



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

# Biological and Environmental Research

**BER Advisory Committee (BERAC)  
Spring Meeting  
April 20, 2023**

*Gary Geernaert  
Associate Director (Acting)*

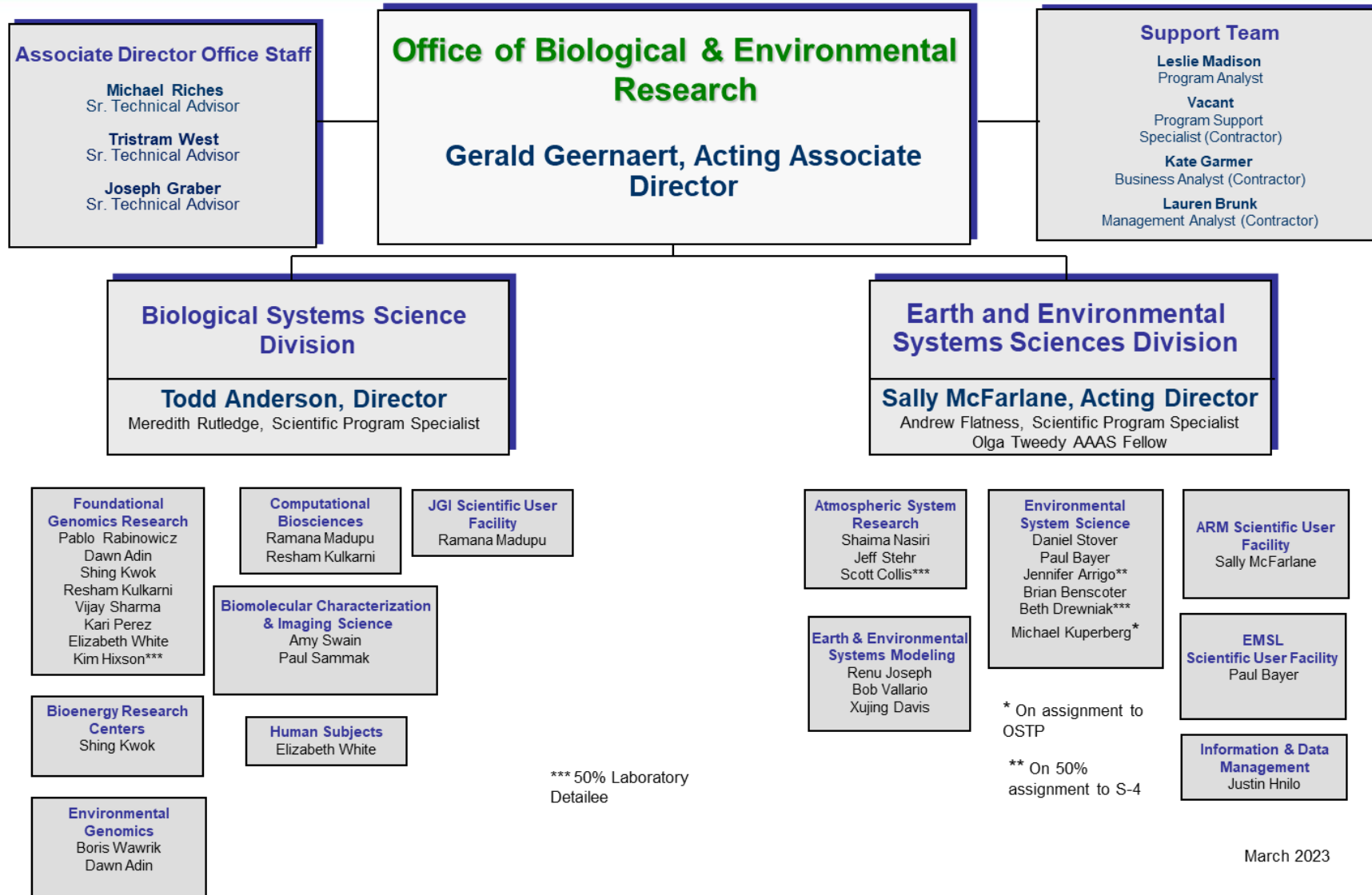
# DOE BER Staff



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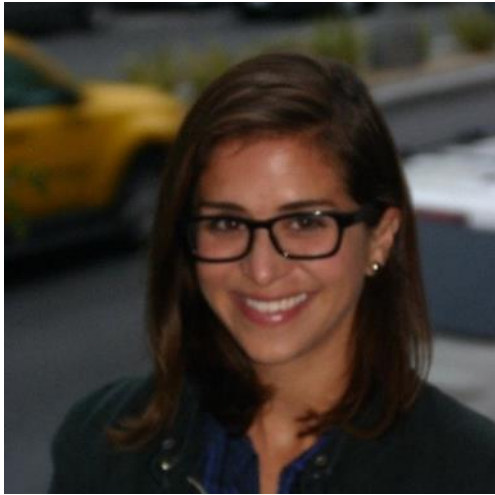
# BER Organization Chart



March 2023

# BER Staff Changes

## *New Staff*



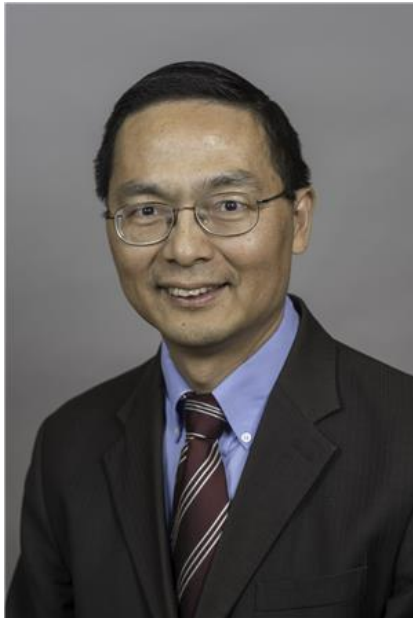
**Kari Perez**  
Program Manager  
Foundational Genomics



**Vijay Sharma**  
Program Manager  
Foundational Genomics

# BERAC Completed Membership

**Huimin Zhao**  
University of Illinois



BERAC Member 2012-2022



**2022 Food, Pharmaceutical and Bioengineering  
Division Award in Chemical Engineering from the  
American Institute of Chemical Engineers (AIChE).**

Recognizes an individual's outstanding chemical engineering contribution in the food, pharmaceutical and/or bioengineering field, of fundamental nature and/or of practical significance to industry and industrial practice.

# Awards



## 2022 Elected AAAS Fellow (BERAC, BER, and DOE)



**Xiaohong Liu**, *Texas A&M University*  
AAAS Fellow, Atmospheric & Hydrospheric Sciences



**Ali Douraghy**, *U.S. Department of Energy*  
*Societal Impacts on Science & Engineering*



**Peter E. Thornton**, *Oak Ridge National Laboratory*  
AAAS Fellow, Atmospheric & Hydrospheric Sciences



**Alistair Rogers**, *Brookhaven National Laboratory*  
AAAS Fellow, Biological Sciences

# BER Mission

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The mission of the Biological and Environmental Research (BER) program is to support transformative science and scientific user facilities to achieve a predictive understanding of complex biological, Earth, and environmental systems for clean energy and climate innovation.

## ➤ ***Biological Systems Science***

Advancing genomic science of plants and microorganisms needed to understand, predict and design biological processes to address long-term challenges in energy production, biotechnology leadership, renewable resource development and carbon management.

## ➤ ***Earth and Environmental Systems Sciences***

Research to characterize and understand the forcings and feedbacks among Earth and energy systems, which includes studies on atmospheric physics and chemistry, ecosystem ecology and biogeochemistry, coastal and urban sciences, and development and validation of Earth system models extending from local to global scales. These models integrate information on the biosphere, atmosphere, terrestrial land masses, oceans, sea ice, subsurface, energy infrastructures and other human components.

# BER – at a glance

**BER RESEARCH SPANS** **185** MORE THAN UNIVERSITIES, NONPROFIT, AND FEDERAL RESEARCH INSTITUTIONS  
**13** DOE NATIONAL LABORATORIES | **47** STATES, WASHINGTON, D.C., AND PUERTO RICO

**32**  
SCIENCE FOCUS AREAS

**480**  
ACTIVE GRANTS

**1,337**  
PUBLICATIONS IN  
**421**  
JOURNALS

**BER** | BY THE NUMBERS  
FY 2022

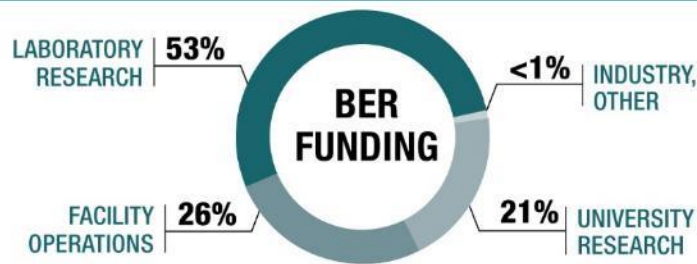
BER supports transformative science to achieve a predictive understanding of complex biological, earth, and environmental systems for energy security, independence, and prosperity.

**4**  
BIOENERGY RESEARCH CENTERS

**\$815 MILLION**  
TOTAL BUDGET

SUPPORTED RESEARCHERS  
**2,010** PhD SCIENTISTS | **580** GRADUATE STUDENTS

MORE THAN **4,100** USERS AT  
**3** USER FACILITIES



**\$240 MILLION**  
USER FACILITY BUDGET





# Research Priorities for FY 2024



- Energy Earthshot Research Centers continue at the DOE Labs while research opportunities within Academia increase (\$45.0M)

- Urban Integrated Field Laboratories are enhanced (\$23.0M)



## **Broadening Participation**

- Expand Reaching a New Energy Sciences Workforce (RENEW) (\$12.5M) and Funding for Accelerated, Inclusive Research (FAIR) (\$6.25M) with scope across BER.
- Expand the climate resilience centers (\$10.0M)

# FY 2024 President's Request

BER FY 2022 and FY 2023 Appropriations and FY 2024 President's Request	FY 2022 Enacted	FY 2023 Enacted	FY 2024 President's Request
Genomic Science	\$275,500	\$328,685	\$338,750
Biomolecular Characterization and Imaging Science	\$45,000	\$45,000	\$45,750
Biological Systems Facilities & Infrastructure	\$84,500	\$90,000	\$92,000
<b>Total, Biological Systems Science</b>	<b>\$405,000</b>	<b>\$463,685</b>	<b>\$476,500</b>
Atmospheric System Research	\$36,000	\$36,000	\$40,000
Environmental System Sciences	\$114,000	\$120,800	\$137,000
Earth and Environmental Systems Modeling	\$105,000	\$115,500	\$120,500
Earth and Environmental Systems Sciences Facilities and Infrastructure	\$155,000	\$172,700	\$147,700
<b>Total, Earth and Environmental Systems Sciences</b>	<b>\$410,000</b>	<b>\$445,000</b>	<b>\$445,200</b>
<b>Subtotal BER</b>	<b>\$815,000</b>	<b>\$908,685</b>	<b>\$921,700</b>
EMSL Microbial Molecular Phenotyping Capability (M2PC) project	\$0	\$0	\$10,000
<b>Total, Biological and Environmental Research</b>	<b>\$815,000</b>	<b>\$908,685</b>	<b>\$931,700</b>

SBIR/STTR funding:

- FY 2022 Enacted: SBIR \$25,184,000 and STTR \$3,545,000
- FY 2023 Enacted: SBIR \$21,327,000 and STTR \$2,999,000
- FY 2024 Request: SBIR \$22,278,000 and STTR \$3,137,000



# FY 2024 President's Request: Additional Challenges & Opportunities

## Core Research and Facility Operations underpinning the BER Mission

- Enhanced **Bioenergy Research Centers** provide new research through individual efforts and inter-BRC shared-theme research underpinning production of clean energy and chemicals from sustainable biomass. (\$118.0M)
- Continue **Biotechnology research** to transform advanced manufacturing (\$3.0M) and accelerate innovations in emerging technologies (\$5.0M).
- **BRaVE research** continues (\$24.0M); Low Dose radiation research within BRaVE increases (\$10.0M).
- Continue the Integrated **Artificial Intelligence for Earth System Predictability (AI4ESP)** to add AI/unsupervised learning approaches to E3SM (\$5.0M); exascale research activities will transition from Exascale Computing Project to a broader focus on software for advanced computing and sustainability across current and future computing platforms. (\$15.0M)
- **JGI** will explore new capabilities in plant transformation capability to accelerate the ability to understand and design new beneficial functions into plants. (\$92.0M)
- **ARM** will initiate full operations with community engagement at its Alabama observatory, and a cloud chamber research effort will be initiated to complement ARM's field observations of cloud-aerosol interactions. (\$85.5M)
- **EMSL** will focus on biological and environmental molecular science and new science for molecular microbial phenotyping. (\$51.2M)

## Construction

- EMSL will initiate construction for the **Molecular Microbial Phenotyping Capability (M2PC)**. (\$10.0M)

# Genomic Sciences: Bioenergy Research Centers

**Integrated, multidisciplinary teams addressing the basic science challenges to cost effective production of fuels, chemicals and materials from renewable plant biomass within emphasis on shared collaborative research among all four Centers.**

## Challenges and Opportunities in FY 2024

- The enhanced Bioenergy Research Centers will provide new research through individual efforts and inter-BRC shared-themes.
- Development of higher yielding, more resilient bioenergy crops.
- Broad-scale studies of the agronomics and economics of bioenergy crop production across large regions will focus on a variety of environmental conditions.
- Optimized plant biomass construction and conversion processes underpinning the basis for biofoundry development continues.
- Microbial conversion technologies to high value fuels, chemicals and other products will continue, yet with a focus on aviation fuels.
- Inter-BRC coordination on 10 shared research objectives to facilitate cooperation on major areas of bioenergy and biotechnology development.



# Artificial Intelligence for Earth System Predictability (AI4ESP)



**Informing community-scale equitable solutions requires much more accurate climate predictions at local scales than what exists today. Artificial Intelligence (AI) combined with physics-based model-data fusion provides the opportunity to rapidly advance capabilities, for science and stakeholders.**

## Challenges and Opportunities in FY 2024

- Hybrid process-/machine learning-based Earth system modeling
- ML-assisted nonlinear multi-scale data assimilation
- Pattern recognition, data mining, unsupervised learning
- Edge computing with AI
- ML assisted experimental design, parameter estimation
- Data-driven multiscale modeling, data–model fusion
- Uncertainty Quantification (UQ) methodologies with AI
- Serves to develop the first prototype hybrid prediction operational capability for the U.S.

Approach is to combine BER's massive observing capabilities with model systems to advance theory and demonstration with AI-enabled analytics and prediction

**E<sup>3</sup>SM** Energy Exascale Earth System Model



BER watershed SFAs and coastal and IFL projects

# National Virtual Climate Laboratory (NVCL)

**Advance access to climate science through public engagement on local to regional scale climate science, equitable solutions, and partnerships with National Laboratories, HBCUs, MSIs, and regional stakeholders.**

- The NVCL will be live in April 2023, with a portal that provides information on climate research activities across the DOE National Laboratories.
- Outreach activities are initiated that include RDPP awardees in FY 2022 and RENEW awardees in FY 2022 and FY 2023.
- National Laboratory engagement in RENEW projects is facilitated by the NVCL in order to foster sustained scientific collaborations.



## **Challenges and Opportunities in FY 2024**

- Expand capabilities in an information portal for HBCUs, MSIs, National Labs, urban and rural public stakeholders and other interested organizations.
- Develop outreach events involving Urban IFLs, climate resilience centers, RENEW awardees, and other interested HBCUs, MSIs, and other interested organizations, to more efficiently advance science and training opportunities.
- Provide support to RENEW awardees with collaborative arrangements involving National Laboratories.

# Urban Integrated Field Laboratory

Advance underpinning science of integrated natural-human urban systems to assure resilience to climate extremes using equitable solutions.

In FY 2022-2023, four Urban IFLs were initiated and led by MSIs, national laboratories, and community partnerships.

- Chicago urban region: led by Argonne National Lab with 10 collaborators.
- Baltimore urban region: led by Johns Hopkins University, with 7 collaborating institutions.
- Texas gulf coast: led by Univ Texas Austin, with 4 collaborating institutions.
- Phoenix-Flagstaff corridor, led by Arizona State University with two collaborators.



## Challenges and Opportunities in FY 2024

- All Urban IFL's continue with their second or third year of investment, with field research and modeling, digital twins and relationships building with global efforts.
- Outreach events are organized to promote best practices across the Urban IFLs and new ideas entrained from the newly established climate resilience centers.
- IFLs will collaborate and leverage capabilities and programs from a variety of federal, state and local stakeholder agencies.

# Climate Resilience Centers

**A network of climate centers that are affiliated with HBCUs/MSIs/HSIs to accelerate basic climate system science towards equitable solutions and community engagement.**

Accomplishments in FY 2023:

- Based on an FOA issued in FY 2023, five climate resilience centers will be initiated and placed at HBCUs, MSIs, HSIs.
- Climate resilience centers have a unique focus on ecological, atmospheric, and/or modeling challenges, each with a risk analysis component.
- Centers leverage ongoing foundational investments in BER research as well as interagency capabilities.
- Centers develop demonstration research projects with multi-institutional collaborations.



## **Challenges and Opportunities in FY2024:**

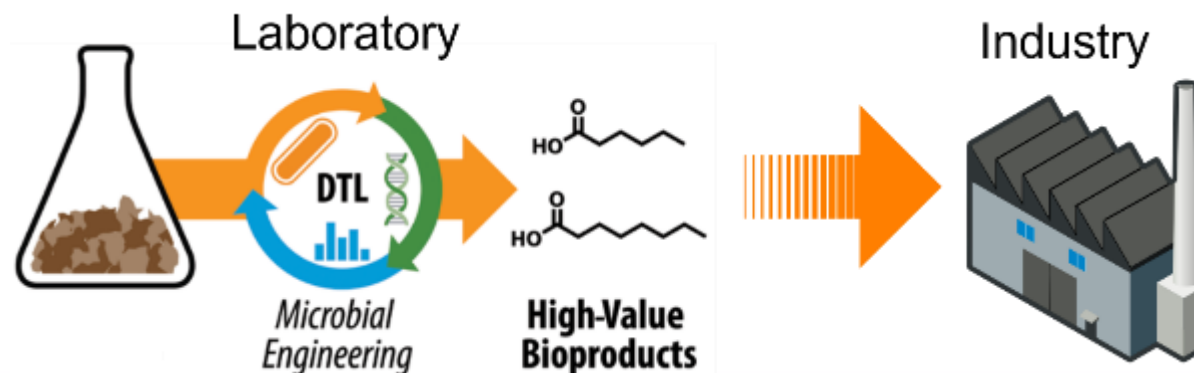
- Expanded from 5 Climate Resilience Centers in FY 2023 to 5-10 centers in FY 2024
- All centers hosted by HBCUs, MSIs, and HSIs
- A formal network of centers is established in FY 2024
- Emphasis on climate and environmental justice



# Genomic Sciences: Earthshots

## Challenges and Opportunities in FY 2024

- The enhanced Energy Earthshot Foundational Research activities – Bringing together multi-investigator, multi-disciplinary teams targeting barriers to implementation of the innovations emerging from basic science into potential solutions for technological challenges.
- Focused on translational science to accelerate basic science discoveries towards commercial applications in clean energy and carbon management technologies.
- Reducing risks associated with R&D scale-up and deployment.
- Continue Combination of Center-focused research (\$2-4M/center) complemented by solicited research through Funding Opportunity Announcements (FOA).



# Earth and Environmental Systems Sciences: Earthshots

Earth and Environmental System Modeling supports research that contributes to the Earthshot topics by providing supporting climate information needed to enhance future designs and deployment strategies for clean energy production capabilities.

## Challenges and Opportunities in FY 2024

- New investments enhance support for Earthshot topics, that focus on efficient design, deployment, and effectiveness of renewable and clean energy infrastructures to combat climate change.
- E.g., simulate the statistics of climatically-changing wind fields and marine currents over the lifetime of energy production infrastructures.



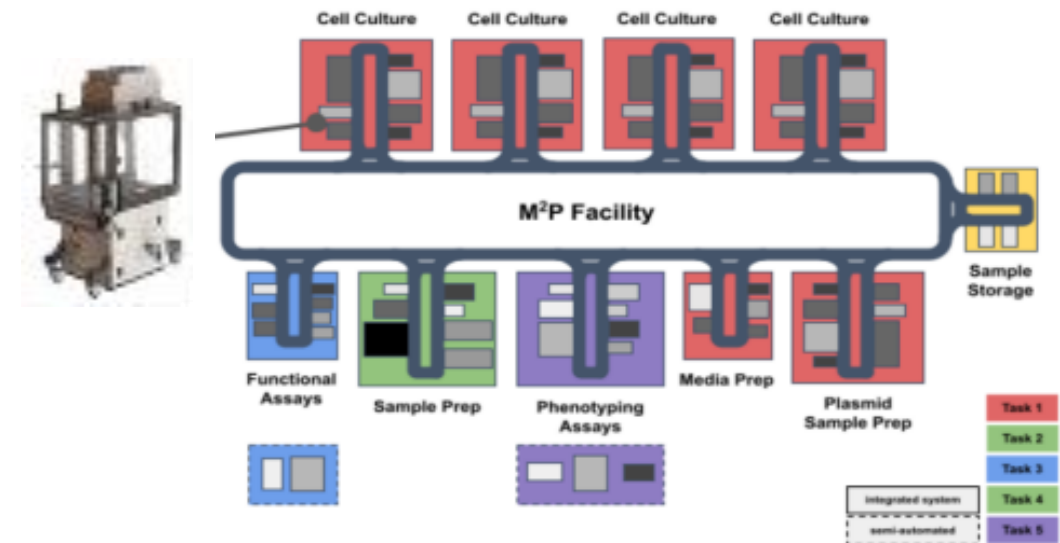
# Microbial Molecular Phenotyping Capability (M<sup>2</sup>PC) project

## Proposed M2PC Project

A high-throughput (HTP) and highly automated phenotyping capability for a broad range of microbes and microbial communities that would match and ideally exceed the capacity and pace of genomics capabilities.

### Project Basics

- Critical Decision 0 (CD-0) received in April 2021.
- Preliminary scope – 36K ft<sup>2</sup> Laboratory space plus Research/analytical equipment
- CD-1 expected in FY 2023, Construction start in 2025, Start-up in 2029.



# In Summary

***BER is accelerating basic science, with the intent to create major opportunities for America's energy and innovation agenda.***

In FY24, BER will:

- Increase investments in the Energy Earthshots to more rapidly advance science-based energy technologies and systems on high priority topics that can transform America's energy future.
- Couple the integration of machine learning and AI with biological and climate sciences to advance world-leading predictive capabilities for climate, energy and the bio-economy, in support of improved decision-making and serve as prototypes for future operational systems.
- Broaden participation in the BER portfolio through the Urban IFLs, climate resilience centers, FAIR, and RENEW to drive a more equitable and expanded workforce in support of DOE science.

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Questions?



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