National Agricultural Research, Extension, Education, and Economics Advisory Board

2017 Relevance and Adequacy Review
Responding to Climate and Energy Needs

Integrative Executive Summary

Review Process

The NAREEE Advisory Board is statutorily required to perform an annual review of all the agricultural and natural resource research, extension, or education activities funded by the U.S. Department of Agriculture to assess their relevance to the Department's established Research, Education and Economics (REE) priorities and to advise USDA on the adequacy of the funding for those activities (7 USC 7613(b)). This annual process is called the Relevance and Adequacy (R&A) review.

> ***(b) Advisory Board review:*** *On an annual basis, the Advisory Board shall review—*
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> ***(1)****The relevance to the priorities established under section 7612 (a) of this title of the funding* ***of all agricultural research, extension, or education activities c****onducted or funded by the Department; and*
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> ***(2)****The adequacy of the funding.*

In Fiscal Year (FY) 2015, the Board, in cooperation with the REE mission area and the Office of the Chief Scientist (OCS), identified the need to strategically revise the R&A review process to ensure that all of the programs and activities within REE's mission scope were included in the review.

As the foundation for the R&A review, the USDA Strategic Plan articulates a comprehensive vision for the Department. Priorities directly related to science, education, and information are identified through the REE Action Plan, which describes a set of strategies and actions that relate to a goal that is either programmatic or that supports administrative activities. The REE Action Plan describes seven Action Goals that reflect the full scope and variety of REE activities; several Goals have sub-goals to provide programmatic emphasis.

Goal 1	Sustainable Intensification of Agricultural Production
Goal 2	Responding to Climate and Energy Needs
Goal 3	Sustainable Use of Natural Resources
Goal 4	Nutrition and Childhood Obesity
Goal 5	Food Safety
Goal 6	Education and Science Literacy
Goal 7	Rural Prosperity/Rural-Urban Interdependence

Under the revised NAREEE R&A review process, every year the Board organizes an R&A review Committee to focus on one or two of the REE Goals identified in the REE Action Plan with the intention of reviewing all seven of the goal areas over the course of five years. The review includes the programs and activities of all four REE agencies—the Agricultural Research Service (ARS), the Economic Research Service (ERS), the National Agricultural Statistics Service (NASS), and the National Institute of Food and Agriculture (NIFA)—as well as the U.S. Forest Service (FS) Research and Development (R&D) program. As noted above, the Board members evaluate the programs on the basis of relevance, quality, and performance and also advise on the adequacy of funding for those programs.

The NAREEE Advisory Board comprises 25 members who represent a broad range of disciplines, stakeholder interests, and geographical locations. In addition, the Board membership is purposefully transient, with members serving staggered terms of three years. Under these conditions, the Board members consistently have sufficient collective knowledge of the priority areas being reviewed, and the proposed review process takes this into consideration by utilizing the members with the relevant experience for the priority areas being reviewed.

To inform the 2017 R&A review, the REE agencies and FS R&D provided input through a well-synthesized overview prepared by the OCS together with more detailed evidence submitted individually by ARS, NIFA, ERS, NASS and FS R&D. Key information and documents included a description of each Action Goal's programming and its specific strategies; available programmatic resources (personnel; budget; facilities; equipment); identified needs of and interactions with stakeholders, including other federal agencies; annual agency reports; and, where available, agency program reviews. The individual agency program reviews are not on the same timeline. Therefore, each agency provided its most recent program review and, if applicable, the most recent annual reports or other supporting documentation to identify any changes or reprogramming efforts in response to those reviews. The NAREEE Advisory Board appreciates the effort and responsiveness of the REE leadership team and agencies in providing additional information as requested.

Based on this input from the REE agencies and FS R&D and the overarching synthesis from the USDA OCS, the R&A Committee members completed their review of the spectrum of Climate and Energy Needs programs. It is important to note that the REE agencies and FS R&D have their own robust programmatic review processes in place. The NAREEE Committee conducted its overarching review through two working groups that focused, respectively, on Sub-goal 2A, Responding to Climate Variability, and Sub-goal 2B, Bioenergy/Biofuels and Bio-based Products, with the two working groups operating as a Committee of the whole. The Committee used information from the agencies' existing individual reviews to evaluate the relevance and funding adequacy across all of the agencies collectively. To guide its evaluation, the NAREEE R&A Committee reviewed the Action Goals with an emphasis on the following questions formulated for R&A reviews by the NAREEE Advisory Board in 2014:

1. What are the key research, education, and extension programming and their specific goals consistent with REE Action Goal(s)?
2. What documented client/stakeholder needs are addressed by the programming for this Action Goal(s)?

3. Does the research, education, and extension for the Action Goal(s) advance agricultural and/or natural resource science and its application? [Address strengths and limitations in answering this question.]
4. Is the funding of this Action Goal(s) adequate to achieve its specific goals and how has its investment accomplished these?
5. What does this Action Goal(s) need to do to address remaining gaps between the activities and accomplishments, evolving stakeholder needs, and the current state and application of agricultural science?
6. Is there complementarity and collaborative effort across the REE agencies and FS R&D in intramural, extramural, and infrastructure funding, short, and long-term research, education, and extension that does not duplicate effort in REE or other federal effort?

Guided by these questions in reviewing the extensive materials provided, the R&A Committee offers the following report. It describes the Committee's observations and assessment of the relevance and funding adequacy of key programming aimed at advancing agricultural and natural resource science, outreach and education, and stakeholder engagement in each of the sub-goals for the Responding to Climate and Energy Needs Goal Areas. The Committee notes that the portfolio across REE and within each of its agencies is extensive and cannot be described in detail in this R&A review report. Rather, this report focuses on highlights, offering a broad synthesis of various agency activities, and on emergent themes for which there was strong consensus among the members of the Committee. Finally, the report presents the R&A Committee's recommendations to address gaps and to strengthen further the portfolio of REE in these Goal Areas.

Sub-goal 2A. Responding to Climate Variability

Introduction

USDA and Climate

USDA plans and implements its climate change research, outreach, and education programs guided by the United States Global Change Research Program (USGCRP), which coordinates 13 federal agencies and departments that contribute to the government's climate change research agenda. USGCRP conducts state-of-the-art research on climate change and other dimensions of global change, such as land use and land cover.

Global climate patterns are changing in unprecedented ways, with implications for all agricultural and natural resource ecosystems and production systems. Climate change is a central consideration in USDA's strategic planning. Strategic Goal 2 of USDA's Strategic Plan is to "Ensure Our National Forests and Private Working Lands Are Conserved, Restored, and Made More Resilient to Climate Change While Enhancing Our Water Resources". Its objectives include restoring and conserving the nation's forests, farms, ranches, and grasslands, and leading efforts to mitigate and adapt to climate change, drought, and extreme weather. The *USDA Climate Change Adaptation Plan* presents strategies and actions to address the effects of climate change on key mission areas, including agricultural production, food security, rural development, and forestry and natural resources conservation.

The REE mission area and the individual REE agencies developed action plans to deliver USDA-conducted and supported science on the strategic goals and priorities of the Department. Supporting and integrating these action plans is a USDA climate change plan. This plan outlines technical, economic, and communications expectations for the Department that will support Strategic Goal 2.

Specific strategies in the REE Action Plan supporting this goals area include:

1. Increase understanding of the processes driving the direct and indirect effects of climate variability on natural and managed ecosystems, including feedbacks to the climate system. Identify and quantify the effects of changing climate, climate variability, and atmospheric composition on agricultural, rangeland, and forest ecosystems' productivity and sustainability, through a trans-disciplinary system science approach involving agricultural sciences, natural and social sciences, mathematics and engineering (ARS, NASS, NIFA, ERS, NRCS, FS R&D).
2. Develop knowledge and tools to enable adaptation of agriculture, forestry, and grasslands to climate variability and to improve the resilience of natural and managed ecosystems and vulnerable populations.
3. Develop knowledge and tools to enhance the contribution of agriculture, forestry, grazing and other land management practices to mitigate atmospheric GHG emissions.
4. Provide information and tools to USDA agencies, stakeholders, and collaborators to improve decision-making. A key aspect of this research is to better measure changes in the carbon sequestered and the effects on GHG emissions as a result of USDA conservation efforts.

To understand the broader context in which REE agencies perform their R&D, it is worth highlighting a key activity and two major programs pertaining to USDA and climate issues.

As a major activity, USDA is currently revising its climate change science and resilience plans to incorporate an improved understanding of carbon cycles and effects of climate change on ecosystems provided by multiple USDA reports. Revisions also aim to reflect USDA GHG mitigation goals and agency adaptation plans and to build upon enhanced USDA communication and outreach capacity. Key reports for developing the revised plan identify consequences of climate change, vulnerabilities to this change, adaptation strategies to reduce the adverse impacts, opportunities to mitigate GHG emissions, and the tools to measure the effects of changing agricultural and forestry practices. These reports include:

- *Effects of Drought on Forest and Rangelands in the United States* (January 2016)
- *USDA's Building Blocks for Climate Smart Agriculture & Forestry: Implementation Plan and Progress Report* (May 2016)
- *U.S. Agriculture and Forestry Greenhouse Gas Inventory: 1990–2013* (August 2016)
- *Climate Change, Global Food Security, and the U.S. Food System* (December 2015)
- *Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory* (July 2014)
- *Climate Change and United States Forests* (2014)
- *Climate Change and Agriculture: Effects and Adaptation* (February 2013)

- *Report of Greenhouse Gas Accounting Tools for Agriculture and Forestry Sectors* (February 2012)
- *Effects of Climatic Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the U.S. Forest Sector* (December 2012)

Two noteworthy USDA climate programs that play a pivotal role for several REE agencies are:

The **Climate Change Program Office** (CCPO) coordinates USDA's responses to climate change and its effects on agriculture, forests, grazing lands, and rural communities. CCPO ensures that USDA is a source of objective, validated, and effective climate change science and technology made easily available to internal and external customers and stakeholders on scales relevant to decision-making. CCPO coordinates and conducts scientific syntheses and assessments, such as the *U.S. Agriculture and Forestry Greenhouse Gas Inventory* that is produced with multiple USDA agency and collaborator contributions. CCPO ensures that USDA climate change research is available to the USDA program agencies—Natural Resource Conservation Service (NRCS), FS R&D, Farm Service Agency (FSA), Rural Development (RD), and Risk Management Agency (RMA)—and is being incorporated in operational planning. CCPO chairs the USDA Global Change Task Force that meets monthly to communicate USDA climate change goals and agency actions to meet those objectives.

The USDA **Climate Hubs** deliver science-based knowledge, practical information, and program support tools to farmers, ranchers, forest landowners, and resource managers to support adaptive decision-making in light of the increased risks and vulnerabilities associated with climate change. Hubs translate climate change projections into potential impacts on the agricultural and forestry sectors and provide periodic regional assessments of risk and vulnerability in the agriculture and forestry sectors. The Hubs receive direct stakeholder input and foster interagency collaboration via direct links to all USDA agencies. Hub activities help to strengthen agricultural production, natural resource management, and rural economic development under increasing climate variability. The ARS, FS, and NRCS provide leadership for regional Climate Hubs. Key partners in this effort include universities, extension, USDA researchers, the private sector, state, local and regional governments, the National Oceanic and Atmospheric Administration (NOAA), Department of Interior (DOI) regional Climate Science Centers (CSC), and non-profits engaged with landowners in conservation.

REE and Climate

The REE role under Action Plan Sub-goal 2A is to develop and deliver science-based knowledge through research, education, and extension that empowers farmers, foresters, ranchers, landowners, resource managers, policymakers, and other federal agencies to address the production, management, and economic risks, challenges, and opportunities of climate variability and change, and to position agricultural communities to significantly reduce emissions of atmospheric GHGs and enhance carbon sequestration.

1.1 — Strategy 1: Increase understanding of the processes driving the direct and indirect effects of climate variability on natural and managed ecosystems, including feedbacks to the climate system. Identify and quantify the effects of changing climate, climate variability, and atmospheric composition on agricultural, rangeland, and forest ecosystems' productivity and sustainability, through a trans-disciplinary system

science approach involving agricultural sciences, natural and social sciences, mathematics and engineering (ARS, NASS, NIFA, ERS, NRCS, FS R&D).

1.1(a) Rationale

Climate-induced changes pose a significant threat to agriculture and food production systems, nationally and internationally. In response, USDA agencies are involved in a number of activities to support the prevention, mitigation, and adaptation to present and predicted changes. Given the potentially dire consequences for the agriculture sector as a result of the new climate patterns, increased support is urgently needed for programs that advance the understanding of direct and indirect effects of climate variability on the processes and functions of natural and managed ecosystems.

For the R&A Committee's review, all five REE agencies and FS R&D provided complete, informative, and useful responses to facilitate the process of assessing the relevance and adequacy of their activities around Strategy 1, which responds to the urgent need to better understand climate change dynamics and impacts.

Committee members drew upon what they learned from the agencies in deliberating on which efforts advance USDA's goals in this area and which need further improvement. For example, the Committee recognizes that NIFA, ARS and FS programs effectively identify and quantify the effects of changing climate, climate variability, and atmospheric composition on agricultural, rangeland, and forest ecosystems' productivity and sustainability. Together, the agencies fund an array of intramural and extramural research and outreach involving agricultural sciences, natural and social sciences, mathematics and engineering. Collaborations and strategic partnerships are commonplace, especially with universities, but also with the non-profit and private sectors.

As noted, ARS, NIFA, and FS are major players in the USDA Climate Hubs. The ARS and the FS fund leadership positions in five Hubs each. These Hubs identify stakeholder research needs and deliver tools for measuring changes and increasing understanding of, and adaptation to, climate-induced change. But budget cuts have hindered collaborations with universities and other potential partners. Furthermore, ARS and FS R&D need more data management support staff and infrastructure, so data are available in useful formats for stakeholders, and they need more research that expands our understanding of soil biome resilience under changing climate conditions. USFS R&D also needs additional staff to support forest planning, including in the National Forest Systems, and to support data and information management to ensure that resources are readily accessible.

NIFA has supported research on adaptability to climate change, but it needs to increase support for longitudinal research on the fundamental causes and impacts of climate change on managed and unmanaged agricultural, forest, and rangeland ecosystems. There are major gaps in knowledge that directly affects producers (e.g., legume germplasm breeders program; regional coordination networks; effects on animal [livestock and aquaculture] physiology and production efficiency; transboundary movement of invasive species; and impact of climate on food and water-borne diseases).

The Committee strongly supports NIFA's move toward the creation of an external advisory group, including professional societies, NGOs, universities, and industry. It is important to

support NIFA's collaboration with NOAA's Sea Grant and Regional Integrated Sciences & Assessments (RISA) programs through joint climate extension programs, and the agency's collaboration with DOI CSC programs through joint climate research, education, and outreach programs. At a minimum, increased communication between departments and agency programs would foster greater collaboration, reduced duplicative effort, and more complete progress on overall federal research priorities. NIFA should take considerable guidance from the National Climate Assessment and priorities of the USGCRP, as well as the 3rd National Climate Assessment and the 4th National Climate Assessment (currently under development) (see the addendum entitled, *The Impacts of Climate Change on Human Health in the United States, A Scientific Assessment*, Chapter 7, Food Safety, Nutrition and Distribution, and Chapter 9, Populations of Concern (https://health2016.globalchange.gov/).

The ERS climate change research program analyzes potential responses of farmers and domestic and international markets to a new climate regime, with a focus on the potential role of technologies such as improved genetic resources, risk management tools, and other policy options for addressing potential impacts. Building on extensive expertise in the economics of land use and land management, conservation program design, and environmental markets, ERS researchers also explore the economic, environmental and land use implications of alternative climate and energy policies. The agency could increase its research on the effects of climate change in relation to industry pricing and consumer behaviors.

The NASS continues to adopt new technologies for the collection of spatial data in support of producer and management decision-making. Both ERS and NASS need to expand staffing and infrastructure for storage and serving of large datasets for managers, producers, and researchers.

All REE agencies and FS R&D will need to increase their collaboration in the collection of and access to rapidly increasing amounts of biophysical and social-cultural data to support transdisciplinary research.

The NAREEE Advisory Board acknowledges the excellent array of programs sponsored and managed by the REE agencies but has identified critical areas where additional effort and emphasis are needed.

1.1(b) Recommendations

1. In 2017-18, conduct a review of climate-related priorities in an integrated manner across all REE agencies and FS R&D.

2. Increase the integration of energy and climate goals across program offerings. An example would be promotion of strategic partnerships between universities, private industries, and venture capitalists to advance clean energy innovation that aids in adaptation to climate variability and change.

3. Continue to elevate the importance of social sciences as a component of transdisciplinary research, and advance interdisciplinary and transdisciplinary agendas, strengthening recommendations to managers and producers.

4. Advance regional and national scale initiatives and promote sharing of data and information to address important climate change issues.

5. Increase the REE agencies and FS R&D emphasis on:
   - Effects of climate on soil quality, agricultural product pricing and productive capacity (ARS and ERS);
   - Effects of climate change on ecosystem services (NIFA and ARS);
   - Impact of climate change on Native American communities, including impacts on first foods (NIFA, ARS, FS);
   - Understanding of uncertainty in ways that are meaningful and useful to decision makers and other stakeholders (all REE agencies and FS R&D);
   - Germplasm breeding programs, effects of climate variability on aquaculture and animal production, negative effects of invasive species, and climate effects on infectious diseases in humans, plants, and animals (NIFA, ARS);
   - Effects of GHGs on the value of environmental services (ARS, NIFA);
   - Emergent thresholds, tipping points, and phase transitions of landscapes under changing climatic conditions (FS R&D).

6. Provide access to research data repositories, and promote the integration of knowledge from diverse disciplines and fields of study.

7. Increase:
   - Collaboration with USDA regional Climate Hubs, including to assess the impact of climate change on food supplies and changes in consumption and pricing policies, and ensure that USDA Climate Hubs continue to build complementarity collaborations with NOAA RISAs, DOI CSCs, Bureau of Indian Affairs and Tribal entities, and other regional climate entities;
   - Collaborative grant planning and implementation efforts with NOAA, Department of Energy (DOE), DOI, and other federal climate and energy programs. Various departments are not generally aware of each other's strategic priorities and action plans, and do not see each other's Request For Proposals until they are released;
   - Collaborative relationship with NOAA Sea Grant extension programs.

1.2 — Strategy 2: Develop knowledge and tools to enable adaptation of agriculture, forestry, and grasslands to climate variability and to improve the resilience of natural and managed ecosystems and vulnerable populations.

1.2(a) Rationale

The Committee commends the Department's current work being done and coordinated across the various USDA agencies. However, while farmers are skilled at adapting to climate variability within historical ranges, those ranges are shifting at an unprecedented rate. Furthermore, efforts to characterize the dynamic relationships between climate systems and agriculture, forestry, and grasslands are relatively new. Researchers and educators are working hard with limited information and resource dollars to develop a baseline and useful data. These efforts have brought together some of the best and brightest talent within the USDA to work on and

explore the effects of climate variability and its environmental consequences. The establishment of the regional Climate Hubs has facilitated and accelerated this multi-agency collaboration.

1.2(b) Recommendations

1. NIFA's research agenda should focus on quantifying the effects of climate change and variability on both agricultural productivity and ecosystem services.

2. Various terms (e.g., "stakeholder") should be defined more clearly, so there is less confusion in gaining and presenting information.

3. All REE agencies and FS R&D should promote practical tools that producers can use to adapt to climate variability.

4. All REE agencies and FS R&D should develop knowledge and tools: 1) to enable agricultural, forestry, and grasslands to adapt to climate variability, and 2) to improve the resilience of natural and managed ecosystems and vulnerable populations.

5. All REE agencies and FS R&D should examine ways in which farmers, agricultural markets, and other stakeholders could respond to a new climate regime, including: 1) implications for increased variability, yield changes, pest problems, and shifting regional water balances, and 2) the role of agricultural research, development, and technology change in adaptation strategies.

6. All REE agencies and FS R&D should examine the economic, environmental, and land use implications of alternative policy and market-based approaches to enhancing agriculture's role as a key participant in efforts to reduce GHG emissions.

7. All REE agencies and FS R&D should build a collaborative relationship with state extension programs and colleges and universities.

1.3 — Strategy 3: **Develop knowledge and tools to enhance the contribution of agriculture, forestry, grazing and other land management practices to mitigate atmospheric GHG emissions.**

1.3(a) Rationale

All REE agencies and FS R&D have amply documented that their programs advance agriculture and natural resource science to minimize GHG emissions. Key research at ARS facilities to mitigate GHG emissions includes identifying management practices that reduce nitrous oxide and nitrogen emissions during application of fertilizer and manure, developing strategies to increase nitrogen use efficiency, and deriving information on field-level nitrogen cycling that can lead to GHG emission reductions. Additional ARS research pertaining to GHG emissions includes soil carbon storage, livestock production practices, and manure storage. Important outcomes from the NIFA-supported research include reducing nitrogen and carbon footprints in production systems, developing fertilizer guidelines that optimize GHG emissions, and identifying new production practices that reduce GHG emissions. ERS research focuses on the potential economic implications of alternative designs for conservation programs and other

market-based approaches for reducing GHGs and improving environmental quality. USFS R&D conducts research to increase carbon sequestration through restoration and silviculture treatments and develops support tools and strategies for decision makers and stakeholders.

The NAREEE Advisory Board sees great strengths in REE Action Sub-goal 2A, as evidenced by the above key mission area programs and findings/recommendations relative to GHG emissions. REE mission area agencies work collaboratively to accomplish goals, complementing each other's strengths in GHG mitigation while avoiding duplicative efforts. The emphasis in REE Action Sub-goal 2A on timely dissemination of information to end users, collection of feedback, and incorporation of stakeholder inputs into GHG mitigation programming is a notable strength.

Because of the complex relationships among production agriculture, GHG emissions, and other factors that determine adoption of mitigation strategies by producers, the NAREEE Advisory Board urges USDA to have a long-term strategy to meet the funding requirements for this REE Action Goal, as dictated by evolving stakeholder needs and project objectives. Based on the current REE and FS R&D climate change portfolio relative to GHG emissions, the Board identified certain critical areas where effort and funding are needed and makes the following recommendations to fill possible knowledge gaps.

1.3(b) Recommendations

1. Increase efforts toward meeting present and future workforce training needs to address climate change issues in general and GHG mitigation in particular.

2. Increase emphasis on strategic communication of compelling GHG data to key policy decision makers who may have different viewpoints about climate change.

3. Enhance collaborations between ARS and universities and increase NIFA grant awards to land-grant institutions to develop agricultural and land management methods, specifically to reduce GHG emissions.

4. Increase REE's intra- and extramural research efforts to mitigate GHG emissions through appropriate livestock production practices and to address emissions through long-term integrated systems research. Increase NIFA research to understand better animal physiology relative to GHG emissions from animal agriculture.

5. Increase emphasis by NASS on satellite-based research and development to provide data on GHG emissions associated with agriculture at local levels.

6. Explore novel methods to gather stakeholder inputs to help all REE agencies and FS R&D craft targeted programming to advance the GHG mitigation aspect of Action Goal 2A.

7. Increase attention to return on investments (ROI) by studying agencies' impacts on GHG mitigation. For example, extensive adoption by producers and other stakeholders of the tools and indices developed by ARS researchers is an indicator of how effectively the agency addresses users' needs.

8. Strengthen the economic impact component in ARS and NIFA programs. The crucial component missing in ARS and NIFA research is showing how GHG emission mitigation strategies impact farmers financially. It is imperative that economic-impact data accompany the research-based recommendations made on GHG mitigation strategies.

9. Increase emphasis on Life-Cycle Analysis of recommended alternative farming systems and strategies for GHG mitigation.

10. Establish criteria for defining robustness of input data and discriminating and selecting appropriate data sets for optimal functioning of ERS models. Validation of models via analysis of predicted vs. actual results may enhance ERS's contribution.

11. Increase ARS and NIFA emphasis on long-term integrated systems research related to GHG mitigation, since a typical project length or funding cycle (five years) will be inadequate to address questions due to complex relationships between production agriculture and GHG emissions.

12. Foster long-term expansion of databases such as GRACEnet to provide environmental services that can assist in assessing GHG emissions.

13. Develop a strategy to address ERS's challenge of obtaining appropriate response data in light of the increasing complexity of large farm operations.

14. Invest more in basic research on soil organic matter, holistic animal health, and crop rotation, and their relationships to GHG emissions.

15. Allow limited duplication of ARS and NIFA sponsored research on GHG mitigation to generate reliable data through rigorous and reproducible long-term experiments.

1.4 — Strategy 4: **Provide information and tools to USDA agencies, stakeholders, and collaborators to improve decision-making.**

1.4(a) Rationale

Climate variability influences agricultural production and sustainability, global food security, and social and political policy discussions. It is difficult to conceive of any agencies, either intramural or extramural to USDA, and associated entities, judicial policy makers, or producers, who are not direct stakeholders relative to climate variability.

REE agencies and FS R&D offer varying levels of strategic trans-agency technology transfer supporting Strategy 4. NIFA focuses on developing and delivering adaptation practices that contribute to adaptation and mitigation of human-induced climate variability, and delivers relevant information and tools to other internal and external agencies and end users. The NIFA funding of land-grant universities—as well as other public research institutions, NGOs, and to a limited extent private companies—leverages these funding partners to produce relevant, viable, and research-based technology transfer. FS R&D on disturbance effects is focused on enhancing ecosystem health and sustainability through mitigation and adaptability. The ARS has targeted

programs at climate change adaptation and sustainable production, is currently reviewing past objectives, and will begin planning the next cycle of adaptation research.

ERS research provides insight into how producers, agricultural markets, and trade might respond to climate variability, as well as to agricultural and energy policy options, public and private investment in R&D, ecosystem markets, and conservation programs with implications for GHG emissions. In support of its research, ERS collaborates with other USDA agencies to develop and expand a suite of models and data resources. NASS has perhaps the greatest influence on Strategy 4 across all internal and external REE agencies and other stakeholders. It has strong ties to the USDA Climate Hubs and robust satellite-based information gathering systems to monitor crop, soil, yield, and GHG conditions and changes linked to climate variability.

As significant partners in the development of the regional Climate Hubs, ARS and FS R&D provide leadership positions in 10 Hubs and use them to identify stakeholder research needs and to deliver research results to stakeholders. The Hubs are a critical bi-directional conduit for disseminating research results to regional partners and stakeholders and for external input back to ARS. Numerous examples exist of how ARS-coordinated research and data efforts around climate change have been used and resulted in positive documented impacts. One ARS product, Technical Bulletin 1939 (*Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory*), has been downloaded more than 600,000 times since its release in July 2014. Stakeholders have requested more information from ARS on the application of the bulletin's science. ARS has worked collaboratively with NRCS in implementing the methods within the COMET-FARM and COMET Planner decision-support tools. Tools such as the Haney Test and NLEAP to improve nutrient management and reduce related emissions; tools for evaluating soil health and condition; and standardized methods for measuring soil carbon and GHG fluxes are seeing widespread adoption and use by collaborators and stakeholders. ARS has an active Twitter presence, with 13.3K followers. NIFA also uses Twitter effectively, with 16.6K followers.

NASS receives stakeholder input through at least one annual data user meeting focused on chemical use statistics and an additional meeting focused on the crop and livestock production statistics program. Data user meetings annually collect crop production statistics that can be used to assess climate-caused change. NASS data are made available to a wide variety of stakeholders. NASS also receives ongoing feedback from data users via an elegant survey instrument through its website. Of the REE agencies, NASS has the largest number of followers on Twitter at 28.7K.

ERS analysis also includes economic, environmental and land use implications of alternative policy and market-based approaches to increasing agriculture's role as a critical partner in the reduction of GHG emissions. The agency has processes and systems to ensure that all components of the program stay relevant and that they provide high quality, objective products. ERS has 24.5K followers on Twitter.

FS R&D focuses on quantifying anthropogenic causes, disturbances, and threats from climate change. The FS contributes to the USGCRP need for science to support development of the *National Climate Assessment* and *State of the Carbon Cycle Report*. FS research utilizes Climate Hub connections to collect stakeholder information.

All USDA agencies, in some fashion, have strong collaborative efforts with land-grant universities and other institutions, leveraging results and data for optimal stakeholder accessibility. In theory, this leverage should result in a substantial positive behavioral change in producers and other end users. The measurement of these changes has recently received more appreciable focus, primarily through expectations of targeted grant outcomes in agency and university outreach collaborations.

1.4(b) Recommendations

1. Require grant recipients to formulate a communications plan for policy makers to strengthen science-based decisions by policy/political stakeholders.

2. Increase surveys of end users' perception of data/results availability, adoption of research-based information, and meaningful impact assessment on a larger-scale accountability metric.

3. Support basic research on soil carbon sequestration through cover crop mixes, integration of grazing into row crop production, long-cycle crop rotation, and the feasibility/profitability of integrated farming systems in comparison with specialized agricultural production.

4. Continue to support NIFA's collaboration with NOAA's Sea Grant and Regional Integrated Sciences Assessments programs through joint climate extension programs, and the agency's collaboration with DOI CSC programs through joint climate research, education, and outreach programs.

1.5 Adequacy of Funding

Adequacy Review Process
The NAREEE Advisory Board assesses the adequacy of funding to implement the programs by applying the following question: *Is the funding of this Action Goal adequate to achieve its specific goals and how has its investment accomplished these?*

To aid the NAREEE Advisory Board in its assessment of the adequacy of funds for Climate and Energy Needs research, the OCS provided a summary of REE agency funding by program area. Specific details of REE agency funding were found in the 2016 USDA Budget Explanatory Notes for Committee on Appropriations. Summaries were provided for the Animal and Plant Health Inspection Service, FS R&D, NRCS, CCPO, FSA, RMA, and USDA Climate Hubs, all non-REE agencies that play a role in coordinating USDA outreach. Funding levels for climate change were provided by USDA's Office of Budget and Performance Analysis as part of a budget crosscut analysis. Bioenergy funding levels were provided by the agencies. A short synopsis by each agency provided important details about the programs.

ARS climate change funding increased from $38.306 million in FY 2014 to $41.564 million in 2015 and is estimated at $45.844 million in 2016. The funds were distributed over four broad research areas, including global carbon cycle, global water cycle, ecosystem changes, and regional and sectorial impacts of climate change. This included funds received by ARS to support the USDA Climate Hubs in the amount of $2.209 million in 2014, $3.470 million in 2015, and $5.470 million in 2016.

ERS allocated $1.865 million in FY 2014, $0.950 million in 2015, and $2.200 million in 2016 to fund its climate change program.

NASS received $0.8 million in FY 2014, $0.981 million in 2015, and $0.750 million in 2016 to integrate the use of remote sensing to measure climate change impacts on agriculture.

NIFA's Agriculture and Food Research Initiative funding for climate change programs was $42.792 million in FY 2014, $20.405 million in 2015, and $15.339 million in 2016. When NIFA's other funding is added into the total budget, NIFA's funding for climate-related programs was $96.989 million in 2015.

FS climate change funding was $22.669 million in FY 2014, $23.747 million in 2015, and $24.736 million in 2016. The FS provided $2.477 and $3.300 million for Climate Hubs in FY 2015 and 2016, respectively. The FS does not believe funding has been adequate to address research goals or to sufficiently support science delivery though the Climate Hubs.

CCPO received funds of $1.994 million in FY 2014, $1.998 million in 2015, and $2.051 million in 2016. Additionally, CCPO received $0.5 million in 2014, $0.667 million in 2015, and $0.5 million in 2016 to support Climate Hubs.

Adequacy Recommendations

For many USDA programs, budget allocations are often in flux, making multi-year planning and investment difficult. This has a negative effect on long-term planning for the research needs of agriculture. Few agricultural projects are short-term or easily solved by a one-time allocation or even with a one-to-three-year commitment. The change in executive administration will make the budget planning process even more complex, with multiple allocation choices made between agencies and projects. If instructed to reduce budgets, it will be critically important that agencies work with their stakeholders and partner agencies to determine the highest priorities for diminishing resources. Increased collaboration and communication will be key for maintaining key projects and priorities. Informing the new Secretary of Agriculture and key departmental staff on stakeholder priorities will be vital to solving the climate- and energy-related needs of agriculture and natural resource management.

The NAREEE Advisory Board offers the following recommendations by strategy, for Action Plan Goal 2A:

1. <u>Climate Strategies 1 and 2:</u> NAREEE recommends that more funding be provided for:

   - Expanded staffing and infrastructure for storage and serving of large research datasets for managers, producers and researchers (ARS, NIFA, ERS, NASS, FS R&D).
   - Expanded travel for collaboration with universities and industry (ARS, ERS, NASS).
   - Staffing for research and service programs (NASS).
   - Expanded research programs on consumer behaviors and industry pricing (ERS).
   - Expanded long-term, decadal research (NIFA).
   - Expanded funding for delivery of new knowledge to managers and producers (USDA Climate Hubs, NIFA, ARS, NAS, ERS, FS R&D, NRCS).

2. Climate Strategy 3: The NAREEE Advisory Board feels strongly that funding has been inadequate for accomplishing the research goals pertaining to the GHG emission component of the Action Plan. Budget reductions have negatively impacted NIFA's ability to develop long-term solutions for mitigating GHG emissions. The Board recommends that more funding be provided for:

    - Research and education on the global carbon cycle and GHG mitigation.
    - FS research on strategies to increase carbon sequestration and carbon stocks through agroforestry and land management.

3. Climate Strategy 4: Stakeholder in its broadest definition is "*a person with an interest or concern in something*". Climate variability, also in its broadest interpretation, influences agricultural production and sustainability, global food security, and social and political policy discussions. It is difficult to conceive of any agencies, either intramural or extramural to USDA, and associate entities, judicial policy makers, or producers, who are not direct stakeholders relative to climate variability.

The NAREEE Advisory Board believes that funding is adequate for both intra- and extramural current technology transfer and data sharing. Additional funding would allow increased data sharing between agencies and between agencies and stakeholders, thereby increasing the capacity for REE agencies to jointly address climate-related issues.

Sub-goal 2B. Bioenergy/Biofuels and Biobased Products

Introduction

USDA and Biomass Production

Over the past several decades a variety of agriculture, forestry, energy, and other stakeholders have articulated a clear need for the United States to invest in fuel resources in addition to traditional fossil fuels. USDA has responded to this development with various programs because alternative fuels and a thriving bioeconomy would support the U.S. economy in general and the agricultural and forestry sectors in particular.

In coordination with DOE and other relevant federal agencies and private organizations, USDA invests in developing new research, education, extension, and economic strategies to support global agricultural innovation aimed at achieving energy efficiency and independence. These investments cover many elements of innovation needed to fully realize the bioeconomy goals. Among the diverse array of USDA's biomass-related endeavors are the ARS Biorefining Program, NIFA-supported Bioeconomy, Bioenergy, and Bioproduct projects, FS R&D, and many others. USDA efforts focus on integrating economically, environmentally, and socially sustainable regional-based biomass production systems into existing agricultural and forestry as the United States expands its development of more sustainable fuel resources.

USDA's Strategic Plan has incorporated goals and objectives directed at contributing to expanding the bioeconomy in the agricultural and forestry sectors. R&D conducted in this area

addresses the uncertainties of expanded biomass and biofuel production to achieve benefits and avoid negative impacts on rural communities, economies, ecosystem services, and the production of food, feed, and fiber. Much of the data generated will enable the economic, social, and environmental benefits and impacts of biofuel production and bioenergy-related policies to be understood and modeled.

Specific strategies in the REE Action Plan supporting this goal area include:

1. Increase biomass production efficiency to reduce production and biorefinery costs: conduct biomass plant improvement research and development to provide feedstocks for advanced biofuels and biobased products. Develop and apply understanding of the molecular basis for key plant traits and improving germplasm and varieties for energy crops. Develop regional-based sustainable new feedstock production systems for bioenergy feedstocks. Develop feedstock logistics and conversion technologies suitable to near-farm scales.
2. Incorporate biomass and dedicated feedstock crops into existing agriculture, forestry, and agroforestry-based systems to increase diversity of the rural economy and sustainable land management.
3. Address the uncertainties of expanded biomass and biofuel production to achieve benefits and avoid negative impacts in rural communities, economies, ecosystem services, and the production of food, feed and fiber. This includes developing biophysical models and polices, and providing a statistical information base and analytical capacity.

BRDI-TAC

In conducting its review, the R&A Committee learned about the efforts of the Biomass Research and Development Initiative (Initiative) Technical Advisory Committee (BRDI-TAC), which is coordinated by the BRDI Board (Board). The Board is an interagency collaborative composed of senior decision makers from federal agencies and the White House, co-chaired by the USDA and DOE. USDA and DOE annually implement the Initiative, which consists of grants made available through the Food and Conservation Energy Act of 2008, Section 9008, and other programs. The BRDI-TAC is an independent body that provides input to agencies regarding the technical focus and direction of the Initiative.

During its deliberations, the R&A Committee considered the recommendations from the BRDI-TAC in the recently released Billion Ton Bioeconomy Initiative (Bioeconomy Initiative) to highlight the potential for a stronger U.S. bioeconomy, specifically some of the impacts of increasing biomass utilization threefold by 2030. The goal of the U.S. Bioeconomy Initiative is to develop innovative approaches to overcoming barriers in order to expand the sustainable use of America's biomass resources and maximize economic, social, and environmental outcomes. The Committee also considered recommendations from the BRDI-TAC 2016 Recommendations released in December 2016. The group evaluated the recommendations found in Appendix B of this report.

Recognizing the importance of the BRDI efforts, a key recommendation resulting from the Committee's R&A review is for REE to provide a full briefing to the new USDA Secretary and key staff on USDA programs and efforts of the BRDI Board and the U.S. Bioeconomy Initiative. Ultimately, such coordination will contribute to developing a clear path forward for successful

biomass private-public partnerships that will allow for companies to minimize risk and maximize ROI, provide an improved footprint for the environment, and make a positive impact on the economy.

REE and Biomass
The REE role under Action Plan Sub-goal 2B is to develop and deliver science-based knowledge through research, education, extension, and economic strategies that support the growth of the bieconomy in the U.S. agricultural and forestry sectors.

2.1 — Strategy 1: **Increase biomass production efficiency to reduce production and biorefinery costs; conduct biomass plant improvement research and development to provide feedstocks for advanced biofuels and biobased products. Develop and apply understanding of the molecular basis for key plant traits and improving germplasm and varieties for energy crops; develop regional-based sustainable new feedstock production systems for bioenergy feedstocks; and develop feedstock logistics and conversion technologies suitable to near-farm scales.**

2.1(a) Rationale

The potential benefits of an expanded U.S. bioeconomy, including to efforts aimed at effectively addressing climate change impacts, have been widely recognized, Working with diverse federal and private-sector partners, REE agencies provide support for the United States' endeavor to create a robust bioeconomy with a variety of product offerings. But the greatest threat to the U.S. agricultural system that would prevent new market entrants and cause existing members to leave the market in biofuel production and harvest is population growth and the increased demand for food. Lack of water and arable land for biofuel production are the foremost considerations with the technology available today, as biofuels must compete against food crop production for space and resources to feed a growing population. Demand for food and water will increase, and may outweigh the demand for biobased fuels, when so many substitute goods are available to perform the same function. However, it must be noted that increased food production will result in more agricultural residues, which are the primary feedstock targeted for biobased energy and non-food products, a dynamic that could allay some of the concerns about competition. Additionally, USDA support for research into landscape design could maximize food and energy feedstock production while minimizing negative impacts to water and soil and reducing fertilizer inputs per ton of production.

As touched on above, the next greatest threat to support for biofuels research is clear: substitutes. As biofuels are simply a substitute for fossil fuels, the converse is also true. The market will decide whether or not to support further harvest, production, and refinement processes. Biofuel support will wither if it cannot compete against easily accessible, plentiful, reliable, and low-cost fossil fuels, natural gas being the most likely competitor. However, byproducts of biofuel processes may in many cases provide economic benefits greater than the biofuel itself. According to the USDA BioPreferred program, key findings from the "Economic Impact Report by the U.S. Biobased Products Industry", in 2014 the bioeconomy added 4.2 million jobs with a 2.76 multiplier effect and added $393 Billion to the U.S. economy.

Without solid economic data to back the progress made on biofuel research, market support for these programs will remain weak. Without support of the free market, the U.S. agricultural

community will reject biofuel crops, as government mandates and subsidies alone cannot support the system.

2.1(b) Recommendations

1. The NAREEE Advisory Board recommends that REE create a feedstock-to-fuels pathway mapping the approaches that have the potential to meet cost-effective targets. REE agencies should then align their collective efforts with those of DOE to allow the private free market to design the system(s) that best serve the need.
2. The Board recommends that REE work with the DOE to provide evidence-based analyses through which projects can demonstrate improvements to the supply chain. These specific areas include: reducing water and land use necessary for feedstock harvest; increasing retainable energy yield; transforming disparate feedstock supplies into uniform raw fuel supplies for refinement; enhancements to refinement that reduce waste and lost energy; landscape design to maximize food and energy feedstock production while minimizing negative impacts to water and soil and reduce fertilizer inputs per ton of production; and improvements to the distribution network that leverage the cost effectiveness of large-scale production at the regional level. ERS could assist the DOE by designing models to compare and determine the validity of project results.
3. The Board recommends the establishment of an industry steering committee with existing fossil fuel and renewable energy producers to identify barriers to the market. As most bioproducts are going to be additives to the primary fuel supply, it is imperative to an efficient and cost-effective supply chain that the products be used seamlessly and priced appropriately by the marketplace.
4. The Board recommends the continuation of coordination efforts with DOE and the BRDI-TAC to check alignment with broader agency and policy goals.

2.2 — Strategy 2: **Incorporate biomass and dedicated feedstock crops into existing agriculture, forestry, and agroforestry-based systems to increase the diversity of the rural economy and sustainable land management.**

2.2(a) Rationale

Research in biomass and bioenergy development has brought together eight different government departments and agencies that are targeting key areas for future research, education, and extension programming, together highlighting opportunities to incorporate biomass and dedicated feedstock crops to enhance the rural economy and sustainable land management systems. As a result of the federal agency team effort, several key research, education, and extension programming findings were made regarding biomass and bioenergy with regard to the rural economy.

When assessing the proposed development of a biomass and bioenergy sector for sustaining and increasing the robustness of rural economies, one must measure the strengths and limitations of the proposal. One of the strengths of this proposal is that it increases sustainability by providing domestic renewable energy, brings jobs to rural areas, specifically targeting the

Midwestern region; it also incorporates partnerships of government and private-sector stakeholders. The long-term strengths include a diverse energy supply stream in domestic markets, long-term U.S. security with a decrease in price volatility in biofuel markets, enhanced land use, and a reduction of GHGs.

Along with these advantages, potential limitations exist. One should consider the increase in costs of feed for livestock, which could result in an increase in meat and dairy prices to consumers as an unintended consequence. Furthermore, as the demand for biomass machinery goes up, the costs to other industries for machinery and equipment could increase as well. Another consideration is that prices received for crops used in biomass may influence prices paid by producers for seed; producers may respond by changing what they plant. Additional considerations are that production of biomass and bioenergy may be geographically isolated. Distribution of fuels and adaptation/compatibilities of those fuels and their use by consumers may present a challenge. Information will be key.

2.2(b) Recommendations

1. The Board recommends that REE require the use of new scientific and technological approaches from academia and laboratories; engagement with multiple partners can accelerate ideas and lead to success. REE should continue to consider a consortia approach that would include ARS catalyst experts in DOE-funded projects such as the ChemCatBio consortium to evaluate and accelerate catalyst improvements.

2. The Board recommends that REE conduct an assessment of long-term market-oriented R&D in bioenergy technology based on partnerships and collaborations between government and industry in order to enhance the rural economy and promote job growth, innovation, and investment.

3. The Board recommends more R&D on biomass-based (transportation) fuels that are environmentally sound and cost-competitive using the adoption and commercialization of the best technologies available. In order to achieve this goal, REE should encourage the integration of bioproducts into the biofuels production at the biorefinery level. REE should partner with DOE to help integrate the focus on bioproducts, with an emphasis on biofuels, by sharing data and designing Funding Opportunity Announcements (FOAs) in a more collaborative manner.

4. The Board recommends that projects include an annual performance measurement component to evaluate the performance of biomass technology and its success in job creation, education and workforce development, and economic revitalization.

5. The Board recommends that USDA pursue R&D to enable domestically grown biobased products that have highest potential to create jobs and improve economies.

6. The Board recommends increasing the exchange of information between DOE, USDA, and existing and emerging partnerships about sustainable, domestic bioenergy supplies to improve market efficiencies and redirect under-performing projects.

2.3 — Strategy 3: Address the uncertainties of expanded biomass and biofuel production to achieve benefits and avoid negative impacts on rural communities, economies, ecosystem services, and the production of food, feed, and fiber. Develop biophysical models to evaluate

the impacts of commercial-scale bioenergy feedstock production systems and policies on long-term productivity and other ecosystem services provided by underlying natural resources. Develop the statistical information base and analytic capacity to understand and model economic, social, and environmental benefits and impacts of biofuel production and bioenergy-related policies.

2.3(a) Rationale

Even with the significant challenges facing the development of a successful bioeconomy, there are many reasons to be optimistic. If the commitment to this sector could be realized, there are many possibilities to add tremendous value to optimize energy and sustainability policies and practices. The BRDI discusses several exciting opportunities, and although at present the challenges seem particularly daunting, thought-provoking innovation and investment could lead to several positive outcomes:

1. Potential to reduce cost and technology risk in the supply chain
2. Possibility to develop low-cost waste resources
3. Increase opportunities and choices to participate in sustainability business practices
4. Contribute to a sustainability framework that considers multi-dimensional impacts and benefits from the use of biomass and communicates these benefits
5. Increase public education about biomass-derived products
6. Develop bioproducts whose economic potential can accelerate biofuel production
7. Continue to expand the market potential for biomass by forecasting market swings to better prepare U.S. producers to invest appropriately
8. Increased private-sector investment and private-public partnerships
9. Support a new and significant job sector, potentially in rural areas

The R&A Committee found that there are a number of limitations creating challenges to the successful development and long-term sustainability of a bioeconomy. The Committee agrees with the BRDI-TAC that "some regulatory and policy issues impede the growth of the bioeconomy." The Committee also feels that ROI has always been the challenge for all biofuels. Although innovation and research have made it possible to utilize technologies to produce fuel and energy from multiple bio-produced feedstocks, current technologies are challenged to do so at an economically competitive price.

These challenges notwithstanding, there are tremendous opportunities for the private sector to increase its sustainability efforts in the bioenergy field. The implementation of successful projects will provide the blueprint, modeling, and confidence to inspire more companies to invest. Investment and continued success will create the momentum and stimulate innovation.

Based on the R&A Committee's observations regarding the important potential for a thriving U.S. bioeconomy together with the concerns that have been raised, the following recommendations encourage USDA to support the biomass industry in preparing for success by integrating the three components of sustainability that take into consideration economic viability, environmental quality, and social needs:

2.3(b) Recommendations

1. The NAREEE Advisory Board recommends that REE explore the unintended consequences of an expanded biomass industry and conduct a welfare and impact analysis of the sustainable use of domestic biomass resources, as well as the impacts of increasing uses of renewable plant materials and waste feedstocks for biofuels, bioproducts, and biopower.
2. The Board recommends that REE consider targeted or joint FOAs to encourage the use of agricultural residues, non-recyclable municipal solid waste, and/or biosolids.
3. To make biomass viable, the NAREEE Advisory Board recommends that USDA evaluate biobased products and determine where gaps are in the analysis, then focus the Department's effort on these gap areas.
4. The Board recommends that USDA enhance its robust statistical information base and the analytic capacity to understand and model economic, social, and environmental benefits and impacts. The NAREEE Advisory Board recommends building capacity with new and untested economic templates.

2.4 — Adequacy of Funding

Adequacy Review Process
As with the NAREEE Advisory Board's review of the funding adequacy for Action Plan 2A, the following question was applied in reviewing funding for Action Plan 2B: *Is the funding of this Action Goal adequate to achieve its specific goals and how has its investment accomplished these?*

For much of the last decade the U.S. economy has paid a substantial economic price for relying predominately on fossil fuels. Unstable crude oil prices and the reliance on imported energy dictated a policy that looked for alternative liquid fuel sources and feedstocks. Public dollars were focused on new research seeking innovative solutions. But with recent discoveries of vast fossil fuel reserves within the borders of the United States, combined with new technologies that increase the recovery of existing supplies, the political and public policy desire to fund research in new feedstocks declined and, with it, research funding.

Funding for all agricultural research in the United States from all sources, including federal and private, is woefully inadequate. Of great concern to the R&A Committee, however, is that the 'adequacy' of funding noted by the agencies actually reflects a diminishing capacity to meet future needs. Both the adequacy of funding relative to the anticipated needs, as well as the science-based assessment of emerging and innovative technologies with promise for more rapid advancement, now need to be more rigorously evaluated.

Additional funding is needed to continuously reduce the gaps among scientists and those working in agriculture and renewable energy systems, and to meet the pressing need to maximize and disseminate innovative approaches to build our national energy supply. In the current constrained-funding context, REE faces the difficult choice of reallocating funds among important and competing priorities. Constrained resources will adversely impact REE's ability to meet its full mission in applying knowledge to develop renewable energy sources.

Adequacy Recommendations

1. The NAREEE Advisory Board recommends the funding for BRDI be reauthorized.

2. The Board agrees with the BRDI 2015 recommendation to “fund and manage a greater number of smaller R&D projects to establish a balanced R&D portfolio that will identify disruptive technologies offering the greatest opportunities for cost reduction”

3. The Board agrees with the BRDI 2016 recommendation to “Expand R&D to reduce feedstock, capital, operating costs, and risks: support efforts to increase yields, improve efficiencies, and innovate around bottlenecks.”

Report Developed by the Climate and Energy Needs Relevancy and Adequacy Committee, a subcommittee of the NAREEE Advisory Board

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APPENDIX A —Evaluative Process and Questions

NAREEE has developed a process for conducting the annual R&A assessment. Each year the Board conducts an R&A assessment on one of the six major goals of the REE Action Plan. In 2017, the R&A review is focused on Action Plan Goal 2, *Responding to Climate and Energy Needs*. This goal includes Sub-goal 2a, *Responding to Climate Variability,* and Sub-goal 2b, *Bioenergy/Biofuels, and Biobased Products*.

The Board uses a set of six evaluative questions to assess: 1) the relevance of REE programs to the stated Action Plan Goal, and 2) the adequacy of funding to implement the programs, as follows:

1. What are the key research, education and extension programs and their specific goals for this REE Action Goal(s)?
2. What documented client/stakeholder needs are being addressed by the programming for this Action Goal(s)?
3. Is the research, education, and extension for the Action Goal(s) advancing agricultural and/or natural resource science and its application? [Address strengths and limitations in answering this question.]
4. Is the funding of this Action Goal(s) adequate to achieve its specific goals and how has its investment accomplished these?
5. What does this Action Goal(s) need to do to address remaining gaps between the activities and accomplishments, evolving stakeholder needs, and the current state and application of agricultural science?
6. Is there complementarity and collaborative effort across REE in terms of intramural, extramural, and infrastructure funding and short- and long-term research, education, and extension that does not duplicate effort in REE or other federal efforts?

APPENDIX B — Biomass Research and Development Technical Advisory Committee 2016 Recommendations

The R&A Committee also considered recommendations pertinent to the R&A review from the BRDI-TAC 2016 Recommendations released in December 2016. The R&A identified the following excerpted recommendations from the BRDI-TAC as the most relevant to the work of the R&A review. To see the full BRDI-TAC report, please visit: [https://biomassboard.gov/pdfs/tac_2016_q4_recommendations.pdf].

The R&A Committee makes the following additional recommendations for further improving BRDI:

- *The goals of BRDI are important to the Billion Ton Bioeconomy Initiative supporting job creation, rural development, and national security. This importance should be reflected in meaningful funding levels. If the nation places a high priority on accelerating the development of a secure biobased economy, BRDI will require appropriations that are similar to what was provided prior to the funding cuts (from the previous $40 million annually) implemented in December 2012. Even after combining the appropriations from two fiscal years (summing to $6 million), BRDI could fund only five awards out of 414 applications. BRDI represents an important translational portion of the federal research portfolio, and $3 million annually will limit the progress of basic research toward strategic applications.*

- *2017 will be the last year of BRDI funding unless it is reauthorized. The R&A Committee recommends that funding for BRDI be reauthorized.*

- *BRDI should document how projects have impacted the commercial state of technology and the bioeconomy to better publicize the successes of the BRDI projects.*
    - *As per the Biomass Research and Development Act [§(e)(2)]: "The objectives of the Initiative are to develop*
        a. *Technologies and processes necessary for abundant commercial production of biofuels at prices competitive with fossil fuels*
        b. *High-value biobased products*
        c. *A diversity of economically and environmentally sustainable domestic sources of renewable biomass for conversion to biofuels, bioenergy, and biobased products."*

- *The R&A Committee recognizes the planned efforts to streamline the application submission process. The Committee suggests that BRDI continue to reduce the time from proposal submission to award selection.*

Under 1. *Recommendations To Improve Profitability and Commercial Viability of Bioeconomy Industries:*

- *Expand R&D to reduce feedstock, capital, operating costs, and risks; support efforts to increase yields, improve efficiencies, and innovate around bottlenecks.*

- *Use existing and new programs focused on de-risking technologies and feedstock production.*
    - *Leverage existing USDA and DOE programs, such as crop insurance and BioPreferred programs, and develop new programs in order to incentivize private investment and financing for feedstock supply.*

- *Enhance the ability to implement sustainable landscape design by emphasizing low carbon-intensive crops and further considering nutrient and land-management best practices.*

- *For commercial-scale systems, breakthrough technologies are needed to reduce capital and operating costs.*
    - *The Billion-Ton Bioeconomy will require novel and disruptive technologies to be commercially successful, but too little is known about specific future breakthroughs. A request for information (RFI) on novel and disruptive technologies is advised by the Committee; that is, the R&A Committee recommends that the BRDI Board release an RFI (or similar mechanism) to solicit new information on these technologies and work with the Committee on future R&D areas for consideration.*
    - *Better enable the approval and certification process of bio-replacements, either direct replacements or functional replacements (i.e., American Society for Testing and Materials). This can be done through better standardization of requirements across the value chain.*

- *Create a new formal network with an open-access environment to build upon and share knowledge, services, facilities, and capabilities to support the growth of the bioeconomy.*
    - *Leverage existing information and networks such as the Biotechnology Innovation Organization, Agricultural. Technology Innovation Partnership, and Biomass Board reports.*

Under *2. Recommendations To Develop and Support Market Drivers of the Bioeconomy*

- *Support actions that enhance the growth of the bioeconomy, such as implementing the Renewable Fuel Standard mandate; increasing federal funding for research; incentivizing use of bioproducts and biofuels; and expanding the BioPreferred Program.*

- *Focus research on areas where we know the market is ready to accept and promote bioproducts/biofuels as they are available. Support initiatives for product and market development.*

- *Create a global feedstock commodity market by identifying and promoting exports of feedstocks, biofuels, and bioproducts where market conditions are more favorable.*

Under *3. Recommendations To Stimulate Public Awareness and Support*

- *The bioeconomy requires a value proposition that is better understood and embraced by the public. Conduct analysis to determine a framework to characterize and quantify the job creation, economic, rural development, public health, national security, and environmental benefits of the bioeconomy.*

- *Improve the science and understanding of indirect land use change.*

- *Assess the economic effects, such as wealth and job creation, rural development, and resource and supply diversity.*