

# BERAC Subcommittee on International Benchmarking: Current Status and Future Steps

Fall BERAC Meeting  
October 21, 2021

# Charge letter questions to BERAC

- Within the BER-supported topical research areas and facility capabilities, in which areas and capabilities, presently or in the foreseeable future, does BER lead in the international community, and in which areas does leadership require strengthening? In identifying these areas, please consider their critical mission relevance, recent history, the status quo, observable trends, and evidence-based projections.
- Are there key international partnerships that could strengthen BER science output and increase global visibility of BER?
- To preserve and foster U.S. leadership with resource constraints, is there a preferred optimization for organizing research, collaboration, and funding mechanisms among labs, universities, and other federal agencies? Are there other key efficiencies and balances that should be considered and modified to improve U.S. leadership in BER research areas?
- For someone deciding whether to pursue a scientific career, or a mature scientist considering whether to stay in the U.S., how can BER programs and facilities be structured and managed to create incentives that will attract and retain talented people? What are the key opportunities for BER in attracting and enhancing careers in BER-supported science?

# A BESAC subcommittee responded to a similar charge

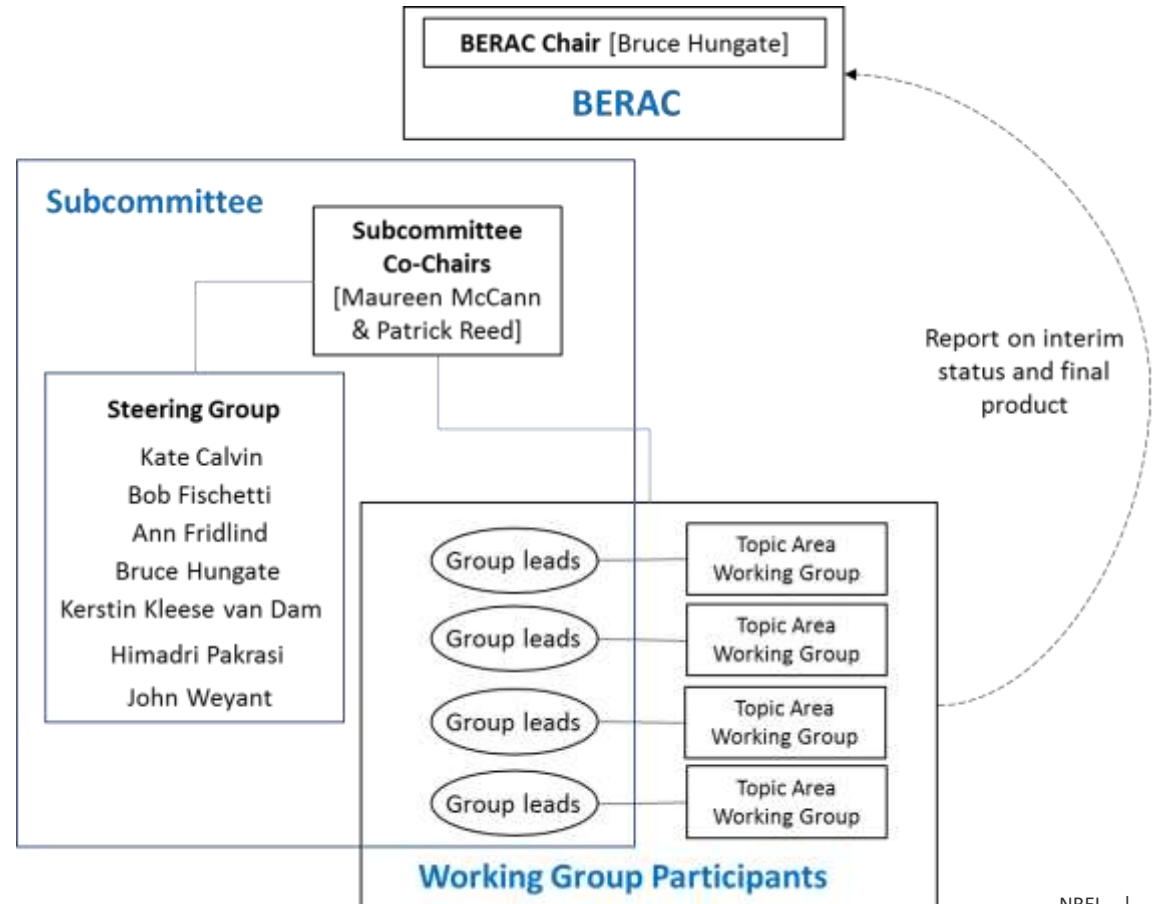


- BERAC’s charge is similar but not identical
- We benefit from BESAC’s thoughtful approach to metrics
- Report contains 9 compelling case studies

Story	Tools and facilities	Subject	Benchmarking message
A Testbed for Secure Quantum Communications	Argonne	Physics	The basic science of creating and controlling entanglement over long-distances, pertinent to quantum communications, with implications for how we think about both information and security; an instance where China and others are investing heavily.
Creating the chemistry for better, smarter materials	LBL	Chemistry	Fundamental science to address looming environmental and supply challenges
Catalyzing a U.S. Manufacturing Revolution	Argonne	Materials	Fundamental research and technology transfer. Talent retention. Facilities availability.
Building a better battery for clean energy storage	LBL, ALS, novel tool	Chemistry	Coordination between national labs and the university-based innovation ecosystem yields both good basic science and economically promising ventures.
Transforming Structural Biological Science and Biomedicine	SLAC, XFEL, LBL, international	Chemistry	Strategic planning of basic science facilities by DOE and broad international collaboration are yielding fundamental new insights and, potentially, new sources of clean energy.
How Data-Driven Science Is Helping Combat the COVID Crisis	Cryo-EM, Machine learning	Chemistry	How DOE investment in basic tools and international collaboration can result in life-changing outcomes. And the emergence of data-driven science and AI/ML as an important basic research methodology.
Competitiveness in Quantum Materials		Materials	Demise of big industrial labs (Bell labs, etc) exposed US weakness in materials synthesis forcing reliance on foreign supplies, until a shift in the culture of physics departments resolved the problem.
Worldwide competition for talent	LBL, user support for soft neutron research	New tools	US can no longer take the international competition for talent for granted
Why Long-Range Planning is Critical to U.S. Competitiveness	SLAC, XFEL, LBL, international	Chemistry	Strategic planning of basic science facilities by DOE and broad international collaboration are yielding fundamental new insights and, potentially, new sources of clean energy.

# Subcommittee and Working Group (WG) structure

- 6 Science Topic areas (~8 report chapters)
- 9 Steering Group members
- 18 Subcommittee members
- 46 working group members and authors



# Report outline – Science Topics and WG co-leads

- 1. Introduction:** Patrick Reed (Cornell Univ) and Maureen McCann (NREL)
- 2. Biodesign:** Himadri Pakrasi (Washington Univ – St Louis), Kristala Jones Prather (MIT) and Huimin Zhao (Univ Illinois – Urbana-Champaign)
- 3. Bioenergy:** Brian Davison (ORNL) and Crysten Blaby (BNL) *Plus Maureen McCann*
- 4. Environmental Science:** Margaret Torn (LBNL) and Michael Gooseff (Univ of Colorado) *Plus Patrick Reed*
- 5. Climate Science:** Kate Calvin (PNNL) and Jerry Meehl (NCAR) *Plus Ann Fridland*
- 6. Enabling Infrastructure:** Bob Fischetti (ANL) and Kerstin Klesse van Dam (BNL)
- 7. Integrative Science (Innovation in Integration):** Ann Fridland (NASA), Allison Campbell (PNNL, retired) Gary Stacey (Univ Missouri) and John Weyant (Stanford)
- 8. Conclusion:** Pat, Maureen, and All

# Chapter outline

- Overview of the scope and scale of the BER research area
- Discuss selection of international comparators for the area, and any additional metrics used beyond the consensus set
- What trends are revealed by quantitative metrics? What impressions are given by interviewees of leadership and past performance?
- Two or three compelling case studies in selected focus areas for illustration
- What can be projected from the trends? What do thought leaders perceive as future opportunities for BER international leadership?
- Identify potential international partnerships, suggestions for optimal organization of the research enterprise, issues of talent recruitment and retention
- Evidence-based recommendations
- References

# General approach to metrics

Our goal is to benchmark performance in the last decade and to be generative for BER's strategy in the next decade with **actionable** recommendations.

- **Quantitative metrics** (e.g., bibliometric data, conference analysis): used for benchmarking BER's practices, structures, protocols and resource investment, products and outcomes
- **Qualitative metrics** (e.g., responses to interview questions): used for assessing the potential for international leadership in the next decade

Three important elements of the report: (1) BER products and their relative impacts as compared to other US and broader international programs; (2) compelling stories/case studies of success or missed opportunities; and (3) a forward-looking perspective recommending opportunities to enhance BER's leadership over the next decade.

# Bibliographic Metrics Acquisition

## Process for developing publication queries

- Stage 1: Web of Science (WoS) queries were developed from a set of topical keywords derived from manual review of proposals, FOA texts, and provided by BER.
- Stage 2: Department of Energy (DOE) Office of Scientific and Technical Information (OSTI) processed BER Science Focus Area (SFA) descriptions against a multi-label classifier, compiling additional candidate keywords relevant to each SFA.
- Stage 3: Final keyword grouping resulted from aggregating Stage 1 and 2 efforts to establish a core keyword list for each SFA.

Queries were constructed to perform exploratory analysis of BER-funded, domestic (U.S.), and international publications for each SFA. Queries were scoped to include a combination of query semantics and pairwise keyword combinations as appropriate. Additional iterations were made to streamline syntax and normalize keyword issues, which included refinements to account for stemming and plurality.





# Bibliographic Metrics Analysis

## Process for analyzing publication queries

- Generated queries represent publications from years 2010 – 2020.
- Productivity, impact, and collaboration were identified as potential measures of scientific leadership.

## Analyses to be conducted for productivity and impact in science

- # publications per year (BER, US, International)
- # citations per year (BER, US, International)
- Average citations per publication (BER, US, International)
- Percent of pubs in top 5% and/or 10% (BER, US, International)

## Analyses to be conducted for collaboration in science

- # of BER pubs with international authorship
- # of international pubs with BER authorship
- Geographic connections among BER and international authors

# Interview protocol

- 10 preliminary interviewees identified and 5-6 open-ended questions drafted per research area
- Invitations sent by WG Co-leads. Links to BER's specific programmatic website(s) included, and a copy of the charge letter.
- 30 - 45 minutes scheduled with the interviewee
- One WG member designated to conduct the interview and a second to take notes, ask clarifying questions
- Each WG discusses hypotheses that emerge from the interviews
- Interview summaries are anonymized

# Public Request for Information

- BERAC Subcommittee is currently in data collection phase.
- This is an opportunity for anyone to respond directly to the Directors initial charge to BERAC.

<https://science.osti.gov/ber/berac/Reports/Current-BERAC-Charges>

- PIs, Managers, and Directors are all welcome to provide input on BER's international standing.

<https://science.osti.gov/ber>  
Posted under "What's New"

Federal Register /Vol. 86, No. 157, page 46233

<https://www.govinfo.gov/content/pkg/FR-2021-08-18/pdf/2021-17658.pdf>

States covered by the NVRA process the information from the form to request an applicant to vote. Notice: EAC, not any other Federal agency processes or collects any information from the Federal form that a registrant applicant submits to a state. Rather, EAC processes the Federal form, and states collect and record the information applicants submit. The Federal form is copyrighted by the registration application, instructions for completing the application (General Instructions and Application Instructions), and state-specific instructions that identify each state's particular requirements. A copy of the current form in English and 14 additional translated languages is available on EAC's website, at <https://www.eac.gov/eac-international-eac-voter-registration-form>.

**Request for Information**  
The objective of this request for information is to gather information on BER's standing in relation to related research efforts occurring nationally and internationally, and how BER might increase its status in conducting world-class basic science currently supported by BER (<https://science.osti.gov/ber/>). Supported research includes Atmospheric Science, Earth and Environmental System Modeling, Environmental Science, Biotechnology, Plant and Microbial Genomics, Data Analytics and Management, and Scientific User Facilities. Computational Knowledgebase Platform, Community Observational and Analytical Research. Information is specifically requested on the status of current capitalization, partnership, funding mechanisms, and workforce development specific to one or more of the aforementioned research areas. Answers or information related, but not limited, to the following questions are specifically requested:

**DEPARTMENT OF ENERGY**  
**Assessing the National and International Standing of BER Basic Research**  
**AGENCY:** Office of Science, Biological and Environmental Research Program, Department of Energy.  
**ACTION:** Request for information.

**SUMMARY:** The Biological and Environmental Research (BER) Program, as DOE's coordinating office for research on biological systems, bioscience, environmental science, and Earth system science, is seeking input on technical and logistical pathways that would enhance the BER research portfolio in comparison to similar international research efforts.

**DATES:** Written comments and information are requested on or before October 31, 2021.

**ADDRESSES:** Interested parties may submit comments by email only. Comments must be sent to [BERAC@ps.ornl.gov](mailto:BERAC@ps.ornl.gov) with the subject line "BER research benchmarking."

**FOR FURTHER INFORMATION CONTACT:** Dr. Tyrone O. West, (301) 903-5135, [Tyrone.West@science.doe.gov](mailto:Tyrone.West@science.doe.gov).

**SUPPLEMENTARY INFORMATION:** A charge was issued from the Director of Office of Science on October 4, 2020, to the BER Advisory Committee (BERAC) to assess BER's standing in relation to related research efforts nationally and internationally, and to consider strategies that would increase BER's

ability to conduct world-class science in core BER research areas. The Director's charge letter may be found here: <https://science.osti.gov/berac/reports/Current-BERAC-Charge>.

The information collected through this request, in addition to other international sources, may be used by BERAC to develop strategies to further strengthen BER's research capabilities. The conclusions drawn from BERAC's effort are expected to serve as a benchmark for BER's standing in core research areas and provide strategies for improvement where appropriate.

**Request for Information**  
The objective of this request for information is to gather information on BER's standing in relation to related research efforts occurring nationally and internationally, and how BER might increase its status in conducting world-class basic science currently supported by BER (<https://science.osti.gov/ber/>). Supported research includes Atmospheric Science, Earth and Environmental System Modeling, Environmental Science, Biotechnology, Plant and Microbial Genomics, Data Analytics and Management, and Scientific User Facilities. Computational Knowledgebase Platform, Community Observational and Analytical Research. Information is specifically requested on the status of current capitalization, partnership, funding mechanisms, and workforce development specific to one or more of the aforementioned research areas. Answers or information related, but not limited, to the following questions are specifically requested:

• Within the BER-supported topical research areas and facility capabilities, in which areas and capabilities, presently or in the immediate future, does BER lead in the international community, and in which areas does leadership require strengthening? In identifying these areas, please consider their critical mission relevance, recent history, the status quo, observable trends, and evidence-based projections.

• Are there key international partnerships that could strengthen BER science output and increase global visibility of BER?

• Is there a preferred organization for organizing research, collaboration, and funding opportunities among labs, universities, and other federal agencies to preserve and foster U.S. leadership with resource constraints? Are there other key efficiencies and balances that should be considered and modified to

improve U.S. leadership in BER research areas?

- How can BER programs and facilities be structured and managed to create incentives that will attract and retain talented people deciding whether to pursue a scientific career, as well as mid-career scientists considering whether to stay in the U.S.?

- What are the key opportunities for BER in attracting and retaining career in BER supported scientific fields?

While the questions provided above can help guide thinking on this topic, any input is welcome which may help DOE assess BER's international standing in the core research areas. The information provided through this request should be presented as specific strategies which DOE Office of Science could implement and track.

**Signing Authority**  
This document of the Department of Energy was signed on August 11, 2021, by Dr. J. Stephen Hinkley, Acting Director, Office of Science, pursuant to delegated authority from the Secretary of Energy. The document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the Federal Register.

Signed in Washington, DC on August 11, 2021.

Tyrone V. West,  
Federal Register Liaison Officer, U.S. Department of Energy  
(301) 903-5130 (P) (301) 914 and  
[DOE-ORR-018](mailto:DOE-ORR-018)

**DEPARTMENT OF ENERGY**  
**Federal Energy Regulatory Commission**  
**Notice of Solicitation of Comments on Proposed Rulemaking**  
(Project No. 3982-09)

**REGULATORY INFORMATION**  
The Commission is soliciting comments on the proposed rulemaking to amend the Commission's rules regarding the filing of applications for the construction of new hydroelectric projects and the modification of existing hydroelectric projects. The Commission is also soliciting comments on the proposed rulemaking to amend the Commission's rules regarding the filing of applications for the construction of new hydroelectric projects and the modification of existing hydroelectric projects.

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Take notice that the following hydroelectric applications have filed with the Commission and are available for public inspection:

# Timeline

Date	Event	Actions
February 2021	Steering Group Kick-off meeting	Discuss process and core research areas
March/April 2021	Steering group meetings	Confirm topic areas and discuss identify subgroup co-leads and members
May/June 2021	Working groups formed	Discuss process, co-leads, topics, and metrics
July - November, 2021	Work	Working groups complete bulk of effort for compiling data and analyzing metrics. Initiate and coordinate report writing.
Oct 21-22, 2021	Fall BERAC	Report out on status of working groups
February 5, 2022		Draft report sent for review by Steering Group and BER
March 5, 2022		Final Draft completed
March 29, 2022		Draft presentation sent to BER for review prior to BERAC meeting
April 7-8, 2022	Spring BERAC	Final Draft report presented to BERAC and voted on for concurrence

# Working Group Introductions and Status

# Working Groups

Working Group	Presenter
Bioenergy	Crysten Blaby
Biodesign	Himadri Pakrasi
Climate	Kate Calvin
Environmental Sciences	Michael Gooseff
Infrastructure	Kerstin Kleese Van Dam
Integrative Science	John Weyant

# Bioenergy: Membership



- Brian Davison, Oak Ridge National Laboratory
  - Corporate Fellow, Chief Scientist for Systems Biology and Biotechnology, Chief Science Officer for CBI
  - Leader in biomass conversion, characterization, and technologies combined with deep knowledge of BER, EERE and the BRCs



- Crysten Blaby-Haas, Brookhaven National Laboratory
  - Lead of the Quantitative Plant Science Initiative SFA
  - Background in systems biology, plant science and sustainability



- Maureen McCann, National Renewable Energy Laboratory
  - Director of the Biosciences Center
  - Former director of Purdue's NEPTUNE Center for Power and Energy and the Center for Direct Catalytic Conversion of Biomass to Biofuels (C3Bio)

# Bioenergy: Membership



- Janet Jansson, Pacific Northwest National Laboratory
  - Chief Scientist for Biology, Lab Fellow, and co-lead of Phenotypic Response of the Soil Microbiome to Environmental Perturbations SFA
  - Microbial ecologist covering environmental microbiome topic



- Ramon Gonzalez, University of South Florida
  - Professor and Florida World Class Scholar
  - Past assignment with ARPA-E
  - Expertise in Metabolic Engineering and Biomanufacturing
  - Bioconversion of C1 feedstocks, synthesis of polyketides and isoprenoids, nitrogen fixation and ammonia production, and bio-upcycling of plastic waste



# Bioenergy: Membership



- Ludmilla Aristilde, Northwestern University
  - Combines experimental techniques with computational simulations to guide the engineering of carbon and nutrient cycling
  - Awardee of Systems Biology of Bioenergy-Relevant Microbes to Enable Production of Next-Generation Biofuels and Bioproducts grant



- Ana Alonso, University of North Texas
  - Expertise in Plant Biochemistry, Metabolomics, and Metabolic Flux Analysis
  - Was a visiting professor with the Great Lakes Bioenergy Research Center and awardee of a DOE-USDA Plant Feedstocks for Bioenergy grant

# Bioenergy: Topical Coverage

- Core topics being considered in benchmarking:
  - Systems Biology
  - Plant Science
  - Sustainability
  - Bioenergy Research Centers
  - Biosystems design – point of connection with Biodesign WG
  - Environmental microbiomes (major SFA topic not covered by other WGs)
- Key resources that informed selection of topics:
  - Major GSP Elements Focusing on Bioenergy Research  
<https://genomicscience.energy.gov/biofuels/index.shtml>

# Bioenergy: Unique Focus

- Large, collaborative, long-term initiatives (such as the BRCs)
- Inter- and intra-agency joint funding (such as DOE-USDA feedstock program)
- Powering the future bioeconomy with fundamental discovery, use-inspired discovery, and translation to industry
- Status: we have invited ten senior thought leaders for interviews.
  - Half are international, two are industrial
  - We have held two interviews and scheduled three others.
  - Then we will follow-up with additional including early career.

# Bioenergy: Outstanding Questions

- How can BER anticipate and respond to shifting national and international priorities for the role of biology in energy resilience without losing the innovation that comes from long-term research projects?
- If you were organizing an international congress in your subtopic of bioenergy, who would be your preferred keynote speakers? (this is to capture thought leaders)

# Biodesign WG: Membership



- Sue Rhee, Carnegie Institution for Science
  - Sue's group combines computational and experimental approaches to study how plants cope with stress such as high temperature and low water. Their current focus is on understanding and engineering metabolic systems and traits.
  - The tools, data, and insights from her lab are important in designing plants to be more resilient to climate change.



- Nathan Hillson, Lawrence Berkeley National Lab
  - Senior Staff Scientist; training spanned computational biophysics, enzymology, cell biology. Entrepreneurial biomanufacturing-applied synthetic biologist leading teams of software and automation engineers, and molecular and microbiologists.
  - Direct and ongoing experience in biological computer-aided design and manufacturing; familiarity with synthetic biology applied to plants and microbiomes, as well as biosecurity (including IP aspects)

# Biodesign WG: Membership



- **Kristala L. J. Prather, Massachusetts Institute of Technology**
  - Kris is the Executive Officer and Arthur D. Little Professor in the Department of Chemical Engineering at MIT.
  - Kris is a BERAC member whose research is centered on metabolic engineering of microbial systems for small molecule production. Particular areas of expertise include novel pathway design and dynamic regulation of metabolism.



- **Huimin Zhao, University of Illinois at Urbana-Champaign**
  - Huimin is the Steven L. Miller Chair in the Department of Chemical and Biomolecular Engineering. He is a member of BERAC.
  - Huimin's primary research interests are in the development and applications of synthetic biology, machine learning, and laboratory automation tools to address society's most daunting challenges in health, energy, and sustainability.

# Biodesign WG: Membership



- **Himadri Pakrasi, Washington University in St. Louis**
  - Himadri is the George William and Irene Koechig Freiberg Professor in the Biology Department. He is a member of BERAC.
  - Himadri's research is centered on metabolic engineering and synthetic biology of photosynthetic organisms for carbon neutral and sustainable bioproduction. He also uses biochemical and biophysical approaches to understand the mechanism of solar energy production by cyanobacteria.



- **Costas D. Maranas, Donald D. Broughton Professor, Chemical Engineering, Penn State**
  - Costas is the Donald D. Broughton Professor in the Department of Chemical Engineering.
  - His expertise is in the reconstruction, analysis and redesign of metabolic networks, as well as in computational protein design. He has a track record in applying computations to aid in bio-design for a variety of organisms and systems ranging from cyanobacteria and plants to microbial communities and soil bacteria.

# Biodesign WG: Topical Coverage

- Core topics being considered in benchmarking
  - Designing biological systems for bioproduction to accelerate national bioeconomy
  - Identifying science and technology drivers to maintain US competitiveness in the global bioeconomy
- Key resources that informed selection of topics
  - BER BSSD Strategic Plan 2021
  - BER Biosystems Design Workshop Report 2011



# Biodesign: Unique Focus

- Attraction and retention of young talents in research and development.
- Current status of start-ups and mature companies in USA as compared to other countries.
- International collaborations to enhance research enterprise.
- Status: we have invited ten thought leaders for interviews.
  - Six are international, one is industrial.
  - We have held four interviews and scheduled three others.
  - Next, we will follow-up with additional early career scientists.

# Biodesign WG: Outstanding Questions

- Does DOE BER (or USA) lead in the international community in designing microbial and plant systems for sustainable bioproducts?
- Which areas of biodesign (computer aided-design/modeling, plant synthetic biology, etc) does the U.S., and DOE BER in particular, require leadership strengthening relative to its international comparators?
- How can the U.S., and DOE BER in particular, best use incentives to attract and retain talented scientists, engineers, and technologists in the biodesign space in its workforce, relative to its international comparators?

# Climate science: Membership



- Kate Calvin, Pacific Northwest National Laboratory
  - Earth Scientist at PNNL.
  - MultiSector Dynamics SFA PI and Biogeochemistry group lead for E3SM
  - Topics: biogeochemistry, drivers/responses, energy/complex systems, reduced-form models



- Jerry Meehl, National Center for Atmospheric Research
  - Senior Scientist at NCAR
  - Chief scientist on a BER Cooperative Agreement
  - Topics: water cycle, drivers/responses, process-based models

# Climate science: Membership



- Ann Fridlind, NASA Goddard Institute for Space Studies
  - Senior NASA Research Scientist; Adjunct Research Professor, The Earth Institute, Columbia University
  - Long history with BER, NASA programs
  - Topics: observations, data-model integration, process-based models



- Klaus Keller, Penn State
  - Professor in the Penn State Department of Geosciences, Associate in the Penn State Earth and Environment Institute
  - Long history with BER
  - Topics: drivers and responses, energy / complex systems, reduced-form models

# Climate Science: Membership



- Johannes Quaas, Universitat Leipzig
  - Professor of Theoretical Meteorology at the University of Leipzig
  - Topics: observations, data-model integration, process-based models



- Shaocheng Xie, Lawrence Livermore National Laboratory
  - Research Scientist and Group Leader at LLNL
  - NGD atmospheric physics group lead for E3SM
  - Topics: observations, data-model integration, process-based models

# Climate science: Topical Coverage

- Core topics being considered in benchmarking
  - Biogeochemistry
  - Water cycle
  - Cryosphere
  - Drivers and responses
  - Energy / complex systems
  - Process-based and reduced-form models
  - Observations
  - Data-model integration
- Key resources that informed selection of topics
  - CESD Strategic Plan (2018)
  - BERAC Grand Challenges Report (2017)

# Climate Science: Unique Focus

- Participation / Leadership in international climate-related efforts:
  - Intergovernmental Panel on Climate Change (IPCC)
  - World Meteorological Organization (WMO) and its programs, like World Climate Research Programme (WCRP)
    - Coupled Model Intercomparison Project (CMIP)
    - Global Energy and Water Exchanges (GEWEX) project
    - Climate and Ocean - Variability, Predictability, and Change (CLIVAR)
  - International Union of Geodesy and Geophysics (IUGG) and its programs, like International Association of Meteorology and Atmospheric Sciences (IAMAS)
- Use of community resources:
  - Models and model results
  - ARM measurements
- Leadership in basic climate research and modeling

# Climate Science: Outstanding Questions

- How do we measure the impact of science?
- How do we normalize metrics to make them comparable between BER and other entities?
- What case studies or examples should we highlight?



# Environmental Science: Membership



- Margaret Torn, Lawrence Berkeley Laboratory (co-lead)
  - Dr. Torn is an ecologist and biogeochemist focusing on carbon cycling, including anthropogenic influences.
  - Lead of the Biosphere-Atmosphere Interactions Program Domain and lead PI of AmeriFlux Management Project, Belowground Biogeochemistry SFA, and Land-Atmosphere Interactions project.



- Michael Gooseff, Univ of Colorado Boulder (co-lead)
  - Dr. Gooseff is a hydrologist focused on stream-groundwater interactions and associated biogeochemical cycling processes.
  - Lead PI of 2 SBR projects and of NSF-funded Long-Term Ecological Research project in Antarctica.

# Environmental Science: Membership



- **Tim Scheibe, Pacific Northwest National Laboratory**
  - Dr. Scheibe is an expert on hydrological processes and related solute transport and fate in coupled surface-subsurface systems.
  - PI for SFA on river corridor processes and lead scientist for multiscale modeling and high-performance computing.



- **Alistair Rogers, Brookhaven National Laboratory**
  - Dr. Rogers pursues an improved understanding of plant and terrestrial ecosystem response to global change, with a specific focus on representation in models.
  - Contributor to two Next-Generation Ecosystem Experiments (Arctic and Tropics) and FACE synthesis.

# Environmental Science: Membership



- Efi Foufoula-Georgiou, University of California, Irvine
  - Dr. Foufoula-Georgiou is an expert in stochastic modeling of hydrologic and geomorphologic processes. She is a distinguished professor and a member of the National Academy of Engineering.
  - Profile of national and international leadership in water resources and earth system science.



- Stan Wullschleger, Oak Ridge National Laboratory
  - Dr. Wullschleger is the Associate ORNL Director and an expert on the sustainable use of herbaceous and woody bioenergy crop applications.
  - Director of the Arctic Next-Generation Ecosystem Experiment

# Environmental Science: Membership



- Markus Kleber, Oregon State University
  - Dr. Kleber is an expert on soil science, specifically organic matter interactions with mineral surfaces and molecular characterization including use of DOE facilities.
  - International leader in theory and observational understanding of soil carbon cycling at pore-to-core scales.



- Patrick Reed, Cornell University
  - Dr. Reed is a hydrologist and water resources systems engineer focused on the interplay of human and environmental systems
  - International leader advancing approaches for better predicting, observing, and managing hydrologic extremes

# Environmental Science: Topical Coverage

- Core topics being considered in benchmarking
  - Watershed Science
  - Terrestrial Ecology
  - Coastal Systems

*All of these include hydrological, biogeochemical, and ecological processes*

- Key resources that informed selection of topics



## Environmental System Science Program

U.S. Department of Energy | Office of Science | Office of Biological and Environmental Research

The Environmental System Science program, within the U.S. Department of Energy's Office of Biological and Environmental Research, examines complex ecological and hydro-biogeochemical processes within terrestrial and coastal systems to understand inherent and emergent properties of changes to Earth and environmental systems.

# Environmental Science: Unique Focus

- Focus on impact and effectiveness of DOE-funded projects and scientific platforms (i.e., laboratory facilities, modeling capabilities, *and* field experiments) that are unique in scale and longevity within watershed, terrestrial ecosystem, and coastal system studies.
- Balance of ‘blue-sky’ vs mission-oriented research within environmental sciences.
- Big science questions lie at the intersection of Environmental Science with Climate Science and perhaps some of the other WGs (scientific infrastructure and Integrative Science)

# Environmental Science: Outstanding Questions

- Key concern on scientific workforce development within DOE. How do scientists advance at labs? How can excellent talent be retained?
- How is intellectual leadership supported by DOE and how can it be strengthened?

# Enabling Infrastructure: Membership



- **Kerstin Kleese van Dam, BNL – Co-chair**
  - Computational Scientist with long term links to climate, environmental and biological sciences. BERAC member.
  - Focus on computing and data facilities, and links to large scale experimental facilities



- **Robert F. Fischetti, ANL – Co-Chair**
  - Biophysicists with an emphasis on the structure of biological molecules. BERAC member.
  - Focus on X-ray beamline development and operations.



# Enabling Infrastructure: Membership



- **Serita Frey, University of New Hampshire**
  - Ecosystem ecologist with emphasis on soil microbial communities and biogeochemistry in a global change context; manage five long-term global change experiments at Harvard Forest LTER
  - Focus on genome facilities (i.e., JGI comparators) and data access policies



- **Thomas R. Schneider, EMBL, Hamburg, Germany**
  - Structural biologist with an emphasis on methodology development
  - Focus on developing research infrastructure and operating x-ray beamlines for structure determination

# Enabling Infrastructure: Membership



- **Kenneth James Davis, Pennsylvania State University**
  - Atmospheric and climate scientist with expertise in earth-atmosphere interactions and the terrestrial carbon cycle.
  - Long-term connections to AmeriFlux, the North American Carbon Program, and airborne and tower-based field research.



- **Ben Evans, Australian National University, Canberra, Australia**
  - Responsible for Data Science and HPC at the National Computing Infrastructure (NCI)
  - Has developed NCI's strategic programs in Climate, Weather, Environment, and Geoscience

# Enabling Infrastructure: Topical Coverage

- Core topics being considered in benchmarking
  - **Available User Facilities for BER scientists** – capabilities, availability, gaps, fitness for BER mission support, accessibility
  - **Quality of facilities in international comparison** – uniqueness, technological comparison, capacity, strategic planning (roadmap)
  - **Approach to leveraging emerging technologies** – timeliness, leader/follower, coordination & collaboration, international comparison
- Key resources that informed selection of topics
  - BER Facilities, International Facilities
  - BER, International Funding agencies
  - Users

# Enabling Infrastructure : Unique Focus

- Provides the required quality infrastructure capabilities (work horse) in sufficient quantity
- Provides a number of transformational, unique infrastructure capabilities that provide researchers with a significant advantage in their discovery science
- There are few missing infrastructure capabilities in the portfolio available to researchers
- A clear strategic decisions on the creation, continuation and sunsetting of infrastructure capabilities across the full portfolio – strategic roadmap available

# Enabling Infrastructure : Outstanding Questions

- Is the infrastructure development guided by long-term, strategic roadmap plans, potentially coordinated across offices, agencies and organizations both nationally or internationally?
- What is the right ratio between unique/leading user facilities and 'work horse' capabilities to obtain scientific leadership?

# Integrative Science : Membership



- Allison Campbell, PNNL retired
  - Former Associate Laboratory Director of Earth and Biological Sciences at PNNL, Former Director of the Environmental Molecular Sciences Laboratory at PNNL.
  - Responsible for PNNL's BER research portfolio; directed a BER user Facility for 10 years
- Ann Fridlind, NASA Goddard Institute for Space Studies
  - Senior NASA Research Scientist; Adjunct Research Professor, The Earth Institute, Columbia University
  - Long history with BER, NASA programs



# Integrative Science : Membership



- Jennifer Pett-Ridge, LLNL
  - Group Leader of LLNL Environmental Isotope Systems team, Laboratory Research Director for LLNL Soil Microbiome SFA, Adjunct Full Professor, Life & Environmental Sciences Dept., UC Merced
  - Long history with BER and NSF programs
  
- Phil Robertson, Michigan State University
  - University Distinguished Professor, Dept of Plant, Soil, and Microbial Sciences and WK Kellogg Biological Station; former Science Director, Great Lakes Bioenergy Research Center.
  - Long history with BER, NSF, USDA programs



# Integrative Science: Membership



- Gary Stacey, University of Missouri, Columbia
  - Curators' Distinguished Professor, Division of Plant Science and Technology, Division of Biochemistry
  - Long history with BER, NSF programs



- Detlef van Vuuren, PBL & University of Utrecht (Netherlands)
  - Senior researcher at PBL and Professor in Integrated Assessment of Global Environmental Change at the Utrecht University
  - Research concentrates on response strategies to global environmental problems & is a member of the Working Group on Coupled Models of the World Climate Research Program (WCRP)



# Integrative Science: Membership



- John Weyant, Stanford University
  - Professor of Management Science and Engineering/Affiliated Faculty in School of Earth, Environment and Energy Sciences
  - Integrated energy and environmental systems modeling, including risk and uncertainty and resilience in multi-sector dynamics with significant history of BER research in these areas.

# Integrative Science: Topical Coverage

- Core topics being considered in benchmarking
  - Competitiveness and innovation of BER/US integrative research
    - Across disciplines/programs/agencies
    - Across theory/field observations/laboratory/modeling
    - Across multiple scales
  - Defining innovation and leadership in these areas
- Key resources that informed selection of topics
  - BER Scientific Focus Area (SFA) categories
  - BER strategic plans
  - BERAC reports
  - Similar reports by other US and Foreign entities-public and private





# Integrative Science : Outstanding Questions

- How to make up for the lack of quantitative metrics and data in this area, including defining leadership?
- What funding mechanisms work here and elsewhere and implications for BER/US efforts?
- How research and collaboration with the private sector works in other agencies/countries compared to the US and lessons learned?

Example of  
International  
Cooperation:



# A Sample of Overarching Questions for Discussion

- How broadly do we define the elements and implications of international leadership itself?
- How can the U.S., and DOE BER in particular, best use incentives to attract and retain talented scientists, engineers, and technologists in the BER science space in its workforce, relative to its international comparators?
- Is the infrastructure development guided by long-term, strategic roadmap plans, potentially coordinated across offices, agencies and organizations both nationally or internationally?
- How do BER funding modalities create mechanisms for integrative collaborative work bridging topical areas, US agencies, major international programs and the private sector?