Office of Science Update

Board on Physics and Astronomy 2024 Fall Meeting

Linda Horton
Associate Deputy Director for Science Programs
Office of Science

U.S. Department of ENERGY | Office of Science

https://science.osti.gov/

U.S. DEPARTMENT OF ENERGY | Office of Science

Driving Discovery Science for the Nation

Fostering Great Minds and Great Ideas.

Providing Unique, World-Class Facilities

Over 29,000 Researchers Supported; at >300 Institutions and 16 DOE Labs

Steward 10 of the 17 DOE National labs

Nearly 40,000 Users of 28 SC Scientific Facilities

FY 2024 Enacted : $8.24B

FY 2025 Request : $8.583B

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	◆ Building the scientific foundations for a fusion energy source
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 National Preparedness for isotope production and distribution

FY 2025 Request for the Office of Science

Requests $8,583M (+$343M; 4.2% increase over FY 2024 appropriation) with increased investments in Administration priorities to include:

- **Artificial Intelligence (+$93M; $259M)**
- Fusion Innovation Research Engine (FIRE) Collaboratives (+$15M; $60M)
- Reaching a New Energy Sciences Workforce (RENEW) (+$69M; $120M)
- Funding for Accelerated, Inclusive Research (FAIR) (+$32M; $64M)
- Climate Initiative ($20M)
- **Microelectronics (+$22M; $95M)**
- SC Energy Earthshots (+$95M; $115M)

FY 2025 Request – Lab & User Facility Operation and Construction Highlights

- Scientific user facility operations, supporting ~88% of operations (+$189.05M)
- Support programmatic line-item construction and MIE projects
- Upgrade core national laboratory infrastructure, i.e., utilities and laboratory workspace through ongoing SLI infrastructure projects and General Plant Projects (+$31.7M; $50M)
  - Reduce backlog of deferred maintenance and improve obsolete infrastructure at SC National Laboratories
  - Continue the Laboratory Operations Apprentice Program (+$2M; $5M)

Office of Science FY 2025 Budget Status

$M	FY 2024 Enacted*	FY 2025 Request	% Change from FY 2024	House Mark	% Change from FY 2024	Senate Mark	% Change from FY 2024
Office of Science, Total	**8,240**	**8,583**	**4.00%**	**8,390**	**1.79%**	**8,600**	**4.19%**
Advanced Scientific Computing Research	1,016	1,153	11.88%	1,105	8.05%	1,152	11.81%
Basic Energy Sciences	2,626	2,582	-1.70%	2,617	-0.34%	2,563	-2.46%
Biological and Environmental Research	900	946	4.86%	850	-5.88%	930	3.23%
Fusion Energy Sciences	790	844	6.40%	825	4.24%	825	4.24%
High Energy Physics	1,200	1,231	2.52%	1,219	1.56%	1,230	2.44%
Nuclear Physics	804	833	3.48%	830	3.13%	850	5.41%
Isotope R&D and Production	130	184	29.35%	170	23.53%	165	21.21%
Accelerator R&D and Production	29	31	6.45%	30	3.33%	31	6.45%
Workforce Development for Teachers and Scientists	40	43	6.98%	32	-25.00%	43	6.98%
Science Laboratories Infrastructure	288	295	2.37%	280	-2.86%	275	-4.73%
Safeguards and Security	190	195	2.56%	195	2.56%	190	0.00%
Program Direction	227	246	7.72%	238	4.62%	246	7.72%
Frontiers in AI for Science, Security, and Technology (FASST)						100	100.00%

*Isotope R&D and Production received an additional $98M under the Foreign Aid Supplemental

FY 2025 House Mark Highlights

Funds SC at $8,390M, +$150M over FY 2024 Enacted, -$193M below FY 2025 Request

- $245M for **QIS research**; $15M for research in support of the Quantum User Expansion for Science and Technology program (QUEST); $20M for testbeds to integrate high performance computing and quantum (flat with the Request)
- $20M for Energy Earthshots ($95M below the Request)
- $40M for FIRE Collaboratives ($20M below the Request)
- Supports expansion of microelectronics research, including **Microelectronics Science Research Centers**
- No funding for RENEW or FAIR initiatives
- Directs establishment of a Carbon Sequestration Research and Geologic Computational Science Initiative
- **Most constructions projects funded at or near the Request**

FY 2025 Senate Mark Highlights

Funds SC at $8,600M, +$360M over FY 2024 Enacted, +$17M over FY 2025 Request

- $160M for **Artificial Intelligence/Machine Learning research** and $100M for Frontiers in Artificial Intelligence for Science, Security and Technology (FASST) (~flat with Request)
- Not less than $265M for **QIS research**, including five National QIS Research Centers ($15M below the Request)
- $60M for Energy Earthshots ($55M below the Request)
- $110M for **microelectronics** ($15M over the Request)
- Not less than $45M for FIRE Collaboratives ($15M below the Request)
- Supports RENEW and FAIR initiatives
- $25M to establish a Carbon Sequestration Research and Geologic Computational Science Initiative and $10M for atmospheric methane removal research
- Facility operations at ~90%
- **Most constructions projects funded at or near the Request**

Frontiers in Artificial Intelligence for Science, Security, and Technology (FASST)

- The speed and scale at which AI is developing requires investment in a strategic capability to meet DOE mission needs of national security, energy security, and scientific discovery that will support sustained economic prosperity for the nation for decades to come
- A focused approach is needed to
  - Prevent the United States from losing its competitive scientific edge and ability to maintain our national and economic security
  - Catalyze a diverse and competitive innovation AI ecosystem
  - Build technical expertise necessary to govern AI
  - Attract and train a talented workforce.

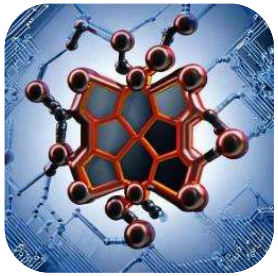
https://www.energy.gov/fasst

FASST will build the world's most powerful integrated scientific AI systems through four key interconnected pillars:

- AI-Ready Data
- Frontier-Scale AI Computing Infrastructure and Platforms
- Safe, Secure, and Trustworthy AI Models and Systems
- **AI Applications**

AI cuts across all SC core science areas

- **AI for Science** – accelerating innovation through scientific AI foundation models trained on highly-curated scientific datasets
- **AI Hardware Innovation** – new AI algorithms and hardware co-design to improve energy efficiency by >100x
- **AI for User Facilities** – optimized, autonomous experiments with real-time data analysis and AI-enabled real-time control of accelerators & detectors to improve operational efficiency
- **Trustworthy AI systems** – storage and archival tools for FAIR (findable, accessible, interoperable, and reusable) data and privacy-preserving algorithms to enable science using proprietary and sensitive data
- **A Diverse AI Workforce** - leverage DOE's technical workforce to integrate AI across the science research community



Real-time analysis of atomic microscopy data

Digital twins and system analysis for soils

Theory-aware AI global experiment control

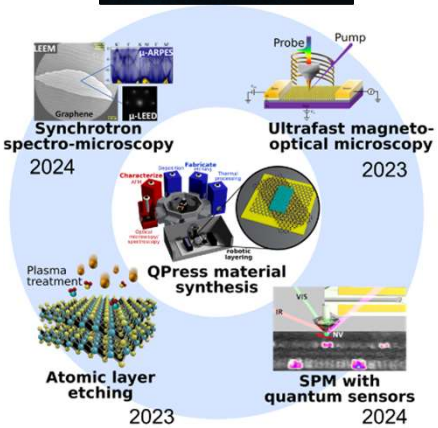
https://www.energy.gov/sites/default/files/2024-07/FASST%20Handout%20%281%29_0.pdf

DOE-SC Roundtables: Transformational Science Enabled by Artificial Intelligence -- October 28-31 & November 7 – 8, 2024

- Analogous to community input on “first science” for new/upgraded user facilities
- Participants will identify Priority Research Opportunities (PROs) for use of evolving AI capabilities to address the most significant challenges associated with the different scientific themes
- Complements focus of ASCR AI workshops

QIS Crosses the Breadth of the Office of Science

- Build strong foundations through sustained investments in core basic QIS research
- Support 5 National QIS Research Centers
- Advance R&D and build unique QIS research infrastructure
  - 5 Nanoscale Science Research Centers have clean rooms for synthesis and characterization tools key for QIS research
  - 2 Quantum Computing Testbeds provide access to novel quantum computing hardware
  - Quantum Computing User Program (QCUP) provides access to industry quantum computing resources
- Promote a diverse quantum ready workforce
- Foster coordination and collaboration



Advanced Microelectronics

- SC supports fundamental research on materials, chemistries, processing, plasmas, isotopes, devices, systems, architectures, algorithms, and software
- Generates foundational knowledge for next-generation technologies for computing, communications, sensing, and power
- Coordinated multi-disciplinary research to accelerate innovation for next generation microelectronics in a co-design ecosystem
- Builds on capabilities at SC user facilities for computation, fabrication, characterization, diagnostics, and validation
- **Microelectronics Science Research Centers** will comprise a network of multiple team awards
  - Review underway for the 2024 National Laboratory Funding Opportunity that focused on microelectronics for extreme environments and energy efficiency
- Complements later-stage investments being made by other agencies through the CHIPS Act

Completed Advisory Charge: Update to Planning for Future Facilities

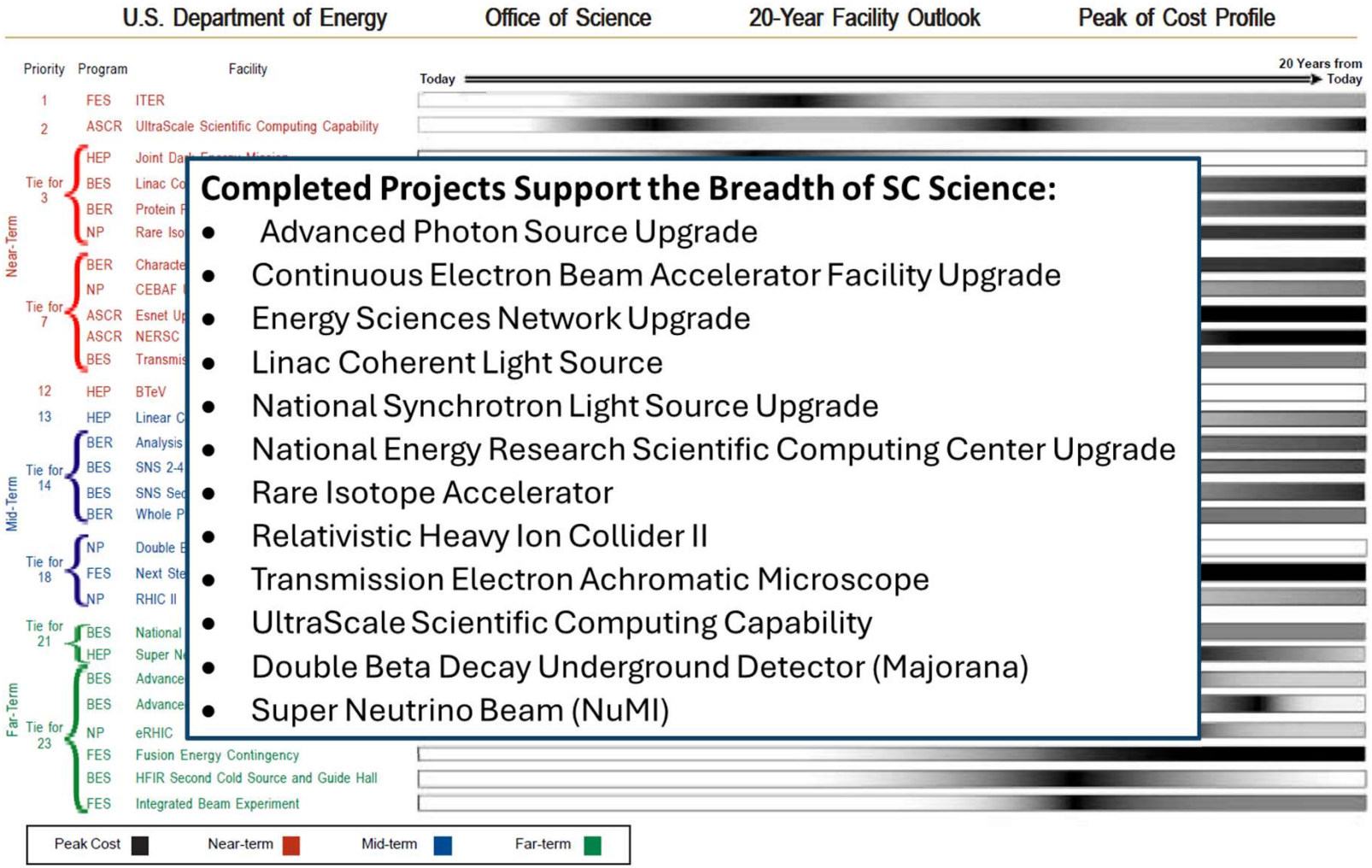
2003 Facilities for the Future of Science established best practice of long-term planning and prioritization

- Provided a prioritized list of major scientific facilities for the next 20 years
- Interim report highlighting progress released in 2007

"We believe that the 20-year vision of future scientific facilities currently being developed in the Office of Science is outstanding and could have a far-reaching, positive effect on the Nation's leadership in science."

– *Dr. Charles M. Vest, Chair of SEAB Task Force on the Future of Science Programs*

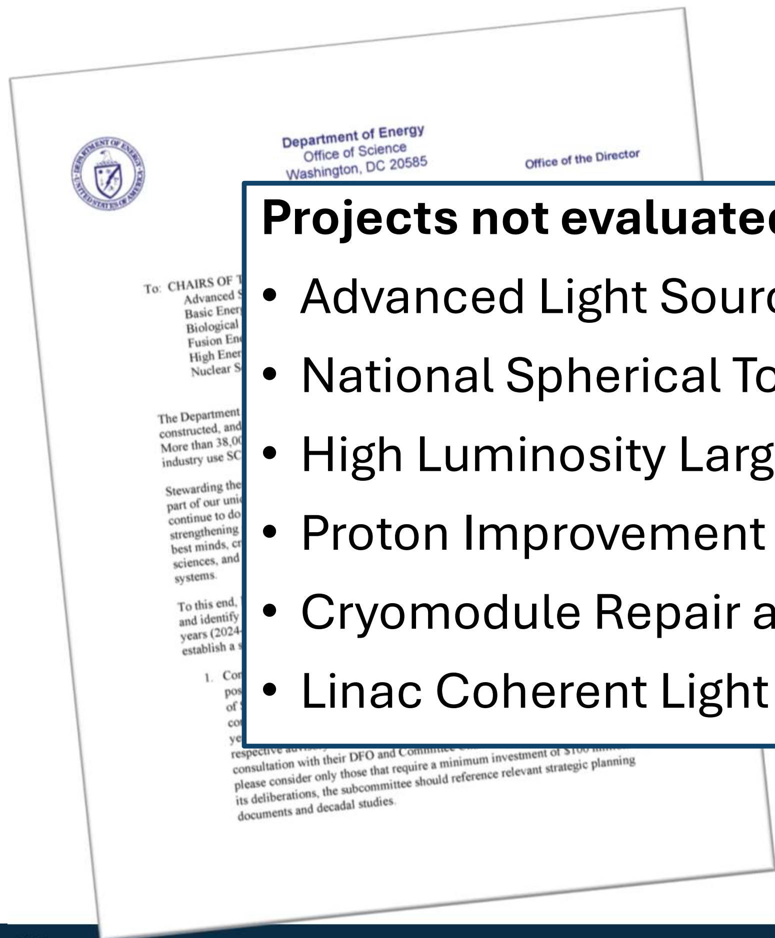
2003 Report prioritized projects across scientific disciplines by focusing on world leadership, timeliness



Completed Projects Support the Breadth of SC Science:

- Advanced Photon Source Upgrade
- Continuous Electron Beam Accelerator Facility Upgrade
- Energy Sciences Network Upgrade
- Linac Coherent Light Source
- National Synchrotron Light Source Upgrade
- National Energy Research Scientific Computing Center Upgrade
- Rare Isotope Accelerator
- Relativistic Heavy Ion Collider II
- Transmission Electron Achromatic Microscope
- UltraScale Scientific Computing Capability
- Double Beta Decay Underground Detector (Majorana)
- Super Neutrino Beam (NuMI)

Information collected for an updated plan to advance U.S. science & innovation leadership for the next decade and beyond


Department of Energy
Office of Science
Washington, DC 20585
Office of the Director

To: CHAIRS OF T
Advanced S
Basic Ener
Biological
Fusion En
High Ener
Nuclear S

The Department
constructed, and
More than 38,00
industry use SC

Stewarding the
part of our uni
continue to do
strengthening
best minds, cr
sciences, and
systems.

To this end,
and identify
years (2024-
establish a s

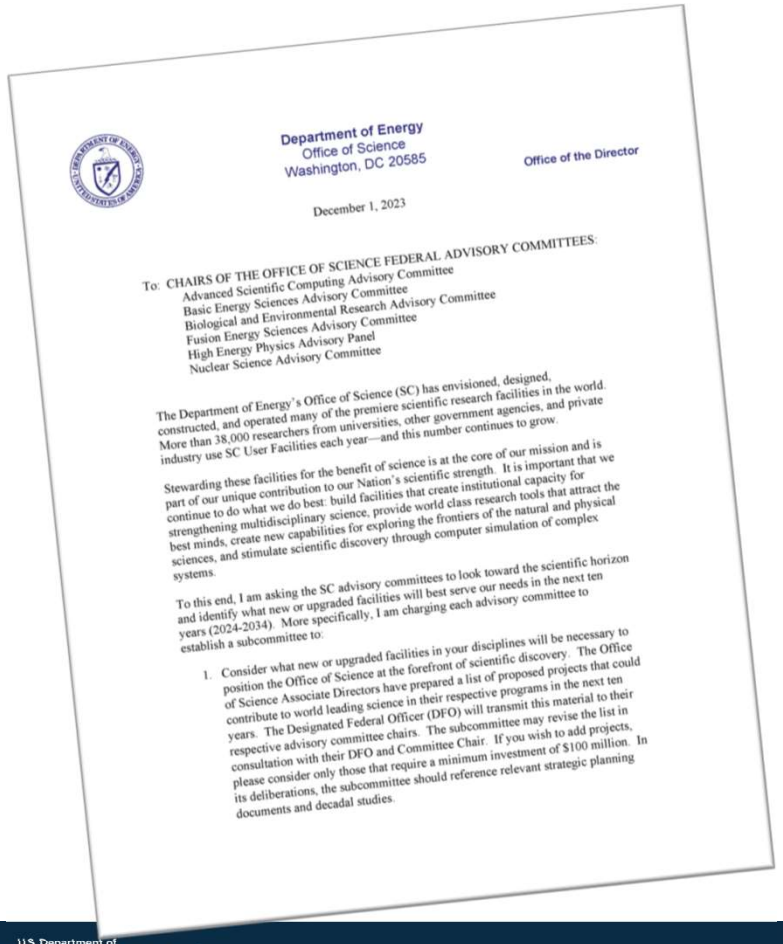
1. Co
pos
of
co
ye
respective advis...
consultation with their DFO and Committee ... investment of $100 million
please consider only those that require a minimum investment of $100 million
its deliberations, the subcommittee should reference relevant strategic planning
documents and decadal studies.

Projects not evaluated as these are nearing completion....

- Advanced Light Source Upgrade
- National Spherical Torus Experiment Upgrade Recovery
- High Luminosity Large Hadron Collider projects
- Proton Improvement Plan II
- Cryomodule Repair and Maintenance Facility
- Linac Coherent Light Source II High Energy upgrade project

- Each advisory committee charged to assess a list of future facilities from the respective SC ... luated).
- ... world- ... cade.
- ... .
- ... te May ... ssments
- SC leadership is using the input to develop a prioritized strategy for investments for next decade.

Information collected for an updated plan to advance U.S. science & innovation leadership for the next decade and beyond



Department of Energy
Office of Science
Washington, DC 20585

Office of the Director

December 1, 2023

To: CHAIRS OF THE OFFICE OF SCIENCE FEDERAL ADVISORY COMMITTEES:
Advanced Scientific Computing Advisory Committee
Basic Energy Sciences Advisory Committee
Biological and Environmental Research Advisory Committee
Fusion Energy Sciences Advisory Committee
High Energy Physics Advisory Panel
Nuclear Science Advisory Committee

The Department of Energy's Office of Science (SC) has envisioned, designed, constructed, and operated many of the premiere scientific research facilities in the world. More than 38,000 researchers from universities, other government agencies, and private industry use SC User Facilities each year—and this number continues to grow.

Stewarding these facilities for the benefit of science is at the core of our mission and is part of our unique contribution to our Nation's scientific strength. It is important that we continue to do what we do best: build facilities that create institutional capacity for strengthening multidisciplinary science, provide world class research tools that attract the best minds, create new capabilities for exploring the frontiers of the natural and physical sciences, and stimulate scientific discovery through computer simulation of complex systems.

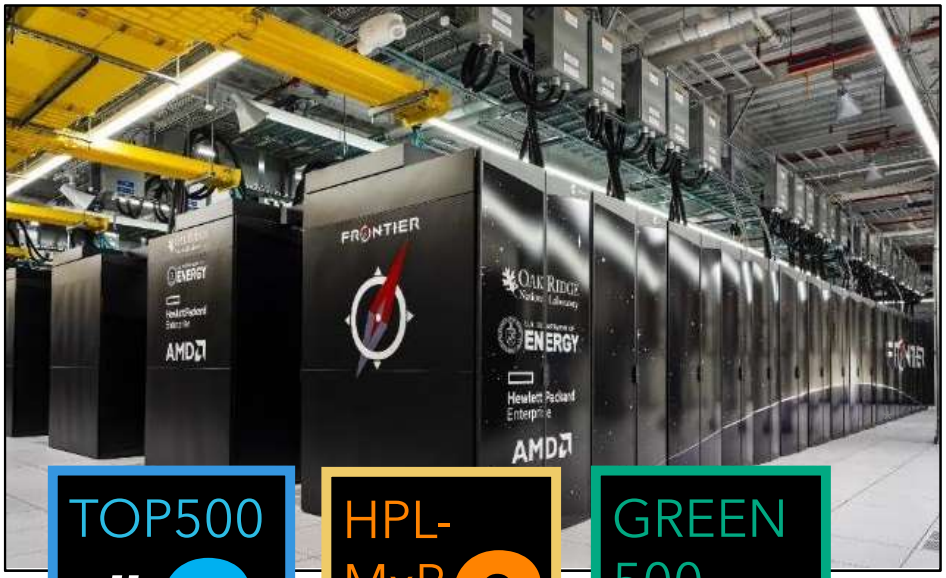
To this end, I am asking the SC advisory committees to look toward the scientific horizon and identify what new or upgraded facilities will best serve our needs in the next ten years (2024-2034). More specifically, I am charging each advisory committee to establish a subcommittee to:

1. Consider what new or upgraded facilities in your disciplines will be necessary to position the Office of Science at the forefront of scientific discovery. The Office of Science Associate Directors have prepared a list of proposed projects that could contribute to world leading science in their respective programs in the next ten years. The Designated Federal Officer (DFO) will transmit this material to their respective advisory committee chairs. The subcommittee may revise the list in consultation with their DFO and Committee Chair. If you wish to add projects, please consider only those that require a minimum investment of $100 million. In its deliberations, the subcommittee should reference relevant strategic planning documents and decadal studies.

- Each advisory committee charged to assess a list of future facilities from the respective SC program (57 total projects evaluated).
- Assessment of:
  - The potential to contribute to world-leading science in the next decade.
  - The readiness for construction.
- Assessments provided to SC in late May 2024, followed by additional assessments and analysis by each program.
- SC leadership is using the input to develop a prioritized strategy for investments for next decade.

Exascale Computing Project Officially Completed

DOE Exascale Supercomputers Lead in Performance and Efficiency



TOP500 #2

HPL-MxP #2

GREEN 500 **Honorable Mention**

TOP500 #3

HPL-MxP #1

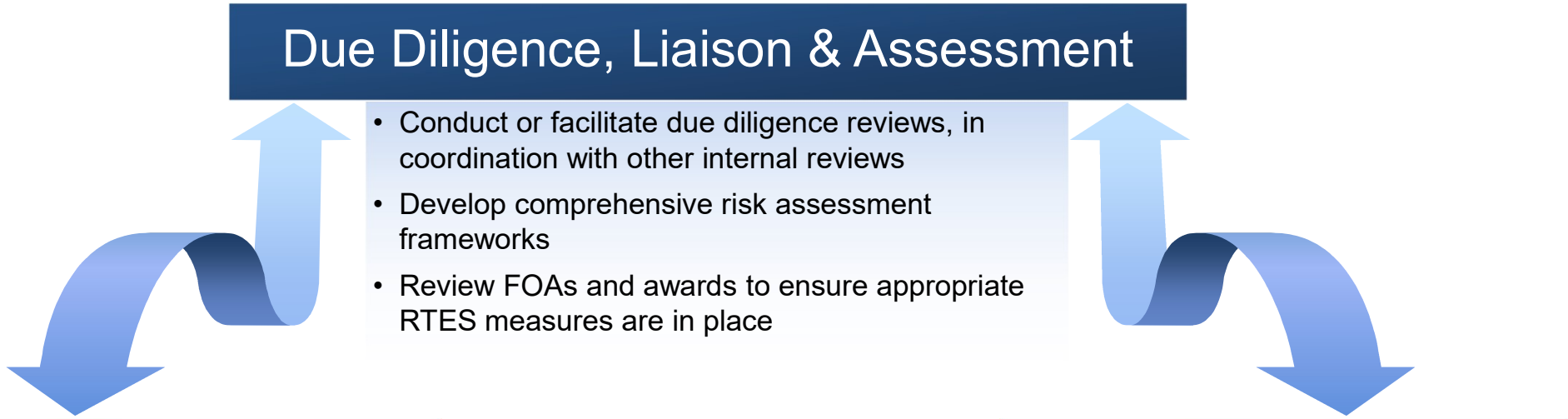
Frontier and Aurora, #2 and #3 on the Top500 list of Supercomputers, **lead the world in computational capability**, and are also **#1 and #2 in the world for AI capability.** Frontier demonstrates that it is possible to achieve immense computational power with energy efficiency.

Research Security at DOE: An Evolving Landscape

- Given DOE's broad mission space, the **research, technology, and economic security (RTES)** policies need to address a wide range of risk levels, and our implementation must be risk-based.

- As RTES policies are developed, DOE and National Labs ensure balance to…
  - Continue to attract and retain the best and brightest;
  - Promote principled international collaborations, which are most beneficial to all when they are:
    - **Built upon** openness, transparency, parity of intellectual and financial contributions, and mutual respect of IP rights
    - **Driven by** scientist-to-scientist ties and scientific community interest
    - **Promoting** US competitiveness and discovery of the 'best science'

Primary RTES Office Functions



Thank you!

Questions?

U.S. Department of ENERGY | Office of Science

https://science.osti.gov/