Steering Committee made several recommendations toward improving the peer review experience and process. BETO thanks the Steering Committee and agrees that the review panels were knowledgeable and thoughtful in their recommendations. BETO appreciates that the peer review takes a significant time commitment for both the Steering Committee and technical reviewers and will consider ways to alleviate this burden in planning future reviews. BETO will also consider how best to balance this against the recommendation that additional time be allotted for audience questions, additional explanation of technology portfolios, and administration.

BETO is glad that the Steering Committee found the revised program review format productive and will note this when planning future program reviews.

Leveraging Knowledge and Collaboration

> "The Steering Committee recommends that BETO continue to communicate and showcase its intra- and interagency work at future peer reviews."

BETO thanks the Steering Committee for their positive acknowledgement of staff dedication, knowledge, and commitment. We agree that our consortia enhance our knowledge and provide valuable input to our various technology areas.

We are glad that the Steering Committee approves of BETO's current levels of international, intra-, and interagency engagement. BETO will implement the Steering Committee's recommendation to continue to highlight intra- and interagency work. With work in support of the goals laid out in the *Bioeconomy Initiative: Implementation Framework* now underway, BETO and the other offices and agencies of BR&D are actively seeking opportunities to discuss and amplify the initiative, its accomplishments, and its activities.

Commercial Relevance and Market Trends

> "Recycling and reuse of plastics continues to have popular support. … New solutions are needed, and the background technology that BETO brings is well positioned to contribute to this difficult problem. BETO has an important role in translating renewable energy technologies in relation to incumbent technologies for policymakers and the public. The transformative work being funded by BETO should be championed in the public forum."

BETO agrees that new solutions are needed for recycling and plastics and appreciates the Steering Committee's support of this effort. BETO plans to expand its support of this area into Fiscal Year 2020 and beyond.

Diverse Portfolio

BETO presented a total of 447 projects (an investment of more of than $700 million) at the 2019 Project Peer Review and acknowledges that the breadth and diversity of this portfolio is vast. We are glad that the Steering Committee feels that the portfolio is appropriately focused.

> "Past and present panels have recommended that BETO incorporate standard measurement and reporting tools for all portfolio projects, such as the use of Work Breakdown Structures (WBS), techno-economic analysis (TEA) models, and Gantt charts. … Instead, we recommend that BETO focus on the panel questions we mentioned—such as how progress is measured, the criteria for making choices, and consistency in assumptions (to name a few)—and that BETO project managers and researchers in individual technology areas should determine the best way to communicate to stakeholders and technical reviewers."

Increased use of TEA to evaluate project feasibility and progress has been heavily encouraged by steering committees and peer review panels during the past decade. The Steering Committee noted that as BETO moves toward lower TRL projects, the use of TEA to guide project management is not as advisable. BETO appreciates this sentiment and is currently having—and will continue to have—internal discussions about revising our strategy for monitoring progress. The Steering Committee suggested that BETO work to standardize assumptions across the different projects, including "reporting costs, product values, risks, market sizes, and environmental benefits." BETO implemented a consortium approach to many of its research areas that allows for standardization of assumptions among project performers. BETO will continue to work on

standardizing assumptions among projects in the portfolio. Further, BETO will investigate how to best communicate how progress is measured, the criteria for making choices, and underlying assumptions for our technical audience.

> "We would like BETO to consider what is it they want the program and peer review process to accomplish. It appears to us that the current methodology of reviewing the portfolio every 2 years, using temporary panel members, is not optimally effective in evaluating the technical aspects, relevance, or progress of the projects currently in the portfolio or understanding the historical effort BETO has accomplished. We suggest BETO consider using the IABs … to evaluate the program and project objectives and … the biannual peer review process for communication purposes and to review a smaller and more focused set of barriers."

BETO appreciates the Steering Committee's thoughtful consideration of review standards and practices and welcomes suggestions for improving the process for reviewers, performers, Steering Committee, and BETO staff. DOE EERE guidance requires that BETO review at least 80%–90% of its portfolio via a rigorous, formal, and documented evaluation process using qualified and independent reviewers not less than every other year. Outputs of the peer review should inform BETO planning and must be considered when determining whether projects should continue, continue with adjustments, or no longer be funded. BETO could investigate the feasibility of narrowing the focus of the peer review while continuing to comply with EERE guidelines.

Although BETO project performers use IABs within their projects, BETO employs only one external advisory board: the BR&D Federal Advisory Committee Act. Because of federal statute, BETO cannot be advised (and hence our projects cannot be reviewed) by an unapproved advisory committee. Further, assembling a review team consisting only of individuals who work with BETO on an ongoing basis could compromise or appear to compromise the objective/external nature of the peer review process.

BETO agrees with the Steering Committee that the peer review process is suboptimal, and we will continue to explore strategies to streamline, shorten, and enhance the process.

Closing Out Old and New Issues

The deep understanding of both science and the bioenergy industry are among the reasons that BETO selected this Steering Committee; the insight into both the current and past industry is highly valuable.

> "We recommend that BETO make a concentrated effort to find commercially applicable solutions for the known lingering issues [regarding equipment choice and how the equipment choice affects a facility's technical and financial performance] that have commercially hindered the industry while we have access to the subject matter experts, vendors, and companies with the knowledge to solve these issues and not need to rediscover and readdress them again in the future." Areas of note include: "solids handling in the areas of bale deconstruction and solids cleaning, transporting, and feeding."

BETO recently launched the Feedstock-Conversion Interface Consortium (FCIC) to address some of these issues. The Advanced Development and Optimization portfolio is also addressing this issue. As the Steering Committee mentioned, it is sometimes difficult for BETO to share proprietary successes and failures of BETO projects. BETO will continue to investigate methods to bring together project performers with subject matter experts, vendors, and companies to help solve these problems.

BETO Goals and Commercial Success

BETO recognizes and agrees with the Steering Committee's assessment that high-value bioproducts are critical to growing the bioeconomy, and BETO appreciates the Steering Committee's strong support of this research direction.

> "We recommend that BETO broaden its focus to include higher value products—not only as byproducts but as primary products. The production of higher value bioproducts reduces the economic investment risk and provides funding for solving technical risks (availability, scale-up, yields, and reduction in operation-and-maintenance [O&M] costs), which can be applied to the fuel production pathway when economics dictate. … We believe the current limitation set on BETO to focus on fuels and only make byproducts with the more difficult to convert elements of the feedstock unnecessarily hinders the potential commercial success of these efforts."

BETO recognizes the importance of R&D to support the bioeconomy as part of a strategy to develop price-competitive biofuels. As the Steering Committee notes, the BETO program resides at DOE, and thus our mission must focus on addressing energy challenges. BETO understands the role that producing high-value coproducts can play in improving the commercial viability of a biorefinery and will seek to appropriately balance and communicate this in support of our current goals of energy storage, reliability, and affordability.

> The second item we believe BETO could apply from the oil refinery business revolves around the quality of feedstock the biorefineries should be willing to take. … The oil refining business … determined that low-price feedstock is key. … The biorefinery should ultimately be designed to do the same and take and use low-priced feedstocks.

BETO appreciates this recommendation. BETO conversion projects are aimed at converting a variety of types and qualities of feedstocks, and these efforts can be expanded. The FCIC is also evaluating strategies for using lower priced feedstocks that meet necessary conversion specifications.

Conclusion

BETO reiterates its thanks of the Steering Committee for their time and recommendations. BETO appreciates that the Steering Committee took the time to not only consider BETO's original questions and guidelines but went above and beyond the call of duty. The Steering Committee continually considered ways to add value to not only the 2019 Project Peer Review but also BETO peer reviews for years to come. The 2019 Steering Committee has been highly engaged, collaborative, and thoughtful throughout the planning process, and it was a pleasure to execute the peer review with them.

Though a challenging, full, and fast-paced week, the BETO peer review is invaluable to the success and future of BETO. We thank the Steering Committee, reviewers, BETO staff, and attendees for their interest in and commitment to BETO's mission of advancing applied research and experimental development to reduce the price of producing of biofuels, biopower, and bioproducts and grow the bioeconomy.

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