Research Strategies Subcommittee: Status Update

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U.S. DEPARTMENT OF ENERGY | Office of Science

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BESAC Charge to the Subcommittee

To establish a subcommittee of BESAC to follow up on its 2021 benchmarking report and advise SC and BES on strategies for prioritizing BES research investments. The goal is to have the report approved by BESAC at the Spring or Summer 2024 meeting.

As a first step in this direction, I ask BESAC to propose strategies for evaluating the prioritization of research investments in BES-supported domains.

These proposals should be area-agnostic strategies that BES management and staff can subsequently apply to specific research topics as BES and the research community go forward. Some questions that BESAC could consider in this report include:

Questions to Consider – from the Charge

- How should BES determine that a topical area is a high priority for increased investment?
- How should BES determine that a topical area is a low priority for continued investment and could be reduced or phased out?
- How should BES identify new topical areas for investment?
- As disciplines converge on complex problems, how should BES identify and foster cross-cutting areas for investment?
- How should BES balance research and instrumentation support for National Laboratories?
- How should BES balance research and instrumentation support for academic grants?

Questions to Consider – from the Charge

- What should be the balance among the research modalities (single principal investigator, small groups, and team research [e.g., EFRCs, Energy Innovation Hubs, Quantum Information Science Research Centers, and computational science centers]) for the future?
- How should BES weigh the potential for technological impact in defining investment priorities?
- How can BES play a useful role in enabling innovations to cross the “valley of death”?
- How sharp or fuzzy should the “basic-applied boundary” be?
- How should BES take account of international competition in its research domains?
- How frequently should these evaluations be revisited?
- **Note: Demographics and appropriate inclusivity in the distribution of funding is a core consideration.**

Subcommittee Members

Berry, Joseph	NREL
Chen, Lin	ANL/Northwestern
Cooper, Valentino	Oak Ridge National Laboratory
Daniels-Race, Theda	LSU
DeBeer, Serena	Max Planck Institute
Epps, Thomas	Delaware
Garcia, Jamie	IBM
Guzman, Javier	ExxonMobil
Helms, Brett	LBNL
Huq, Ashfia	SNL
Isaacs, Eric	Carnegie Institute
Kastner, Marc **(Vice Chair)**	MIT Retired
Mallapragada, Surya	Ames Laboratory, Iowa State
Meng, Shirley	ANL/U Of Chicago
Musumeci, Pietro	University of California, Los Angeles
Segalman, Rachel	UC-Santa Barbara
Takeuchi, Esther **(Chair)**	BNL/Stony Brook University
Tirrell, Matt	ANL/U Chicago

Approach

- Compilation, analysis and discussion of prior reports from other organizations relevant to assessment of research portfolios.
- Discussion of current approaches in use at DOE.
  - Information provided by BES staff on methods currently employed.
- Four sub-groups are addressing specific topics.
- Subgroups have conducted their analyses and developed summary slides.
- Subcommittee meeting monthly, team leads 2X per month

Subgroups

- **Sub Group 1** — **Document the DOE BES objectives.**
  Matt Tirrell (TL), Lin Chen, Tino Cooper, Javier Guzman
- **Sub Group 2** — **Document the DOE BES current practices used for portfolio analysis.**
  Eric Isaacs (TL), Joe Berry, Theda Daniels-Race, Rachel Segalman
- **Sub Group 3** — **Summarize relevant aspects of prior reports compiled by the subcommittee.**
  Pietro Musumeci (TL), Thomas Epps, Jamie Garcia, Surya Mallapragada
- **Sub Group 4** — **Conduct test case of portfolio analysis for an area considered in the International Benchmarking Report.**
  Shirley Meng (TL), Serena DeBeer, Brett Helms, Ashfia Huq

Subgroup 1: Document the DOE BES objectives.

- This subgroup translated the charge letter into desired and achievable outcomes.
- The charge letter posed questions.
- This group transformed the questions into statements of desired outcomes that the study would enable.
- Work consisted of thorough discussions of the questions posed in the charge letter.
- An effort was made to think beyond the charge letter (“*out-of-the-box”*) to suggest desired outcomes
- A set of statements are used to characterize the desired outcomes of this study.

Subgroup 1: Document the DOE BES objectives - Summary

1) BES strengthens its investments to maintain and advance foundational scientific knowledge and international competitiveness.
2) BES is nimble in investing and disinvesting in topical areas of research.
3) BES optimizes the balance in its portfolio of university and national laboratory research.
4) BES optimizes balance in funding research and instrumentation.
5) BES optimizes the balance among various modalities of funding: PI, group, team, center, hub...
6) BES addresses increasing costs of research.
7) BES has effective tools for insight into evaluating basic research that is use-inspired.
8) BES has effective approaches into how to invest in and prioritize workforce- enhancing measures relative to research, instrumentation, and facilities.

Subgroup 2: Document the DOE BES current practices used for portfolio analysis.

BES Strategic planning: effective balance of bottom up and top down

Strategic planning:

- Is critical to defining BES research directions
- Is a major component of BES program managers' and leaderships' jobs
- Enables BES to effectively address cutting edge foundational science and long-standing energy science challenges

BES strategic planning involves the synthesis of multiple streams of input:

- Scientific communities (workshops/roundtables, PI meeting, conferences, etc.)
- International trends
- DOE SC priorities
- Other Federal agency and non-governmental activities and priorities
- Administration (DOE, White House), Congressional priorities

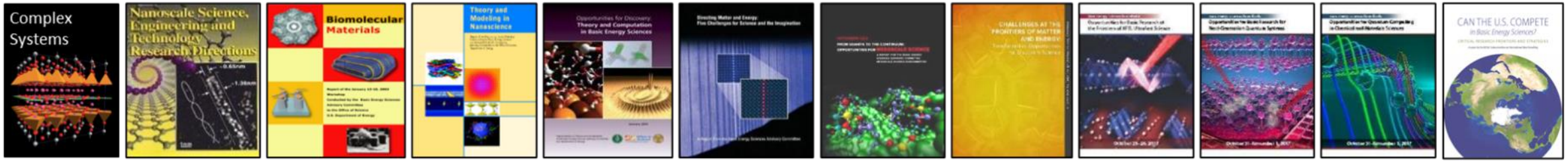
Subgroup 2: Document the DOE BES current practices used for portfolio analysis.

BES self-evaluation of its research portfolio

- Many dimensions to success are considered
- Performance of PIs as evidenced through the metrics mentioned above
- The balance in supported institution type (e.g., R1/non-R1, MSI, ERI, DOE lab) and location (e.g., institutions in EPSCoR eligible states, geographic regions)
- Progress in scientifically challenging areas
- Transition of discovery to applied R&D
- Important awards for BES-funded research as well as technology impacts
- Quantitative metrics and qualitative metrics that are obtained through formal reviews and informal discussion between BES and performers are synthesized and considered collectively to determine the overall health of the program

20+ Years of Community-driven Input

Science for Discovery



Science for National Needs

National Scientific User Facilities, the 21st century tools of science

Subgroup 3: Summarize relevant aspects of prior reports compiled by the subcommittee

- Conducted general review/summary of various reports available in the literature on research assessment to identify relevant material
- Collected and organized common recurring ideas and concepts in research assessment by themes
- Extracted relevant lessons learned and best practices to inform recommendations

RoRI RESEARCH ON RESEARCH INSTITUTE

NIH Office of Portfolio Analysis

The Leiden Manifesto for research metrics

Signatory of DORA

Subgroup 3: Summarize relevant aspects of prior reports compiled by the subcommittee

- **NIH Portfolio Assessment - Machine Learning Portfolio (2021-2025)**
  - Document: NIH office of portfolio analysis 2021-2025
  - Use AI/Machine learning techniques to quantify a retrospective method for future work

- **NASA: Foundations of a Healthy and Vital Research Community for NASA Science (2022)**
  - Analysis of needs and current portfolio for items relevant to NASA.

- **UK: The Metric Tide (2014)**
  - Document: RE-151221-TheMetricTideFullReportExecSummary(1)
  - Creation of the REF (research excellence framework) model

- **Future Research Assessment Programme (FRAP) (2020): discusses The Metric Tide**
  - Document: Harnessing the Metric Tide - December 2022 – final
  - Panel in the UK that discusses the impact of the REF model and provides recommendations

Subgroup 3: Summarize relevant aspects of prior reports compiled by the subcommittee

- **San Francisco Declaration on Research Assessment DORA (2012)**
  - Document for strategies for the future: DORA-Strategic-Plan-2023-2026-FINAL
  - One of the original groups to create a declaration to improve guidelines for research metrics
- **Leiden Manifesto (2015)**
  - Document: Leiden Manifesto
  - Use 10 principles to guide research assessment based on more qualitative judgment
- **Research on Research Institute (RoRI, 2021) Working Paper**
  - Document: RoRI_Responsible_Research_Assessment_2020
  - Create a summary on why DORA was created and provide case studies on how DORA + other leaders in the research metric community have impacted the way research is measured
- **Netherlands: Strategy Evaluation Protocol (SEP, 2021-2027)**
  - Document: Netherlands Standard Evaluation Protocol_2021-2027
  - Purpose: Highlight a different perspective on how to create a committee and assess research throughout a 6 year period. Self-evaluation from a research unit is discussed.

Subgroup 3: Summarize relevant aspects of prior reports compiled by the subcommittee - Summary

- Publication/patents/other numerical metrics

  Quantitative metrics. Risks and danger of solely relying on these (DORA, Leiden, Metric Tide).

  Need for balanced approach. Combine multiple indicators (e. g. tech transfer).

- Methodologies and AI/ML tools in research assessment

  AI/ML methods (NIH) developed to normalize across fields and evaluate impact of scientific results or programs. Importance of developing transparent and simple tools for data collection and analysis.

- Expert input

  Addresses limitation in isolated numerical metrics. Provide normalization by field and apply field/program specific considerations. Broad and comprehensive (inclusive) is must.

- Inclusion of funded investigators into planning of research directions

  UK/Netherlands reports emphasize relevance of self-assessment. Helps both research assessors and investigators to make sure that program goals are met.

Subgroup 4 – Conduct test case of portfolio analysis for an area considered in the International Benchmarking Report

- Portfolio analysis aids in ensuring resources are being allocated efficiently and effectively. It also serves to identify underperforming areas that may need more support or areas where resources could be better utilized elsewhere.
- A data-driven approach aids in more quickly identifying areas where improvements may be needed to ensure that the highest scientific and ethical standards are being upheld.
- Basic energy science is a rapidly evolving field on a global stage. It is critical to devise and test methods for identifying new fields of research with the potential to disrupt the field, but remain nascent and primed for future BES investments.
- Risk assessment provides a complementary understanding of what would happen were the U.S. left behind, due to lack of sustained investment.
- It is realized that cost could be a consideration in advanced methods of portfolio analysis.

Subgroup 4 – Conduct test case of portfolio analysis for an area considered in the International Benchmarking Report

- Portfolio analyses need to be field specific
  - For a more mature field – research cost is different than emerging fields
- Possible leading indicators: Funding, Citations, Awards, Industry Growth
- Time-series data should be an aspect in the analysis
- Growth trend (science instead of commodity)
- Metrics should be available to PMs
  - Maintain subject matter expertise.
  - Provide career development opportunities to PM's. This is particularly important to catch innovations and early work in a burgeoning field.

Subgroup 4 – Conduct test case of portfolio analysis for an area considered in the International Benchmarking Report - Test Case

1. Joint Center for Energy Storage Research (JCESR):

- JCESR is a DOE Energy Innovation Hub. The Hub mission is to advance promising areas of energy science and engineering from the earliest stages of research to commercialization. (2012-2023)

2. EFRC:

1. Breakthrough Electrolytes for Energy Storage and Systems (BEES2) Robert Savinell (Case Western Reserve U.); Class: 2018-2026 (active)
2. Center for Mesoscale Transport Properties (m2m#S) Amy Marschilok (Stony Brook University); Class: 2014-2026 (active)
3. Mechano-Chemical Understanding of Solid Ion Conductors (MUSIC) Jeff Sakamoto (U. Michigan); Class: 2022-2026 (active)
4. Fast and Cooperative Ion Transport in Polymer Based Materials (FaCT)Valentino R. Cooper (ORNL); Class: 2022-2026 (active)
5. *Synthetic Control Across Length-scales for Advancing Rechargeable (SCALAR) Sarah Tolbert (UCLA); Class: 2018-2024*
6. *Nanostructures for Electrical Energy Storage (NEES) Gary Rubloff (UMD); Class: 2009-2020*
7. *The NorthEast Center for Chemical Energy Storage (NECCES) Stanley Whittingham (SUNY Binghamton) 2009-2020*
8. *Center for Electrochemical Energy Science (CEES) Paul Fenter (ANL); Class: 2009-2020*

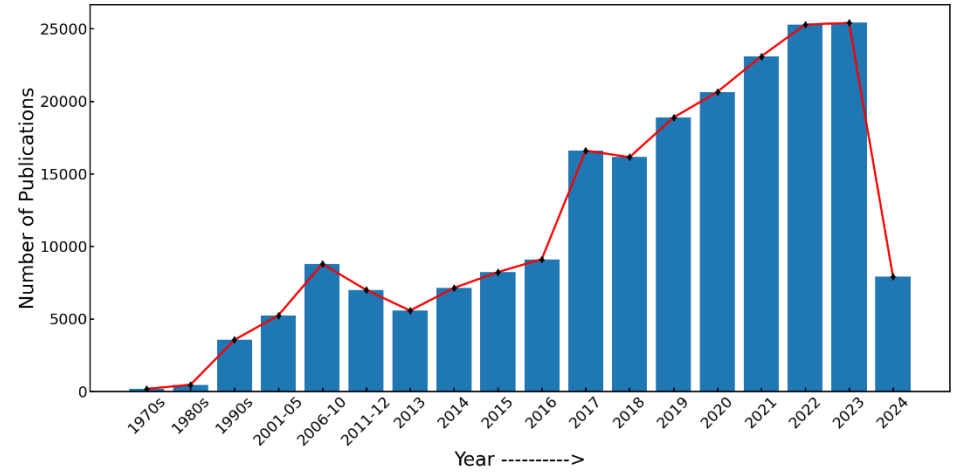
3. EERE Battery500 and other consortiums (EERE)

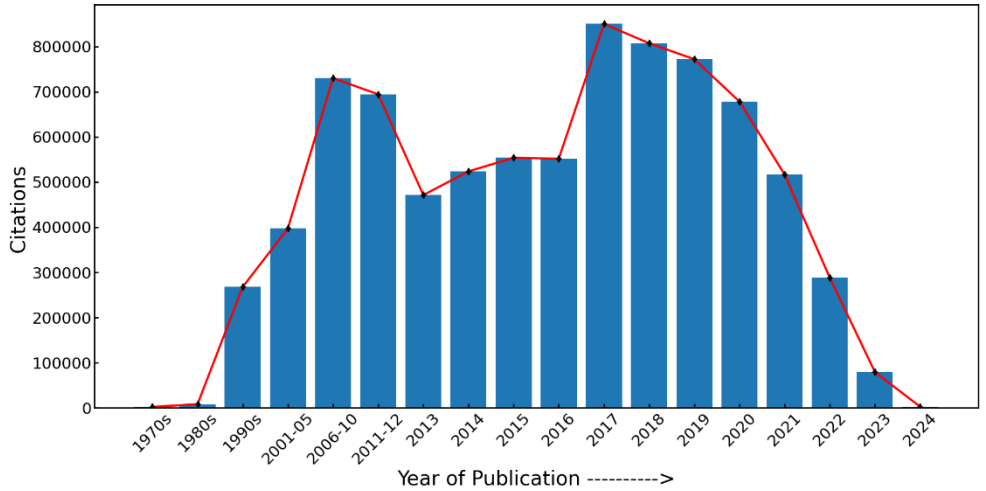
4. Volta Foundation Battery Report (non-profit) and Faraday Report (UK)

Subgroup 4 – Conduct test case of portfolio analysis for an area considered in the International Benchmarking Report: Example Approach

- Publications
- Citations
- Patents
- Workforce Development (# of alums)
- Industry interactions
- Amount of Funding
- Comparison with similar activities in Europe and Asia, data from international hubs
- Awards/Fellowships

May indicate trend toward interest in battery types beyond lithium.





WOS Search word: Lithium Ion Battery

Subcommittee Findings

BES current practices in use are effective.

BES strategic planning necessarily involves the synthesis of multiple streams of input.

- Engagement of scientific communities (workshops/roundtables, PI meeting, conferences, etc.).
- Consideration of DOE SC priorities, Federal agency and non-governmental priorities, Administration and Congressional priorities.
- PMs consider both cutting edge foundational science and long-standing energy science challenges and needs.
- Portfolio analysis is an important tool for effective strategic planning to provide information relative to defining BES research directions.

Subcommittee Findings

- Prior report of portfolio analysis by NIH using ML/AI approaches. Significant investment is required, so the benefit versus the investment needs to be considered.
- Significant assessment of prior reports on research analysis is useful. It is necessary to separate the approaches evaluating the program or PI versus the portfolio.

Appropriate advances in portfolio analysis methodology could assist BES in the following:

- maintain and advance foundational scientific knowledge and international competitiveness.
- be nimble in investing and disinvesting in topical areas of research
- balance its portfolio of university and national laboratory research; research and instrumentation; various modalities of funding (PI, group, team, center, hub).
- manage increasing costs of research.
- insight into effective tools for evaluating basic research that is use-inspired and may have technological impacts.
- Appropriate investment and prioritization of workforce enhancing measures relative to research, instrumentation, and facilities.

Subcommittee Recommendations

BES should continue the practices that are effective.

BES should continue to incorporate appropriate metrics for success that ensure BES portfolio breadth and reach (locale, institution type, level of risk, etc.)

Continued use of qualitative measures is recommended.

Portfolio Analysis is important. Continued and expanded use is warranted.

BES should consider some innovative approaches for assessing new and emerging scientific trends.

Subcommittee Recommendations

Portfolio Analysis

The desired goals of the portfolio need to be clearly outlined and communicated.

- The portfolio should be assessed for investment balance to investigate the impact on achieving the outlined goals.
- Portfolio analysis is possible using currently available tools (subgroup 4 example)
- New tools (AI/ML/language processing) should be considered for use to evaluate the portfolios as a whole and their impact on achieving the stated goals.
- Outcomes of AI/ML based tools not yet totally clear and new tools should be evaluated for appropriate application to BES.
- Develop appropriate training tools to ensure robust and accurate implementation of research portfolio assessment approaches.
- Consideration of implementation cost is a factor.
- Collaboration across agencies for common tools and assessment strategies can help identify emerging and cross-cutting initiatives, as well as overlap with different branches of DOE/other funding agencies. This may also be an approach to mitigate the cost of implementation.

Subcommittee Recommendations

Possible approaches for identifying and assessing new and emerging scientific trends.

- Analyze topics proposed to the early career program and other FOAs to identify trends.
- Encourage BES Program Managers to include awards for small programs to specifically support new directions in their portfolio.
- Broaden internal BES program manager strategic planning to include ARPA-like pitches for new directions that could be highlighted in the annual FOA
- Use team research modalities to foster new ideas.

Original

- Analyze what topics new postdoctoral scientists are pursuing.
- Create a program where BES Program Managers manage small programs to specifically drive new ideas with internal pitches for funding.
- Use EFRCs to incubate new ideas.