U.S. DEPARTMENT OF ENERGY | Office of Science

# Informational Webinar:
# Science Foundations for Energy Earthshots

## DE-FOA-0003003

*March 27, 2023*

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| FOA Issue Date: | March 21, 2023 |
| Submission Deadline for Pre-Applications: | April 25, 2023, at 5:00 PM Eastern Time |
| Pre-Application Response Date: | May 23, 2023, at 11:59 PM Eastern Time |
| Submission Deadline for Applications: | June 21, 2023, at 11:59 PM Eastern Time |

https://science.osti.gov/Funding-Opportunities

***Disclaimer :*** *This presentation summarizes the contents of the FOA. Nothing in this webinar is intended to add to, take away from, or contradict any of the requirements of the FOA. If there are any inconsistencies between the FOA and this presentation or statements from DOE personnel, the FOA is the controlling document.*

# DOE's Office of Science:
## Meeting the Nation's Challenges Today and into the Future

*The DOE Office of Science (SC) mission is to deliver the scientific discoveries and major scientific tools to transform our understanding of nature and advance the energy, economic, and national security of the United States.*

### Advancing the frontiers of science

Largest Federal supporter of basic research in the physical sciences

Research activities support nearly 29,000 PhDs, scientific and engineering professionals, support staff, and graduate/undergraduate students at more than 300 universities and at all 17 DOE laboratories

### Accelerating discovery with cutting-edge research tools

- Operate 28 scientific user facilities for nearly 34,000 users per year
  - High-performance computing
  - X-ray and neutron sources
  - Physics facilities
  - Nanoscience centers
  - Biocharacterization facilities
- Design and construction of next-generation facilities to support the scientific community

# The Office of Science Research Portfolio

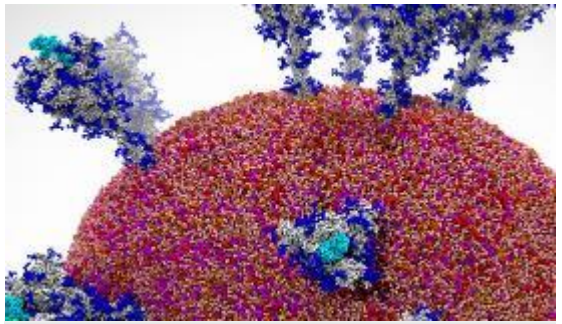
| | |
|---|---|
| **Advanced Scientific Computing Research** | • **Delivering world leading computational and networking capabilities to extend the frontiers of science and technology** |
| **Basic Energy Sciences** | • **Understanding, predicting, and ultimately controlling matter and energy flow at the electronic, atomic, and molecular levels** |
| **Biological and Environmental Research** | • **Understanding complex biological, earth, and environmental systems** |
| **Fusion Energy Sciences** | • **Supporting the development of a fusion energy source and supporting research in plasma science** |
| **High Energy Physics** | • **Understanding how the universe works at its most fundamental level** |
| **Nuclear Physics** | • **Discovering, exploring, and understanding all forms of nuclear matter** |
| **Isotope R&D and Production** | • **Supporting isotope research, development, production, processing and distribution to meet the needs of the Nation** |
| **Accelerator R&D and Production** | • **Supporting new technologies for use in SC's scientific facilities and in commercial products** |

# Advanced Scientific Computing Research (ASCR)

- ASCR research lays the groundwork for scientific discoveries
  - **Applied Mathematics and Computer Science foundations** to advance the understanding of natural and engineered systems and to reveal scientific insight from high end simulations, models, and data.
  - **Advanced Computing** to prepare for the future of science based on emerging advanced computing technologies and microelectronics.
- ASCR facilities drive American global leadership in computing, data and networking
  - As we deploy the world's first **exascale supercomputers** and the Nation's most **advanced scientific network**, we continue to build a more integrated and open national research infrastructure for all.
- ASCR's investments and strategic partnerships enable scientific breakthroughs and advance America's economic competitiveness
  - ASCR's world-leading programs in **interdisciplinary research** enable scientific applications take full advantage of computing and networking capabilities that push the frontiers.
  - Unique models of partnerships accelerate the competitiveness of **American computing technologies, advanced manufacturing,** and **high-tech companies -** large and small**.**
- ASCR invests in people
  - **Computational Science Graduate Fellowship** – producing computational leaders since 1991.

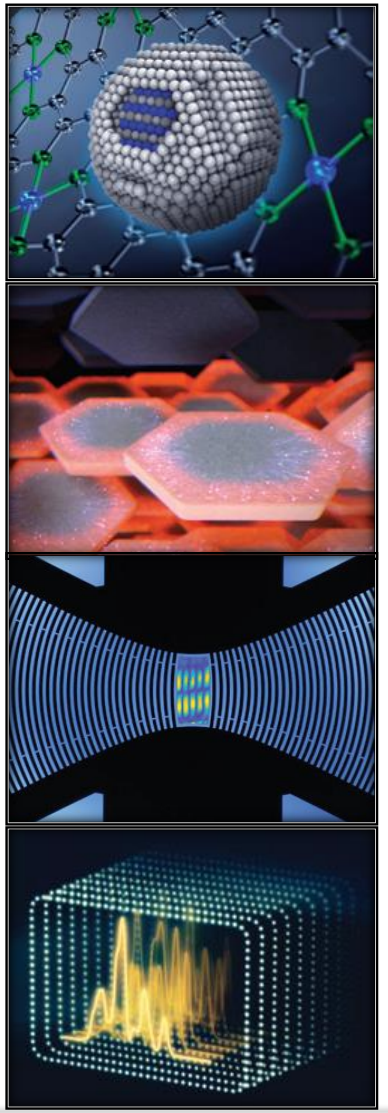
Leadership Computing


Quantum Testbeds


Gordon Bell Prize researchers leverage modeling and AI to understand COVID mutations

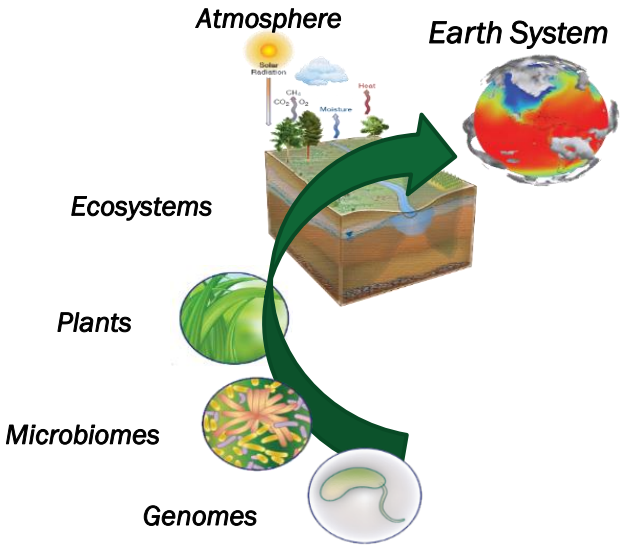
# Basic Energy Sciences (BES)

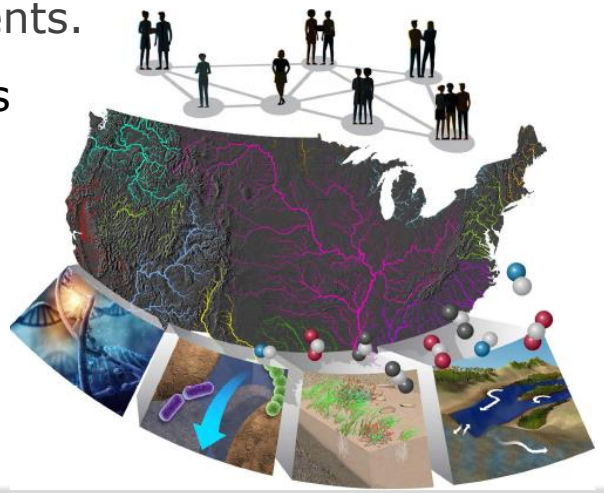
- BES supports discovery science and use-inspired research to solve the challenges facing today's advanced technologies for energy, manufacturing, medicine, and national priorities. BES provides:
  - A **vibrant community of academic and national laboratory researchers** who focus on understanding materials and chemical sciences at the atomic and molecular scales
  - **Cutting-edge scientific facilities** with specialized, state-of-the-art instrumentation such as advanced x-ray light sources, neutron scattering sources, and nanoscale science research centers that are used by **thousands of scientists from many fields**
- BES-supported discoveries drive U.S. leadership in science, sustain innovation across diverse technologies and improve economic and national security.
  - **Foundational scientific understanding** of chemical and materials processes starting at the level of electrons is essential for advancing energy, transportation, chemical, manufacturing, quantum information science, and microelectronics technologies.
  - Continuous progress in basic science is critical to **sustaining U.S. innovation and competitiveness**.
  - Some of the toughest challenges are being tackled by **collaborative teams with diverse skills** at the BES-supported Energy Innovation Hubs and Energy Frontier Research Centers.



# Biological and Environmental Research (BER)

- BER supports **transformative biological, Earth, and environmental research** to achieve a predictive understanding of complex systems relevant to **energy and environmental issues** of national importance.
  - Topics of interest are biological, biogeochemical, and physical processes that span from **molecular to regional to global scales.**
- BER's portfolio includes research in:
  - Genomics to **understand and design** biological systems so they can be leveraged for sustainable bioenergy and bioproduct production from renewable plant biomass and support a **burgeoning US-based bioeconomy**.
  - Earth and environmental research to combine scientific understanding of the atmosphere, oceans, land systems, and cryosphere with advanced analytics to **accurately model the Earth system**, both in urban and natural environments.
- BER supports 3 DOE Office of Science **User Facilities** with unique, world-class scientific instruments and capabilities:
  - DOE Joint Genome Institute (**JGI**)
  - Atmospheric Radiation Measurement (**ARM**) User Facility
  - Environmental Molecular Science Laboratory (**EMSL**)



# Science Foundations for Energy Earthshots

Goal is to enhance **crosscutting fundamental research** in support of the Energy Earthshot goals

- Priority will be given to applications that focus on crosscutting research relevant to multiple Energy Earthshots:
  - Hydrogen Shot
  - Carbon Negative Shot
  - Industrial Heat Shot
  - Long Duration Storage Shot
  - Enhanced Geothermal Shot
  - Floating Offshore Wind Shot
- Applications encouraged to address more than one of the SC research programs:
  - Advanced Scientific Computing Research (ASCR)
  - Basic Energy Sciences (BES)
  - Biological and Environmental Research (BER)

# Energy Earthshots: *Necessary and Urgent*

Energy Earthshots target the major breakthroughs
*we must achieve* in the next decade to solve the climate crisis and reach our 2050 net-zero carbon goals.

- Make a major impact to *reduce emissions*
- Address the *hardest technology barriers*
- Set highly *ambitious decadal targets*
- Are *compelling, bold, and inspirational*
- Significantly *engage stakeholders*

ENERGY earthshots
U.S. DEPARTMENT OF ENERGY

**Leverage Past Success**

SunShot
U.S. Department of Energy

# Energy Earthshot
*Hydrogen*

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Hydrogen

- Fundamental breakthroughs needed for:
  - Hydrogen production
  - Hydrogen sources, sinks, and quantification

- To accomplish this goal, DOE has identified several possible pathways:

| Electrolysis | Thermal Conversion (e.g., NG) | Advanced Pathways |
|---|---|---|
| Cost: ~$5/kg $H_2$ (at low volume) | Cost: $1.50/kg but high emissions | >$10/kg $H_2$/TBD |

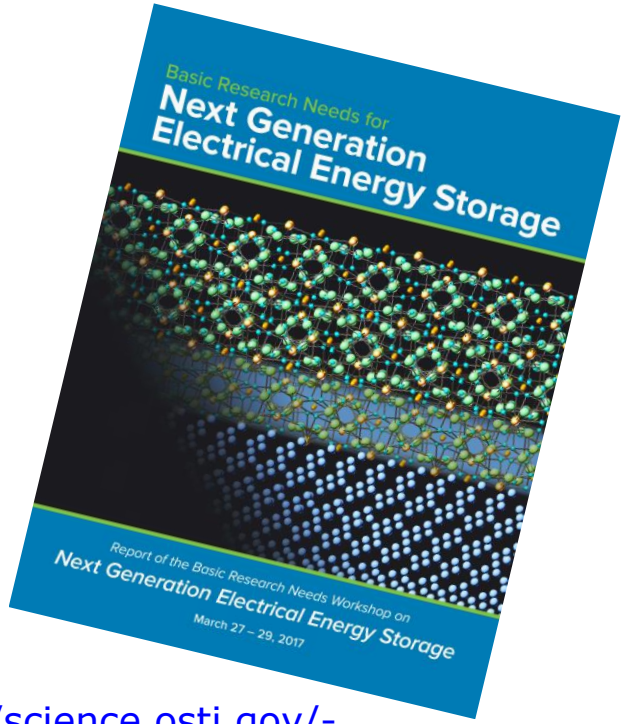

https://science.osti.gov/-/media/bes/pdf/brochures/2021/Hydrogen_Roundtable_Report.pdf

Target: Hydrogen Production

# Energy Earthshot
## *Long Duration Storage*

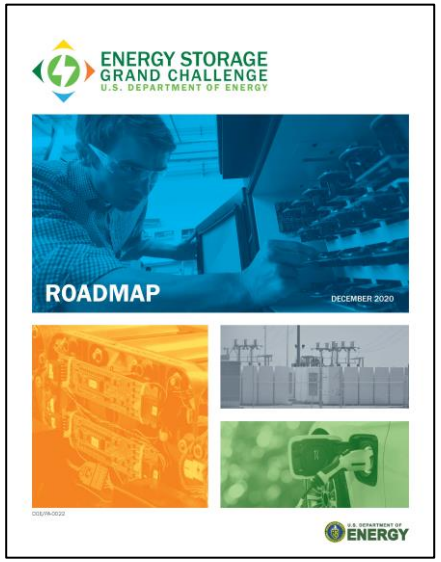
ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Storage™

- Fundamental breakthroughs needed for:
  - Electrochemical energy storage
  - Electrothermal energy storage
  - Chemical energy storage via energy carriers
  - Electromechanical energy storage




https://science.osti.gov/-/media/bes/pdf/reports/2017/BRNIDTET_rpt_print.pdf

**DOE's Energy Storage Grand Challenge Roadmap**
https://www.energy.gov/sites/default/files/2020/12/f81/Energy%20Storage%20Grand%20Challenge%20Roadmap.pdf




Target

Reduce storage costs by **90%** from a 2020 Li-ion baseline...

...in storage systems that deliver **10+** hours of duration

...in **1** decade

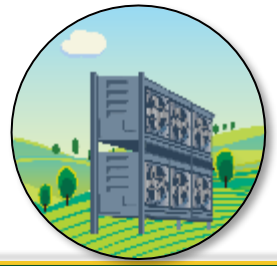
# Energy Earthshot
## *Carbon Negative*

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Carbon Negative™

- Fundamental breakthroughs needed for:
  - Biological sequestration and storage of carbon
  - Abiotic sequestration and storage of carbon
  - Coupled experimental and computational research to better understand the fundamental kinetics of carbonization and $CO_2$ reactivity
  - Measurement, monitoring, and validation


https://science.osti.gov/-/media/bes/pdf/brochures/2022/CDR_RT_Brochure.pdf

Direct Air Capture with Storage



Bioenergy with Carbon Capture and Sequestration

Enhanced Mineralization

Soil Carbon Sequestration

Target


U.S. DEPARTMENT OF ENERGY | Office of Science

# Energy Earthshot
## *Enhanced Geothermal*


- Fundamental breakthroughs needed for:
  - Experimental and computational efforts to understand mesoscale to regional subsurface constitutive mechanics and fluid injection response in EGS environments
  - Innovative approaches for EGS data collection and analysis
  - Understanding materials behavior and geochemical/geomechanical processes in EGS wellbore environments

Target

90% Reduction

2035

# Energy Earthshot
## *Floating Offshore Wind*

- Fundamental breakthroughs needed for:
  - Materials, Modeling, and Control for Floating Wind Turbines
  - Modeling and Measuring the Wind-Farm and Surrounding Environment
  - Transmission, Co-Generation, and Storage
- DOE has identified several key goals for offshore wind:
  - Transmission Development
  - Co-Generation Applications

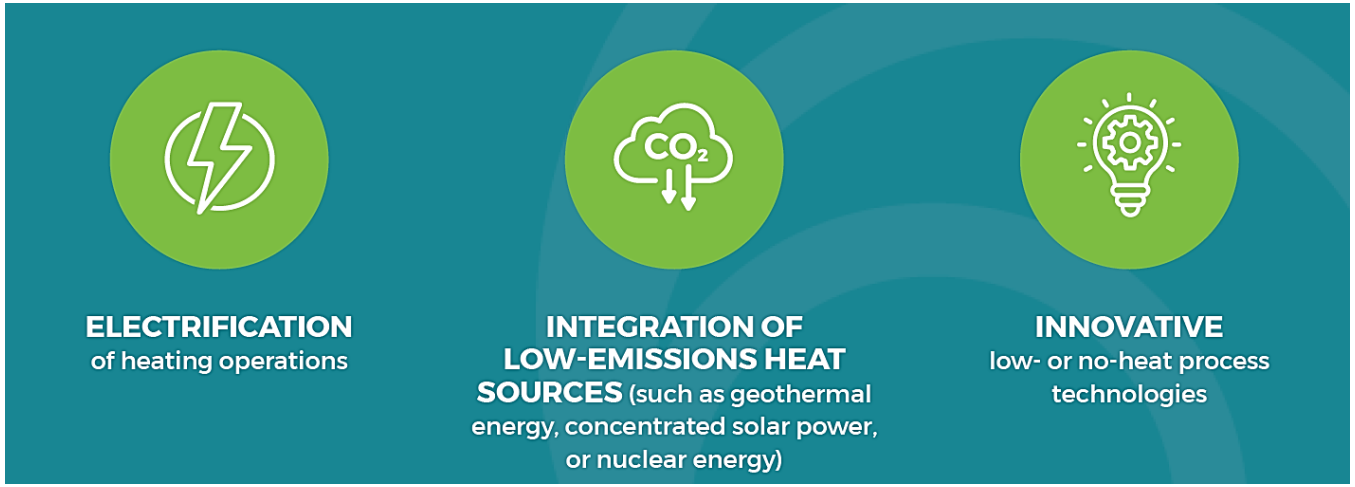

Target

>70% Reduction

2035

# Energy Earthshot
## *Industrial Heat*

- Fundamental breakthroughs needed to:
  - Reduce the carbon footprint of heating
  - Develop alternatives to heat-requiring processes and/or reduce requirements for thermal energy
  - Advance opportunities for heat recovery and use




DOE has identified 3 key pathways to decarbonize industrial heat & achieve the target

# This funding opportunity:

Concepts for addressing foundational scientific challenges underlaying the Energy Earthshots for the present and future challenges.

- Basic research focused on *creativity and innovation*
- Should be crosscutting, impacting multiple Earthshots and of relevance to multiple SC programs
- Examples in the Funding Opportunity Announcement are illustrative only (not prioritized)

# Examples of crosscutting research to stimulate innovative thinking

- Example: Measurement and sensing
  - Advances in measurement science, tailored to Energy Earthshot applications (e.g., $H_2$, $C/CO_2$, methane, temperatures, salinity levels, etc.) are needed for extreme environments (e.g., extremes of temperatures, pressures, acidity, and wear).
- Example: Multiscale Processes and Systems
  - Studies of processes and systems phenomena across temporal and spatial scales could advance multiple Energy Earthshot goals.

# Eligibility/Teaming Requirements

- Eligible lead institutions: universities/colleges, non-profit/for profit organizations
- MSIs (including HBCUs) and researchers from groups historically underrepresented in STEM are **encouraged to lead applications**. Applications that include their participation in teams are also encouraged.
- Eligible subrecipients: DOE laboratories, universities/colleges, non-profit/for profit organizations, non-DOE FFRDCs, other federal agencies

# Limitations

- Applicant institutions are limited to no more than 3 pre-applications and 3 applications.
- There is no limitation to the number of applications on which an institution appears as a subrecipient (i.e., not the lead institution).
- An individual may not be named as the lead investigator on more than 1 pre-application or application.
- The lead investigator on a pre-application or application may also be listed as senior or key personnel on separate submissions without limitation.
- There is no restriction on the number of pre-applications or applications in which an individual may participate as senior/key personnel.

# Pre-Applications Are Required

- Section IV.B.2 specifies the format of the pre-application. The cover page must identify the relevant Earthshots and SC programs (ASCR, BES, and/or BER) with most relevant listed first.
- A listing of individuals who should not serve as merit reviewers must also be submitted in PAMS with the pre-application.
  - Detailed instructions for how to craft such a listing are provided in Section VIII of the FOA.
  - For your convenience, a template is available at https://science.osti.gov/grants/Policy-and-Guidance/Agreement-Forms (Collaborator Template).
  - The list must be uploaded, preferably in Excel format, as an additional attachment in PAMS. **This is a new procedure.**
- Pre-application encouragement decisions may be informed by a competitiveness review.
- Applications that have not been encouraged by DOE may be declined without merit review.
- Please work with your institution's sponsored research office to ensure that submission limitations are satisfied.

# Awards and Funding Levels

- DOE anticipates that a total of $150 million in current and future fiscal year funds will be used to support awards under this FOA.
- Applications should be between $500,000 and $2 million per year.
- Project periods should be for three years.

# Promoting Inclusive and Equitable Research (PIER) Plan

- Beginning in FY 2023, Office of Science solicitations require applicants to submit a plan for **Promoting Inclusive and Equitable Research (PIER) Plan**, along with their research proposals.
  - This is a requirement for proposals submitted to all Office of Science solicitations, as well as invited proposals from the DOE national laboratories.
- PIER Plans are limited to 3 pages and should describe the activities and strategies that investigators and research personnel will incorporate to promote diversity, equity, inclusion, and accessibility in their research projects.
  - The complexity and detail of a PIER Plan is expected to increase with the size of the research team and the number of personnel to be supported.
  - The PIER Plans will be evaluated under a new merit review criterion as part of the peer review process.
- Additional information and FAQs: https://science.osti.gov/grants/Applicant-and-Awardee-Resources/PIER-Plans

# For more information

- The FOA is the authoritative source for this competition:
  - https://science.osti.gov/-/media/grants/pdf/foas/2023/SC_FOA_0003003.pdf
- If you still have questions, you can contact sc.earthshots@science.doe.gov.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