Measuring and Assessing the Value and Scientific ROI of NERSC's Leadership Computing in Advancing Science Key Findings

October 4th, 2024

www.HyperionResearch.com
www.hpcuserforum.com

Mark Nossokoff, Jaclyn Ludema, and Earl Joseph

About Hyperion Research

(www.HyperionResearch.com & www.HPCUserForum.com)

Hyperion Research mission:

- *Hyperion Research helps organizations make effective decisions and seize growth opportunities*
  - *By providing research and recommendations in high performance computing and emerging technology areas*

HPC User Forum mission:

- *To improve the health of the HPC/AI/QC industry*
  - *Through open discussions, information sharing and initiatives involving HPC users in industry, government and academia along with HPC vendors and other interested parties*

The Hyperion Research Team

Analysts

- Earl Joseph, CEO*
- Bob Sorensen, SVP Research
- Mark Nossokoff, Research Director*
- Jaclyn Ludema, Analyst*
- Melissa Riddle, Data Analyst
- Thomas Sorensen, Analyst

Executive

- Jean Sorensen, COO

Global Accounts

- Mike Thorp, Sr. Global Sales Executive*
- Kurt Gantrish, Sr. Account Executive

Survey Specialist

- Cary Sudan, Principal Survey Specialist

Consultants

- Katsuya Nishi, Japan and Asia
- Kirsten Chapman, KC Associates
- Andrew Rugg, Certus Insights
- Jie Wu, China and Technology Trends
- Mara Jacob, HPC User Forum Support

* Primary contributors on this project

Agenda

- **Project Goals**
- **Methodology**
- **Demographics**
  - Study participants
  - NERSC Office, Program, & Science Category profiles
  - Additional projects included
- **Key Findings**
  - Notable research conducted at NERSC
  - Overview
  - Innovation Return on Research (RoR)
- **Other Findings**

Project Goals

- **Measure and convey the impact, value and scientific ROI of investments in leadership computing centers**
- **Show the value and returns from scientific research, R&D, discoveries and other accomplishments made through the use of large-scale advanced computing**
- **Provide the ability to articulate the value that comes from investments in leadership computing**
- **Focus of the assessment will be projects conducted at NERSC, including projects over the last few decades**


Methodology

- **Used the Hyperion Research framework that measures the value of scientific computing projects to fit NERSC's unique mission:**
  - Advancing Science, Advancing Engineering, Economic Growth, Saving Lives, National Security
- **Measured the historical value by surveying individual projects and accomplishments**
  - NERSC provided researchers' contact information, research topics
  - NERSC introduced Hyperion Research and requested support for the project
  - Hyperion Research invited researchers to participate and schedule 30-minute phone conversations
- **Analyzed the results and compare the results to other sites**

Study Research Projects

Principal Investigator (PI)	Organization	Research Title
Aluie, Hussein	University of Rochester	Computational Studies Across Time and Length Scales of Multifunctional Ionic Polymers Membranes
Austregesilo, Alexander	Jefferson Lab	Analysis and Simulation for the GlueX Detector: studying the strong nuclear force and searching for exotic configurations of quarks and gluons
Bajdich, Michal	SLAC National Accelerator Laboratory	SUNCAT-FWP CATALYSIS PROJECT: focusing on CO2 reduction, nitrogen reduction, and water splitting
Baron, Edward	University of Oklahoma	High performance computing in support of the DIII-D National Fusion Facility
Baron, Edward	University of Oklahoma	Synthetic Spectra of Astrophysical Objects
Burrows, Adam	Princeton University	Three-Dimensional Simulations of Core-Collapse Supernovae: to understand how supernova explosions occur, resulting in the formation of neutron stars or black holes.
Calafiura, Paolo	Lawrence Berkeley National Laboratory	Detector Simulation of the CERN ATLAS Detector on NERSC HPCs
Car, Roberto	Princeton University	Chemistry in Solution and at Interfaces: to fit the potential energy of interaction among atoms.
Ching, Wai-Yim	University of Missouri - Kansas City	Structure refinement of Spike-protein of SARS-COV-2: This approach allows them to analyze the entire complex structure of the virus, rather than breaking it down into smaller separate pieces.
Christ, Norman	Columbia Univeristy	High Energy Particle Physics - Symmetry of Nature. The equivalence of particles and antiparticles. Right-handed vs. left-handed
DeTar, Carleton	University of Utah	Flavor physics: the focus is on understanding physics beyond the Standard Model
Fagnan, Kjiersten	DOE Joint Genome Institute (JGI)	Joint Genome Institute - Production Sequencing and Genomics: researching areas such as nutrient cycling, biofuels, microbial communities, and plant genomics.
Galli, Giulia	University of Chicago	First Principles Simulations of Nanostructures: to study matter at the atomic level
Gavini, Vikram	University of Michigan	PRISMS: Integrated multiscale modeling of Mg structural alloys: The goal is to understand and improve the mechanical properties of magnesium alloys

Study Research Projects (continued)

PI	Organization	Research Title
Glezakou, Vassiliki	Oak Ridge National Laboratory	Carbon management and energy efficiency through multifunctional catalysis
Gottlieb, Ore, Tchekhovskoy, Alexander (Sasha)	Northwestern University	Effects of remnant neutron star lifetime on compact object merger outflows, nucleosynthesis, and emission: The goal is to connect the merger event itself with the observable electromagnetic signatures, allowing scientists to extract valuable physics information from these observations.
Gupta, Rajan	Los Alamos National Laboratory	High Precision Calculations of the Nucleon Structure for Fundamental Symmetries: to create a better understanding the properties of neutrons and protons.
Gupta, Rajan	Los Alamos National Laboratory	Lattice QCD search for physics beyond the standard model
Hoffman, Forrest	Oak Ridge National Laboratory	Reducing Uncertainties in Biogeochemical Interactions through Synthesis and Computation (RUBISCO): to study the interactions between biogeochemistry and the climate system.
Howard, Dr. Nathan	Massachusetts Institute of Technology	Computational Studies in Plasma Physics and Fusion Energy: Multi-scale Turbulence in Tokamak Reactors: to reduce heat and particle losses in fusion plasmas.
Jardin, Stephen	Princeton Plasma Physics Laboratory	3D Extended MHD simulation of fusion plasmas: for tokamak fusion reactors.
Jena, Puru	Virginia Commonwealth University	Cluster and Nanostructure for Energy and Bio Applications: for improved energy production and storage.
Leung, Lai-Yung Ruby	Pacific Northwest National Laboratory	Water Cycle and Climate Extremes Modeling (WACCEM): to understand how various aspects of the water cycle, particularly precipitation, have changed in the past and how they might change in the future.
Leung, Lai-Yung Ruby	Pacific Northwest National Laboratory	Energy Exascale Earth System Modeling (E3SM): improving the understanding of how energy use contributes to climate change and how climate change may affect future energy use and infrastructure.
Mavrikakis, Manos	University of Wisconsin - Madison	First-Principles Catalyst Design for Environmentally Benign Energy Production: to uncover why certain materials are effective catalysts while others are not.
Mccallen, David	Lawrence Berkeley National Laboratory	High Performance Simulations for Regional Scale Earthquake Hazard and Risk Assessments
Monzani, Maria Elena	SLAC National Accelerator Laboratory	LZ - LUX ZEPLIN experiment, which aims to detect dark matter.
Perahia, Dvora	Clemson University	Computational Studies Across Time and Length Scales of Multifunctional Ionic Polymers Membranes: The focus is on polymers with ionic groups that can conduct ions, generate electricity, and trap nanoparticles.

Study Research Projects (continued)

PI	Organization	Research Title
Petreczky, Peter	Brookhaven National Lab	Quarkonia in Hot Medium: the properties of matter under extreme conditions.
Qian, Jin	Lawrence Berkeley National Laboratory	From Molecules to Continuum: Developing a Universal Approach for Accurate Description of X-ray Photo: for nanoscale phenomena.
Qiu, Diana	Yale University	Electronic and Optical Properties of Layered Materials for Energy Applications: to develop new theoretical and computational tools for understanding how materials interact with light.
Radice, David	The Pennsylvania State University	Nuclear Astrophysics with Numerical Relativity: the collision between neutron stars
Ryne, Robert	Lawrence Berkeley National Laboratory	Frontiers in Accelerator Design: Advanced Modeling for Next-Generation BES Accelerators: the design and development of particle accelerators.
Sako, Masao	University of Pennsylvania	The Dark Energy Survey Supernova Search: The project aimed to measure the properties of around 300 million galaxies and discover thousands of new supernova explosions.
Sankaranarayanan, Subramanian	Argonne National Laboratory	Development of New Force Fields using Machine Learning and First Principles Physics
Sharifzadeh, Sahar	Boston University	Large-Scale Many-Body Perturbation Theory Simulations of Optoelectronic Materials: to understand the electronic properties of materials at the atomic scale.
Smith, Sterling	General Atomics	Computing in support of the DIII-D National Fusion Facility: the goal is to study how to confine and heat plasma efficiently enough to achieve fusion
Trebotich, David	Lawrence Berkeley National Laboratory	Advanced Simulation of Pore Scale Flow and Transport Processes in Nanoporous Materials: examining how fluids interact with materials at a microscopic level (around 1-100 microns).
Ullrich, Paul	University of California Davis	A Framework for Improving the Analysis and Modeling of Earth System and Intersectoral Dynamics at Regional Scales
Vermaas, Josh	Michigan State University	Large Scale Molecular Simulations to Support Photosynthesis and Carbon Fixation
Wang, Hailong	Pacific Northwest National Laboratory	High-Latitude Application and Testing (HiLAT) of Earth System Models & Regional Arctic System Model
Wu, Xifan	Temple University	Theoretical spectra calculations of liquid water and ion solutions

Collaborating Organizations

The PIs were supported by many research organizations and utilized supporting computational computing facilities

- **Supporting research organizations**
  - Brookhaven National Lab
  - CERN
  - Indiana University
  - MIT
  - Pittsburgh Supercomputer Center
  - Sandia National Lab
  - UC-Berkeley
  - UC-Davis
  - University of Arizona
  - University of Bristol
  - University of Connecticut
  - University of Edinburgh
- **Supporting computational facilities**
  - PI host/local organization clusters
  - Argonne National Lab
  - Hamburg University
  - HLRN
  - Jefferson Lab
  - Jüelich
  - Oak Ridge National Lab
  - Lawrence Livermore National Lab
  - NCAR
  - NCSA
  - TACC
  - University of Chicago
  - University of Georgia

Additional Projects Included

- **6 Nobel Prize winners utilized NERSC resources**

Year	Category	Principal Investigator (PI)	Research Title	Organization
2017	Chemistry	Frank Joachim, Eva Nogales	Correlative Cryo-EM and Molecular Dynamics Simulations of Ribosomal Structure	Lawrence Berkeley National Laboratory
2015	Physics	Takaaki Kajita, Art McDonald	Sudbury Neutrino Experiment	Tokyo University; Queen's University (Kingston, Ontario)
2013	Chemistry	Martin Karplus, Paul Bash	Multiscale Chemical Modeling	Harvard; Northwestern
2011	Physics	Saul Perlmutter	Supernova Cosmology Project	Lawrence Berkeley National Laboratory
2007	Peace	Warren Washington, et al	Fourth Report of the Intergovernmental Panel on Climate Change (IPCC) (climate modelling)	NERSC
2006	Physics	George Smoot	Birth of Precision Cosmology	Lawrence Berkeley National Laboratory

- **Other notable leadership site accomplishments**
  - First large-scale application to achieve Tflop performance
  - Global repository for LHC raw data and ensuing analysis enable worldwide collaboration

NERSC Office, Program, and Science Category Profiles of Participants

Office	#
Basic Energy Sciences	16
High Energy Physics	7
Nuclear Physics	7
Biological and Environmental Research	6
Fusion Energy Sciences	4
NERSC Directors Reserve	2

Program	#
Chemical Sciences, Geosciences, & Biosciences (CSGB)	9
Nuclear Physics	7
High Energy Physics	6
Materials Sciences and Engineering	6
Earth and Environmental Systems Sciences Division (EESSD)	5
Fusion Energy Sciences	4
Biological Systems Science	1
DDR Campaign	1
DDR Scale	1
Scientific User Facilities	1

Science Category	#
Physics : Astrophysics	4
Chemistry : Catalysis	3
Chemistry : Chemical Physics	3
Earth Systems : Coupled Systems	3
Energy : Fusion	3
Physics : High Energy Physics (Theory)	3
Physics : Nuclear Physics (Theory)	3
Earth and Environmental Systems	2
Materials Science : General	2
Physics : Condensed Matter	2
Physics : High Energy Physics (Experimental)	2
Biosciences : Genomics	1
Biosciences : Molecular Science	1
Chemistry : Physical Chemistry	1
Energy : General	1
Geoscience : Geochemistry	1
Materials Science : Biomolecular Materials	1
Materials Science : Energy Storage	1
Materials Science : Soft Matter	1
Physics : Accelerator Science	1
Physics : Cosmology	1
Physics : Nuclear Physics (Experimental)	1
Physics : Plasma Physics	1

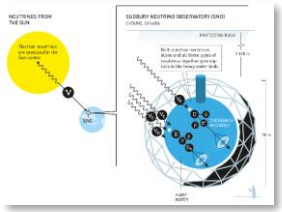
HYPERION RESEARCH

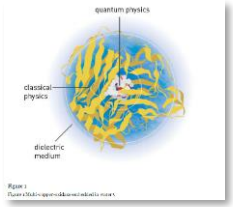
Key Findings

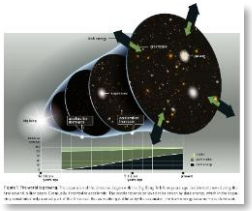
Notable Research Conducted at NERSC

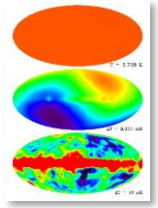
Nobel Prize Winners			
Year	**Category**	**PI**	**Research Title**
2017	Chemistry	Frank Joachim, Eva Nogales	Correlative Cryo-EM and Molecular Dynamics Simulations of Ribosomal Structure
2015	Physics	Takaaki Kajita, Art McDonald	Sudbury Neutrino Experiment
2013	Chemistry	Martin Karplus, Paul Bash	Multiscale Chemical Modeling
2011	Physics	Saul Perlmutter	Supernova Cosmology Project
2007	Peace	Warren Washington, et al	Fourth Report of the Intergovernmental Panel on Climate Change (IPCC) (climate modelling)
2006	Physics	George Smoot	Birth of Precision Cosmology

*









Select Highlighted NERSC Research	
PI	**Research Title**
Robert Ryne	Frontiers in Accelerator Design: Advanced Modeling for Next-Generation BES Accelerators
Ruby Leung	Energy Exascale Earth System Modeling
Subramanian Sankaranarayanan	Development of New Force Fields using Machine Learning and First Principles Physics
Puru Jena	Cluster and Nanostructure for Energy and Bio Applications
Paul Ullrich	A Framework for Improving Analysis and Modeling of Earth System and Intersectoral Dynamics at Regional Scales
Wai-Yim Ching	Structure refinement of Spike-protein of SARS-COV-2
Kjiersten Fagnan	Joint Genome Institute - Production Sequencing and Genomics
Sterling Smith	High performance computing in support of the DIII-D National Fusion Facility
Jin Qian	From Molecules to Continuum: Developing a Universal Approach for Accurate Description of X-ray Photo
Michal Bajdich	SUNCAT-FWP Catalysis
Giulia Galli	First principles simulations of nanostructures

* Source: nobelprize.org

Key Findings Overview

Inclusive of 6 Nobel Prize awards, 42 interviews with leading researchers and notable research from annual reports

- **Research performed at NERSC touches most scientific areas**
  - Fusion energy as an alternative fuel source
  - Astrophysics for understanding matter and the origins of the universe
  - Climate and weather for earlier, more accurate predictions
  - Water splitting for harvesting hydrogen for fuel
  - Earth sciences for mitigating impacts from earthquakes
  - Genomics to address challenges in agriculture, environmental science, and sustainable energy production
- **Advancing Science is the clear mission of most researchers**
  - Outcomes also heavily contribute to Advancing Engineering, Saving Lives, Economic Growth and National Security (non-defense-related)
- **NERSC accomplishments go beyond scientific discovery**
  - Enables collaborations with global research institutions
  - First demonstration of Tflop performance at scale
- **Glowing reviews/praise for NERSC**
  - Research would not have been possible without NERSC
  - Performance and continued roadmap of resources
  - Quality and knowledge of support personnel
  - Response timeliness of support personnel
  - Simplicity of process to submit grants & secure time on the infrastructure

Innovation Return on Research (ROR) Results

The Innovation Return on Research (ROR) Metrics Used in the Study

In order to properly quantify the innovation from HPC projects, Hyperion Research uses a rating system that measures both the importance and the impact of each innovation in this study.

- **The IMPORTANCE of this innovation compared to all other innovations in the specific field over the last ten years:**
  - 5 (One of the top 2 to 3 innovations in the last decade)
  - 4 (One of the top 5 innovations in the last decade)
  - 3 (One of the top 10 innovations in the last decade)
  - 2 (One of the top 25 innovations in the last decade)
  - 1 (One of the top 50 innovations in the last decade)

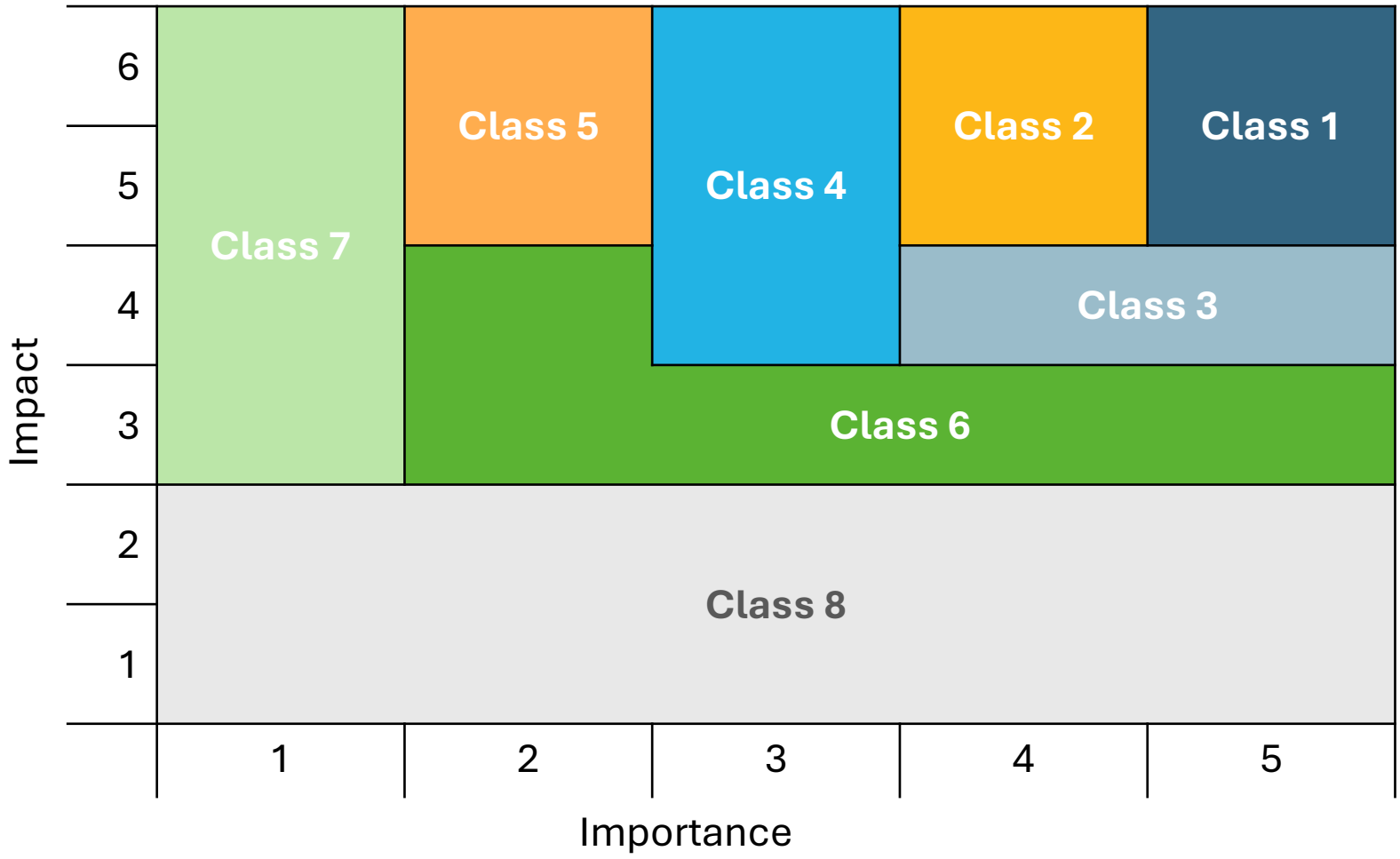
- **The IMPACT of this innovation to multiple organizations:**
  - 6 (It is useful to over 50 organizations)
  - 5 (It is useful to 10 to 49 organizations)
  - 4 (It is useful to 6 to 9 organizations)
  - 3 (It is useful to 2 to 5 organizations)
  - 2 (It is only useful to 1 organization)
  - 1 (It is recognized ONLY by experts in the field)

The Innovation Class Index

Combining these two measures, Hyperion Research creates an overall INNOVATION CLASS rating for these projects:

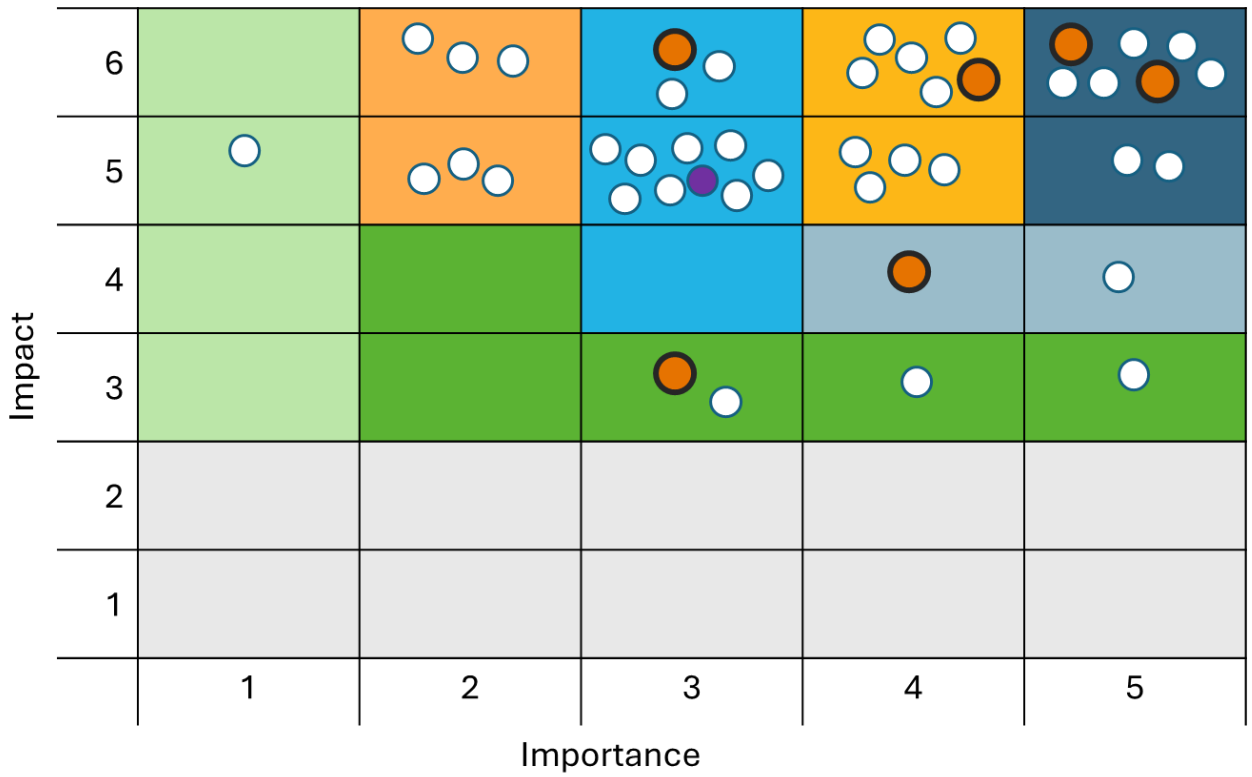
1. Class 1 innovations – One of the top 2 to 3 innovations in the last decade PLUS useful to over 10 organizations
2. Class 2 innovations – One of the top 5 innovations in the last decade PLUS useful to over 10 organizations
3. Class 3 innovations – One of the top 5 innovations in the last decade PLUS useful to over 5 organizations
4. Class 4 innovations – One of the top 10 innovations in the last decade PLUS useful to over 5 organizations
5. Class 5 innovations – One of the top 25 innovations in the last decade PLUS useful to at over 10 organizations
6. Class 6 innovations – One of the top 25 innovations in the last decade PLUS useful to at least 2 organizations
7. Class 7 innovations – One of the top 50 innovations in the last decade PLUS useful to at least 2 organizations
8. Class 8 innovations – All other innovations

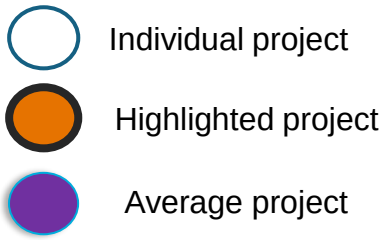
Innovation Class Research Mapping



Innovation Class Research Mapping

Majority of research from the study has high potential for substantial impact on society





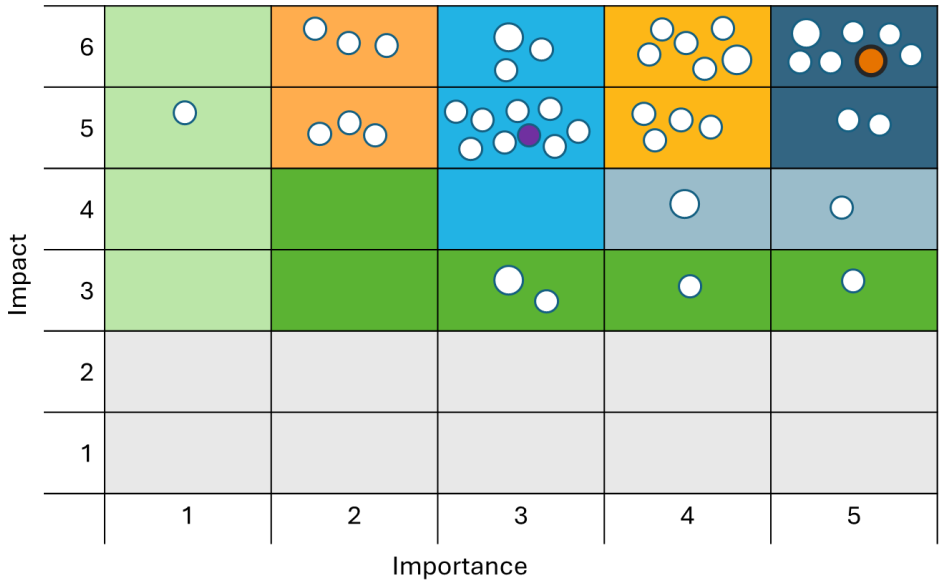
Energy Exascale Earth System Modeling (E3SM): improving understanding of how energy use contributes to current and may affect future climate change

Ruby Leung, Pacific Northwest National Lab (PNNL)

- **Summary Description**
  - Create a sophisticated earth system model that can take advantage of exascale computing capabilities.
- **Impact to the World**
  - Latest version can run at very high resolutions (down to 3 km globally), incorporating both natural earth systems and human activities.
  - Allows for complex interactions between climate change and human energy use.
  - Features variable resolution capabilities, enabling researchers to focus computational resources on specific areas of interest, such as North America or Antarctica.

Office	Program	Category
Research	EESSD	Earth Systems: Coupled Systems

Advances Science	Advances Engineering	Saving Lives	Economic Growth	National Security
x	x	x	x	x



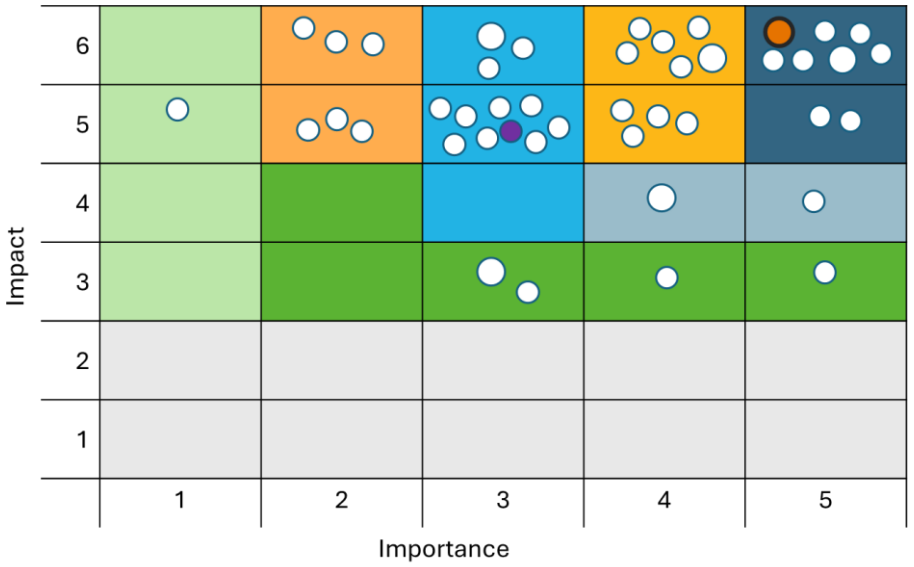
Joint Genome Institute - Production Sequencing and Genomics: researching areas such as nutrient cycling, biofuels, microbial communities, and plant genomics.

Kjiersten Fagnan, DOE Joint Genome Institute (JGI)

- **Summary Description**
  - Contribute to better understanding of nutrient cycling, the development of improved biofuels, and insights into how microbial communities work.
- **Impact to the World**
  - Addressing challenges in agriculture, environmental science, and sustainable energy production.
  - Support a large community of scientists (around 2000) who use this information for their research. The ability to process and analyze complex metagenomic samples has opened up new avenues of research.

Office	Program	Category
Biological and Environmental Research	Biological Systems Science	Biosciences: Genomics

Advances Science	Advances Engineering	Saving Lives	Economic Growth	National Security
x	x			



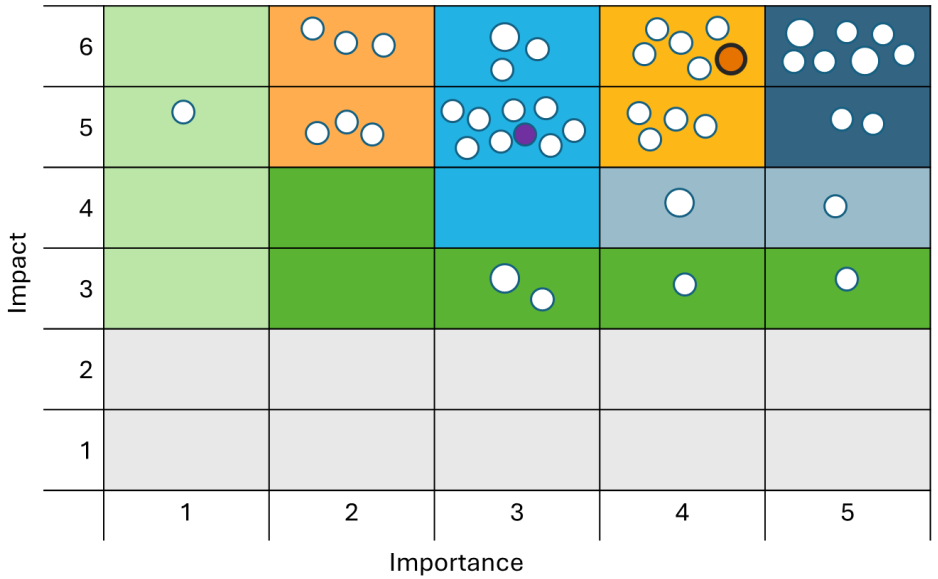
Computing in support of the DIII-D National Fusion Facility: the goal is to study how to confine and heat plasma efficiently enough to achieve fusion

Sterling Smith, General Atomics

- **Summary Description**
  - Fusion research the D3D tokamak device, a donut-shaped vacuum chamber that uses powerful magnetic fields to confine and heat plasma to extremely high temperatures.
  - Study how to confine and heat plasma efficiently enough to achieve fusion, where atomic nuclei combine to release energy.
- **Impact to the World**
  - Seeks to understand, control, and mitigate turbulence and heat transport within the plasma.
  - Scientists used NERSC's real-time queue and Superfacility API to perform rapid analysis between plasma experiments, every 15 minutes during operational days.

Office	Program	Category
Fusion Energy Sciences	Fusion Energy Sciences	Energy: Fusion

Advances Science	Advances Engineering	Saving Lives	Economic Growth	National Security
x				



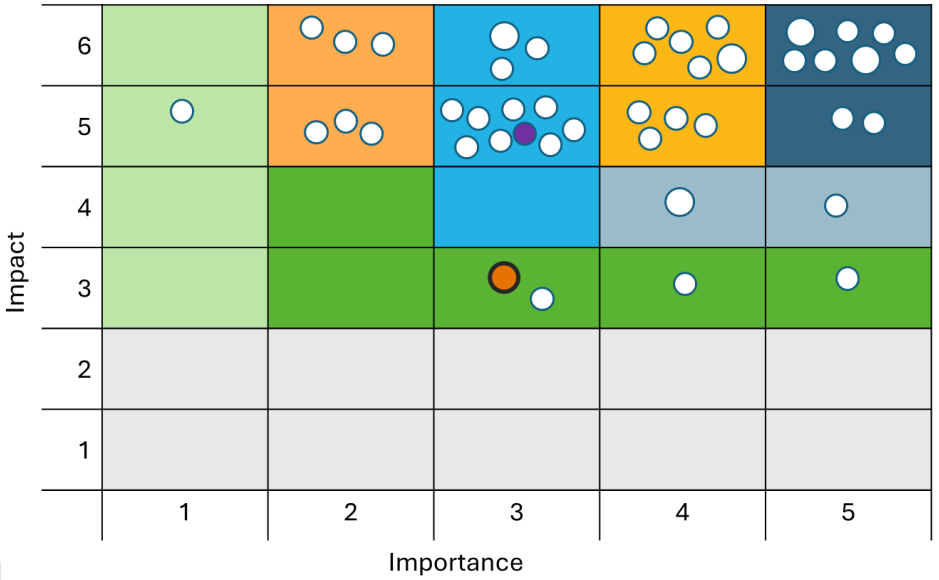
SUNCAT-FWP Catalysis Project: focusing on CO2 reduction, nitrogen reduction, and water splitting

Michal Bajdich, SLAC National Accelerator Lab

- **Summary Description**
  - Electrocatalysis, thermal catalysis, and application of machine learning and AI.
  - Development of an iridium-based catalyst for water splitting, crucial for enabling a hydrogen economy.
- **Impact to the World**
  - The iridium catalyst, optimized through computational methods, showed exceptional performance in transforming oxygen from water.
  - Demonstrated the highest activity among iridium catalysts.
  - Led to a collaboration with the largest hydrogen electrolyzer in the US.

Office	Program	Category
Basic Energy Sciences	Chemical Sciences, Geosciences, & Biosciences (CSGB)	Chemistry: Catalysis

Advances Science	Advances Engineering	Saving Lives	Economic Growth	National Security
x	x			



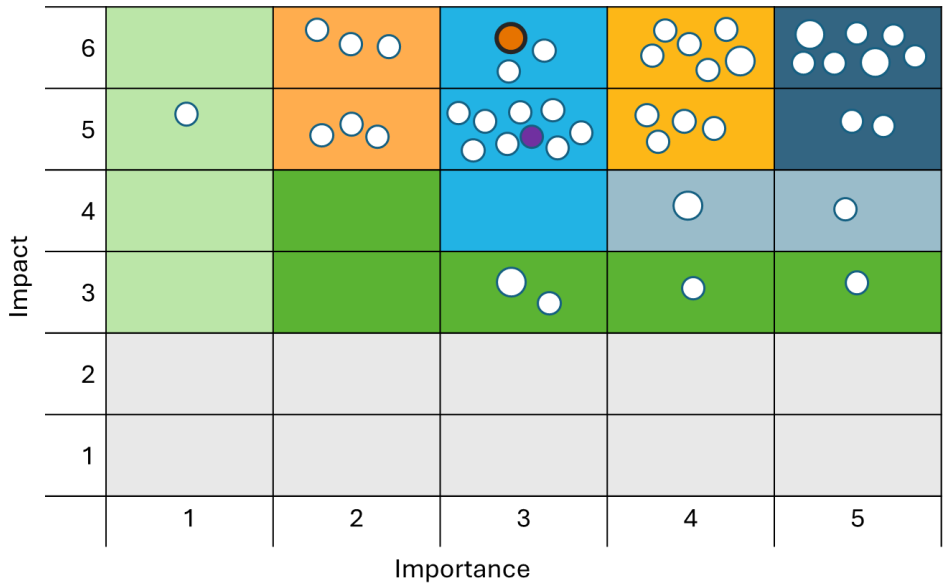
First Principles Simulations of Nanostructures: to study matter at the atomic level

Guilia Galli, University of Chicago

- **Summary Description**
  - Simulating materials at the quantum mechanical level to identify and design materials with properties suitable for quantum applications
  - Development of more efficient materials for energy harvesting and conversion.
- **Impact to the World**
  - Contribute to more powerful computers, ultra-sensitive sensors, and secure communication systems
  - Potential to accelerate the transition to clean energy technologies and reduce reliance on fossil fuels.

Office	Program	Category
Basic Energy	Materials Sciences and Engineering	Materials Science: General

Advances Science	Advances Engineering	Saving Lives	Economic Growth	National Security
x	x			



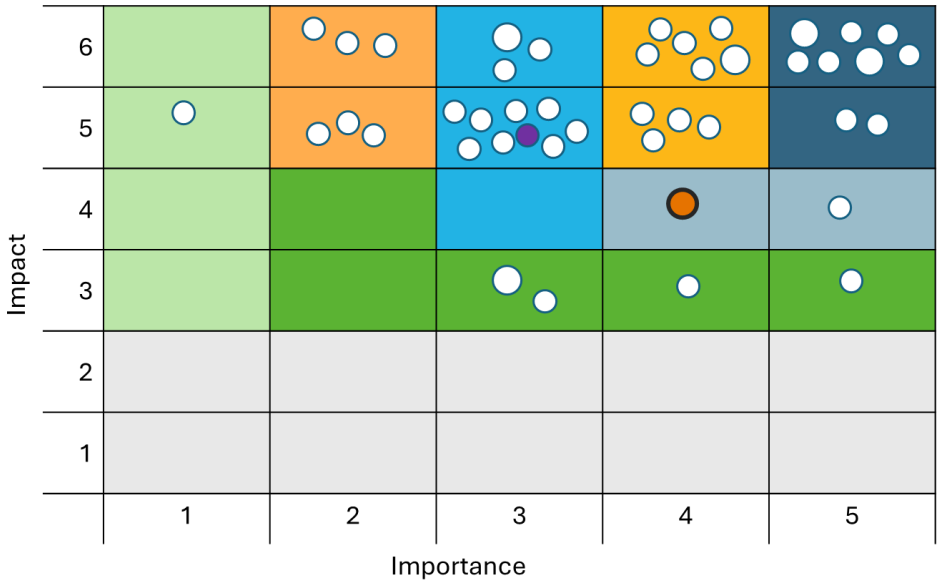
From Molecules to Continuum: Developing a Universal Approach for Accurate Description of X-ray Photo: for nanoscale phenomena

Jin Qian, Lawrence Berkeley National Lab (LBNL)

- **Summary Description**
  - Developing tools to predict spectroscopic signatures, particularly X-ray Photo Electron Spectroscopy (XPS), for nanoscale phenomena
  - using a specialized form of Density Functional Theory (DFT) called real space Kohn-Sham DFT.
- **Impact to the World**
  - Achieved simulation os systems with 10,000s of atoms, up from 100s prior.
  - Addressing chemistry and material science problems, with potential applications in catalysis and battery research.

Office	Program	Category
Basic Energy Sciences	Chemical Sciences, Geosciences & Biosciences (CSGB)	Chemistry: Chemical Physics

Advances Science	Advances Engineering	Saving Lives	Economic Growth	National Security
x	x			



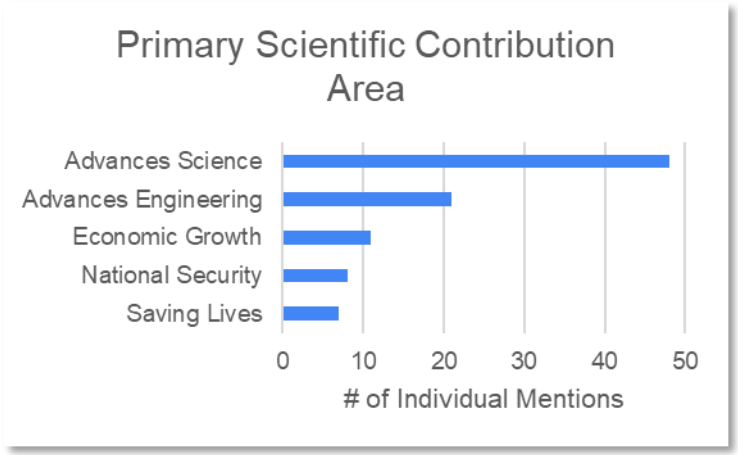
HYPERION RESEARCH

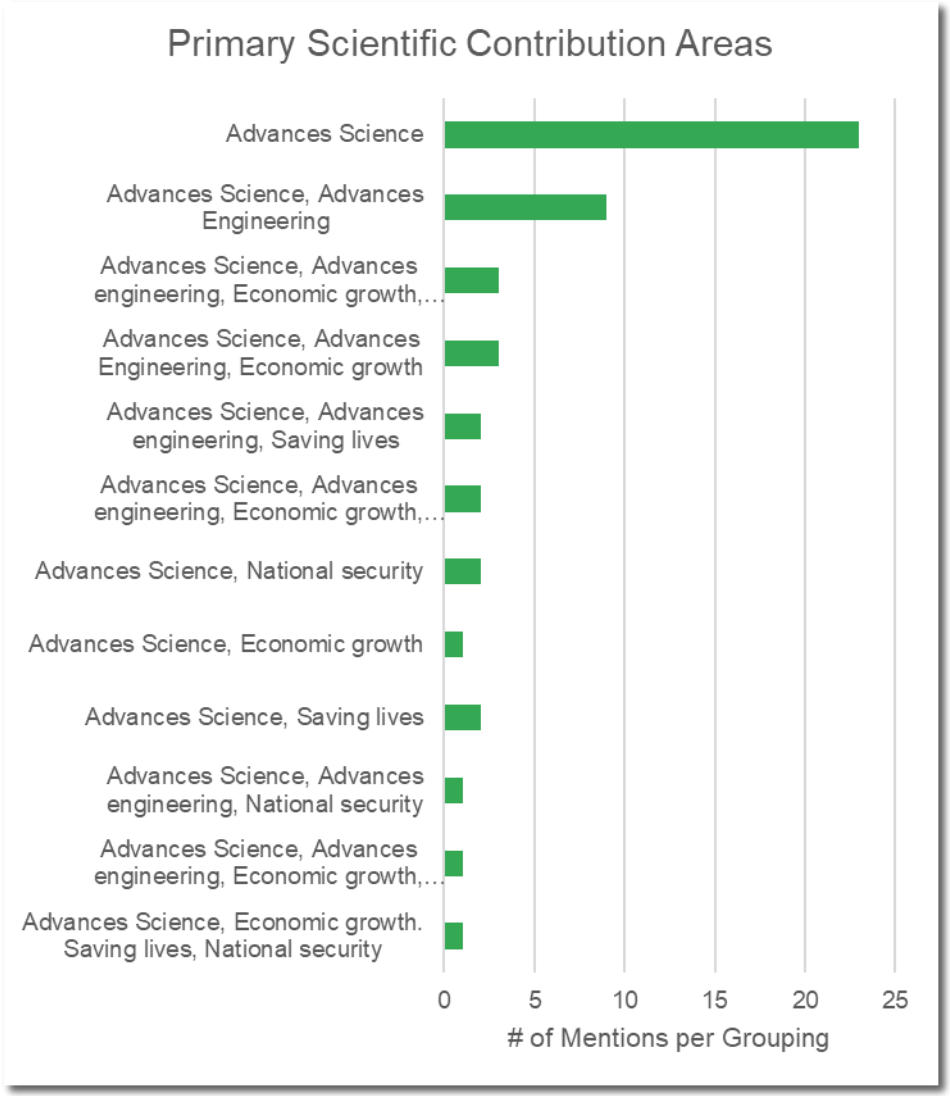
Other Findings

Primary Scientific Contribution Area

"Advances Science" was the predominant area

- **Q: *Which of the following areas best describes the primary scientific contribution of your research (select all that apply):***
  - Advances Science
  - Advances Engineering
  - Economic Growth
  - Saving Lives
  - National Security

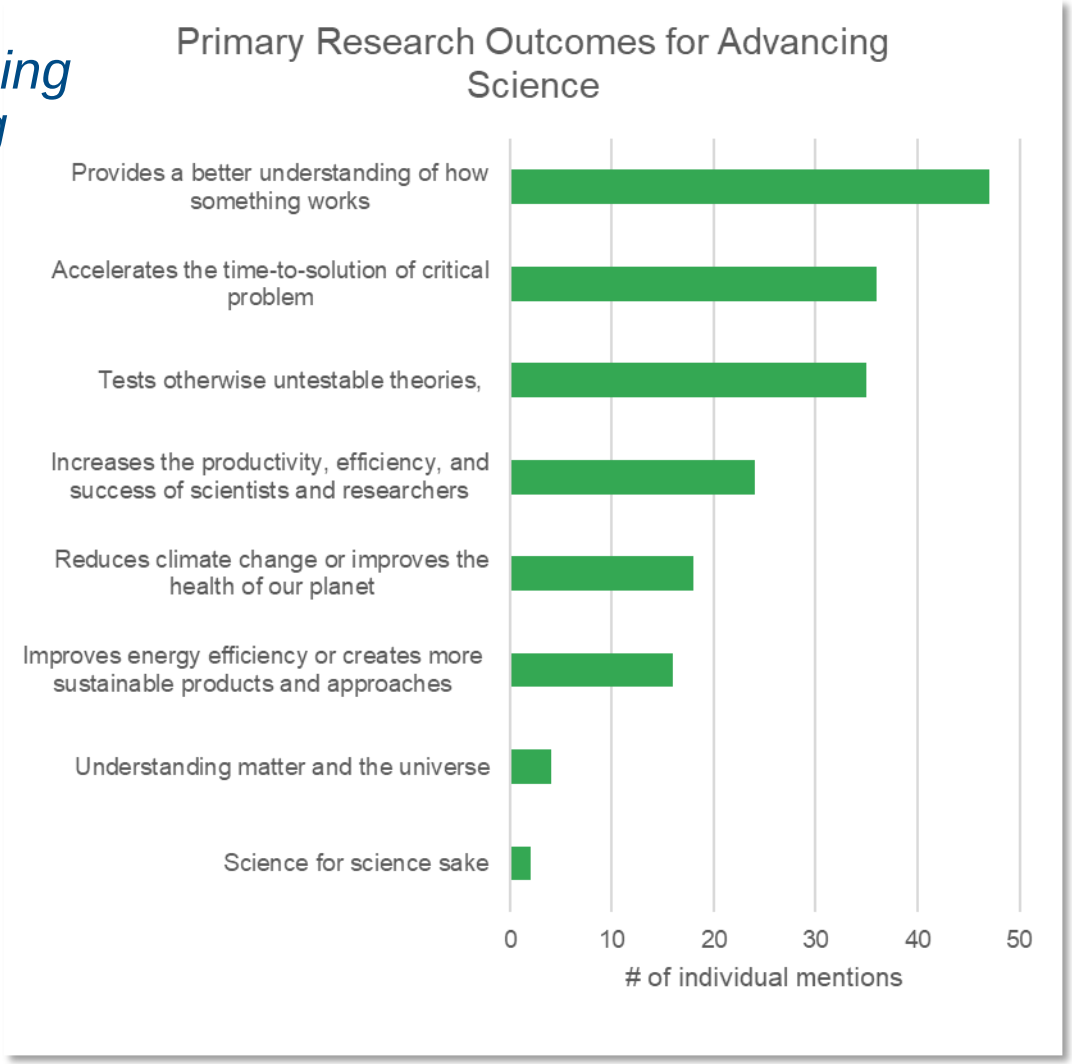




Primary Research Outcomes for Advancing Science

"Providing a better understanding of how something works" was the top Advancing Science outcome

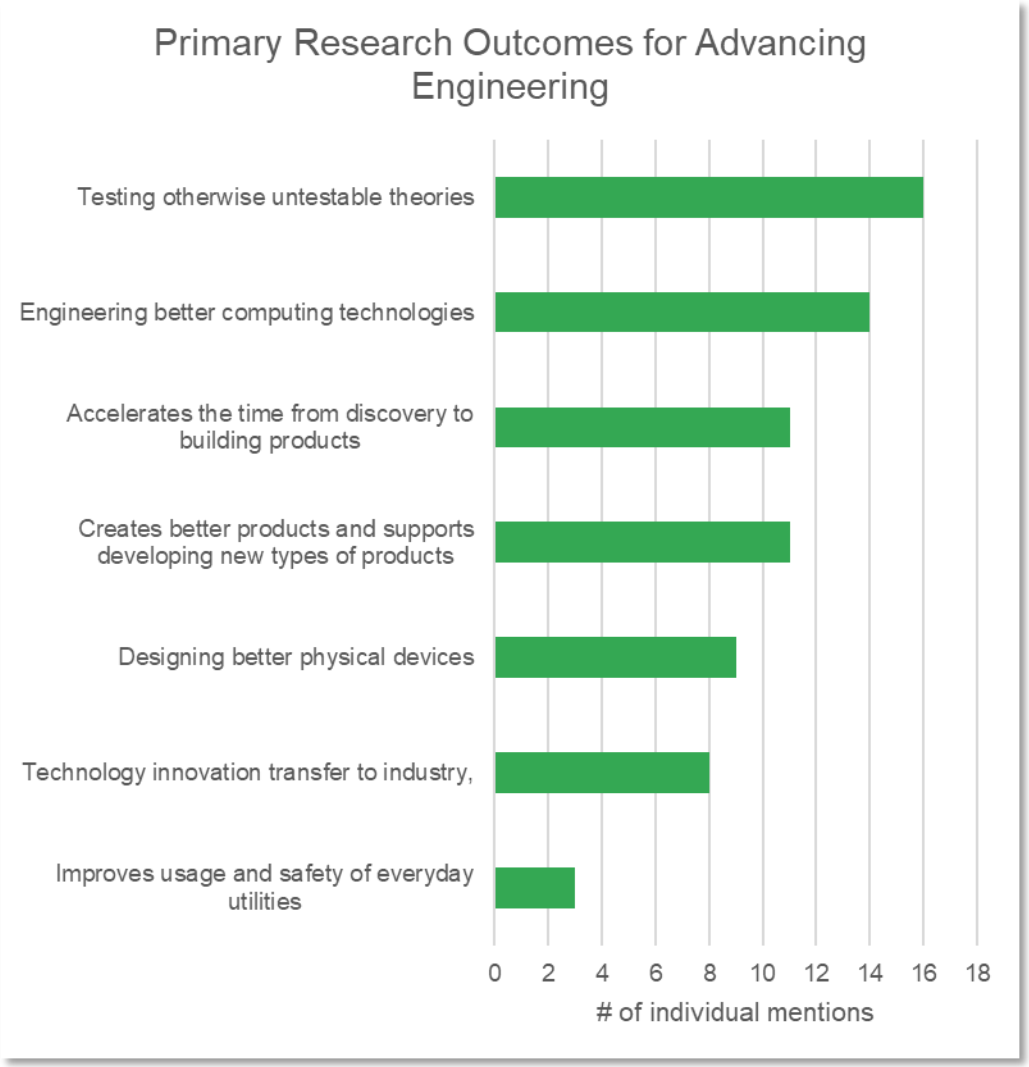
- **Q: *Which of the following best reflects the outcome of your research: (select all that apply)***
  - Provides a better understanding of how something works
  - Accelerates the time-to-solution of critical problem
  - Tests otherwise untestable theories,
  - Reduces climate change or improves the health of our planet
  - Improves energy efficiency or creates more sustainable products and approaches
  - Increases the productivity, efficiency, and success of scientists and researchers
  - Other (please specify)
- **Other:**
  - Understanding matter and the universe
  - Science for science's sake



Primary Research Outcomes for Advancing Engineering

"Testing otherwise untestable theories" was the top Advancing Engineering outcome

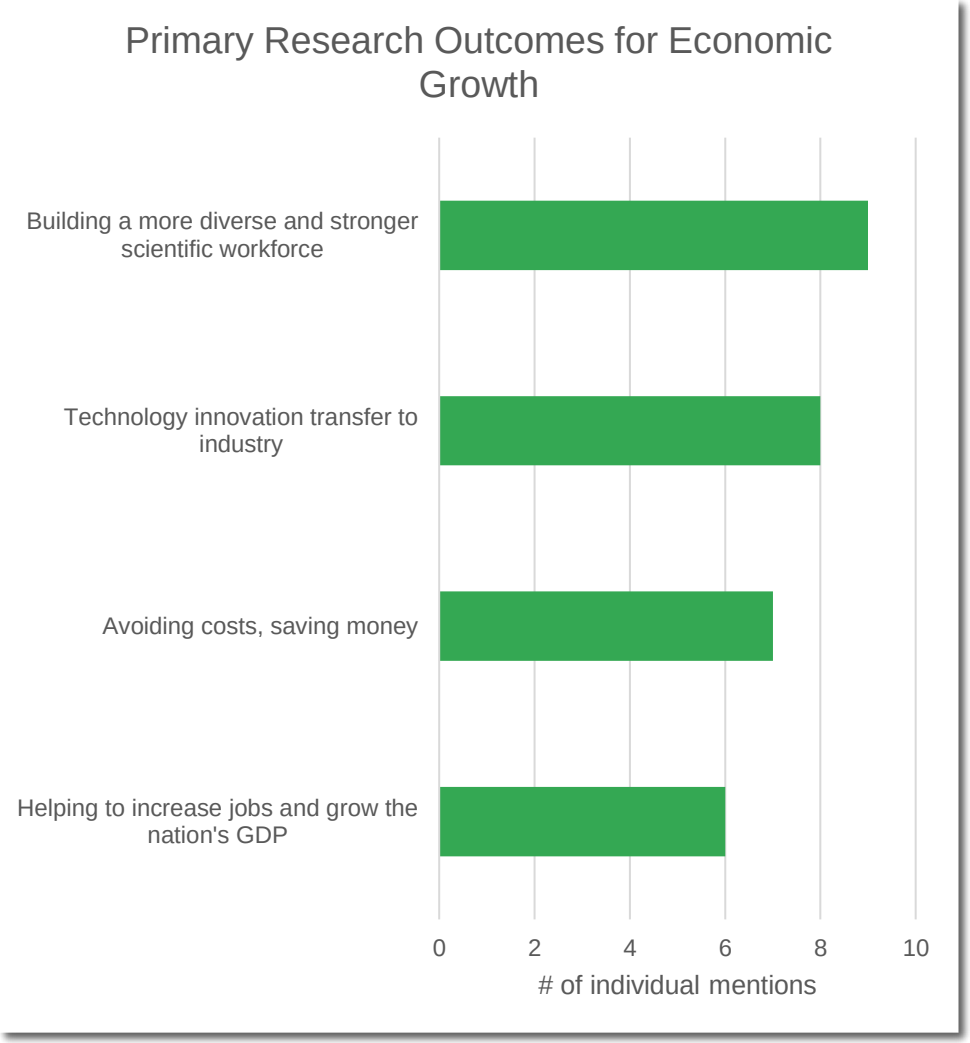
- **Q: *Which of the following best reflects the outcome of your research: (select all that apply)***
  - Creates better products and supports developing new types of products
  - Designing better physical devices
  - Accelerates the time from discovery to building products
  - Testing otherwise untestable theories
  - Technology innovation transfer to industry
  - Engineering better computing technologies
  - Improves usage and safety of everyday utilities



Primary Research Outcomes for Economic Growth

"Building a more diverse and stronger scientific workforce" was the top Economic Growth outcome

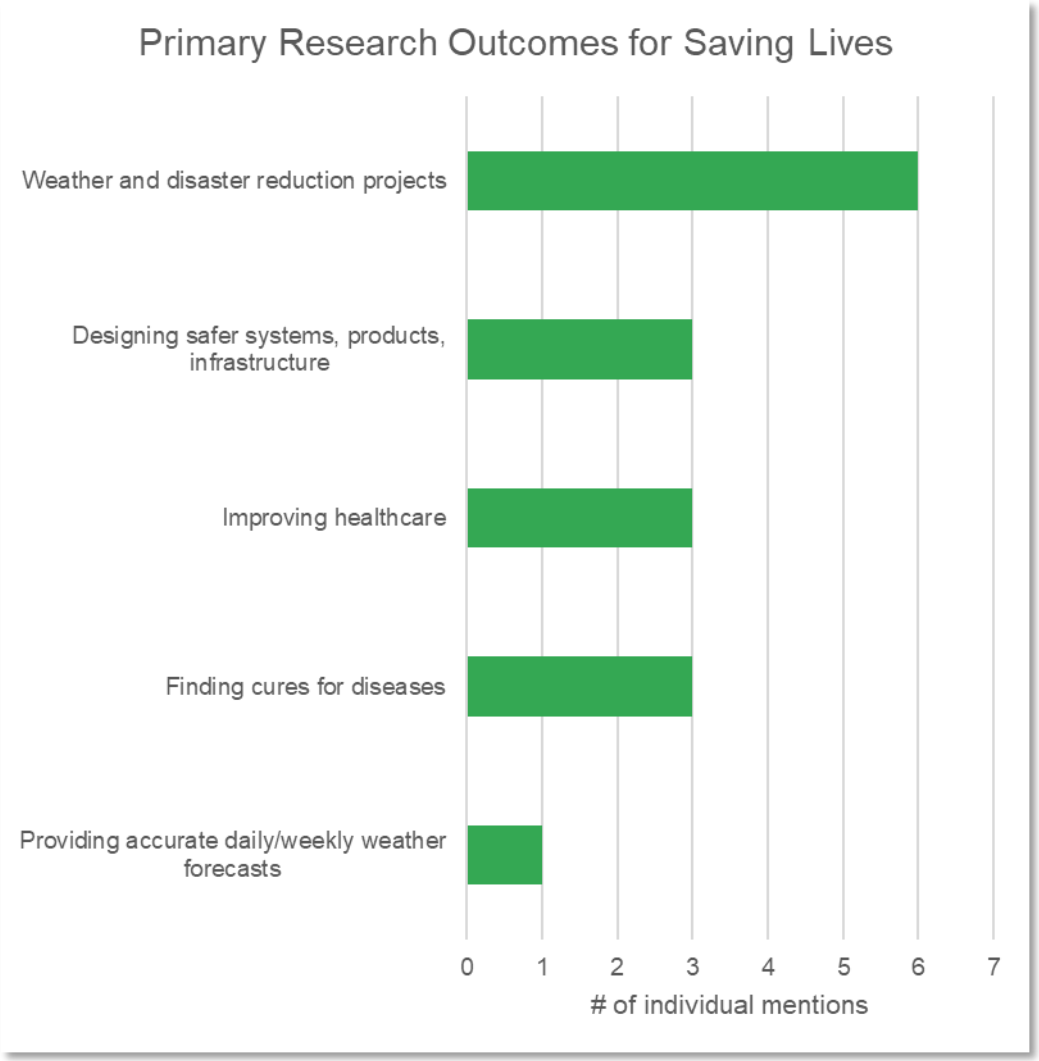
- **Q: *Which of the following best reflects the outcome of your research: (select all that apply)***
  - Helping to increase jobs and grow the nation's GDP
  - Technology innovation transfer to industry
  - Avoiding costs, saving money
  - Building a more diverse and stronger scientific workforce



Primary Research Outcomes for Saving Lives

"Weather and disaster reduction projects" was the top Saving Lives outcome

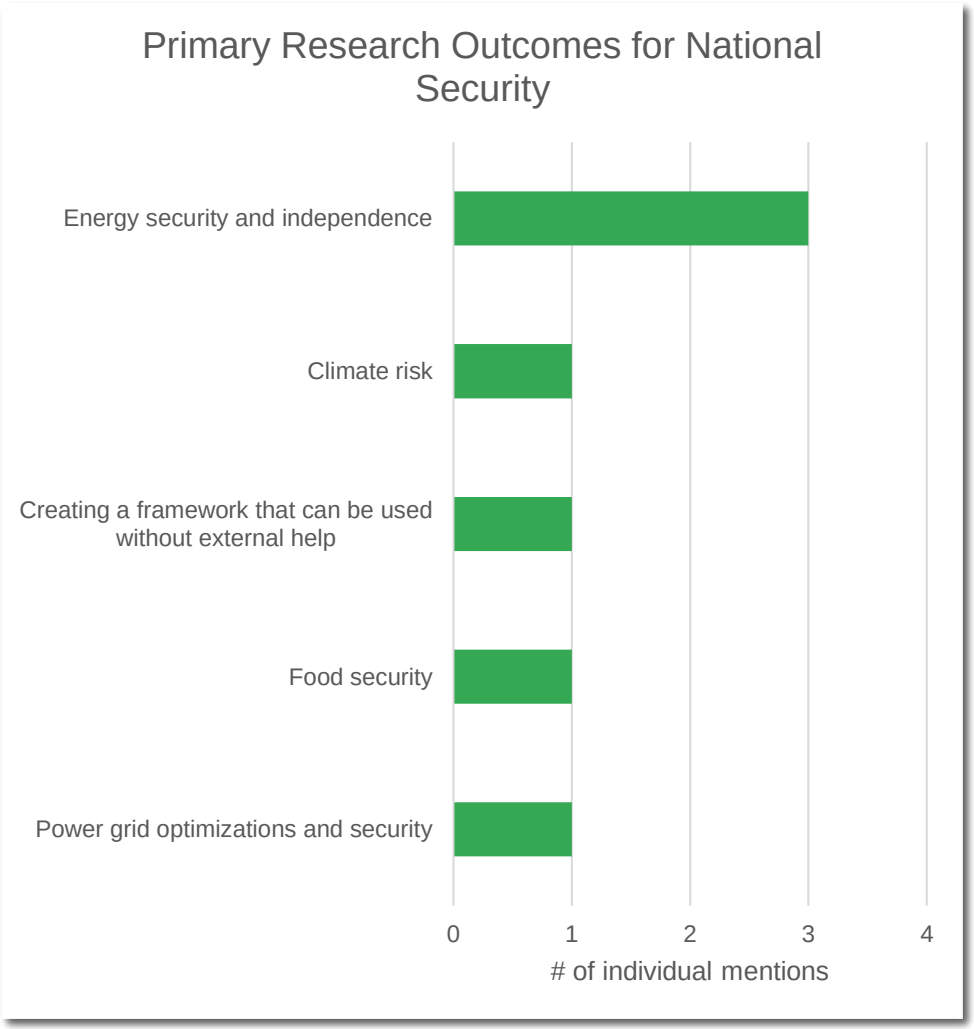
- **Q: *Which of the following best reflects the outcome of your research: (select all that apply)***
  - Weather and disaster reduction projects
  - Finding cures for diseases
  - Providing accurate daily/weekly weather forecasts
  - Improving healthcare
  - Designing safer systems, products, infrastructure



Primary Research Outcomes for National Security

"Energy security and independence" was the top National Security outcome

- **Q: *Which of the following best reflects the outcome of your research: (select all that apply)***
  - Creating a framework that can be used without external help
  - Improvements in cybersecurity, making AI safer, tracking bad players
  - Other
- **Other**
  - Climate risk
  - Energy security and independence
  - Food security
  - Power grid optimizations and security



HYPERION RESEARCH

NERSC Utilization

Computationally Demanding Scientific Workloads Require NERSC

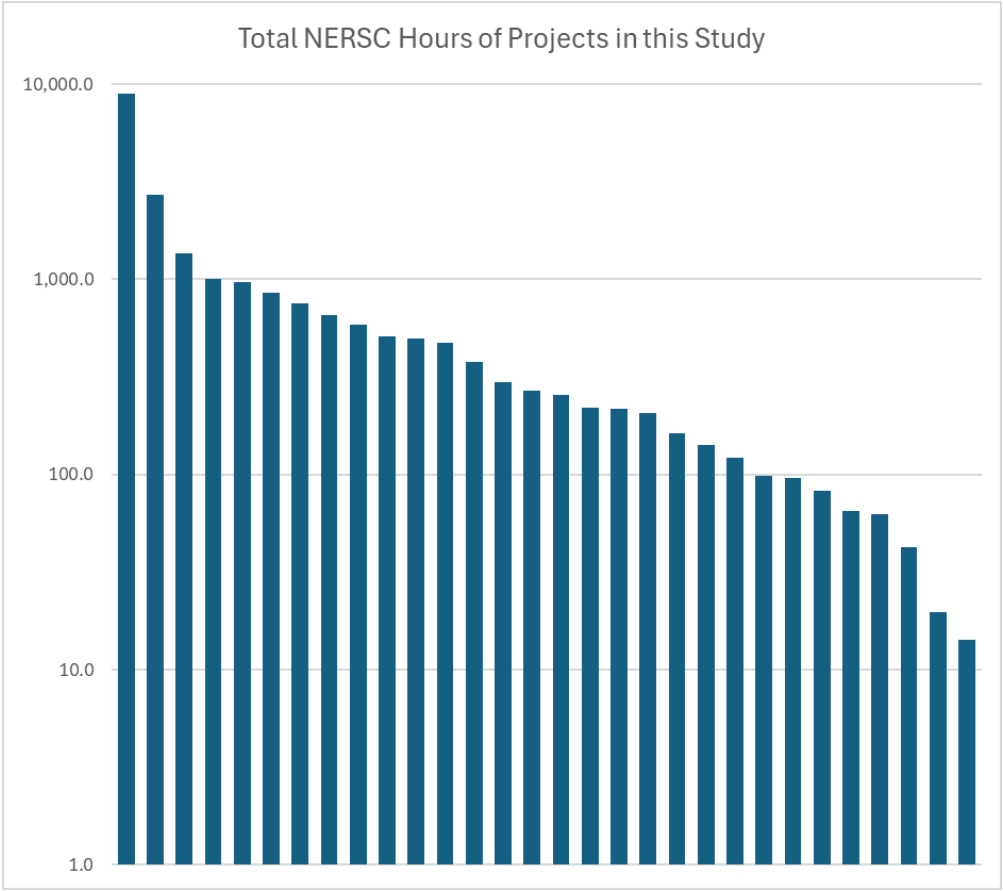
Surveyed 42 projects consume on average 20% of "NERSC" hours

- **What is a NERSC hour?**
  - Normalized utilization metric for computational usage
  - Allows comparison across time and architectures
  - Example: if a project used 1/365 of all the hours available at NERSC, then it would get credit for 24 NERSC Center Hours (1 day)
- **Current snapshot of total NERSC utilization**
  - > 10,000 users
  - > 1,000 projects
- **Study participant utilization**
  - 42 projects or "users"
  - Average NERSC hours of all projects would consume almost 20% of total NERSC hours

NERSC Hour Utilization for Included Research

Includes utilization across multiple years

- **Projects ranged from 3-24 years, with many still in progress**
- **Top 3 included projects:**
  - Advanced Simulation of Pore Scale Flow and Transport Processes in Nanoporous Materials (Trebotich)
  - Computational Studies in Plasma Physics and Fusion Energy (Howard)
  - Quarkonia in Hot Medium (Petreczky)



Quotes from Researchers

Quote	Attribution
The insights we gained into multi-scale turbulence in fusion plasmas would not have been possible without the use of NERSC resources.	Nathan Howard, a Fusion Energy researcher from MIT Plasma Science and Fusion Center
NERSC is an extremely valuable resource for researchers supported by the DOE because it's accessible for any researcher. Continuous access to HPC resources is critical and they provide extremely good support. I really like to work with NERSC and without them, the research would not have been possible.	A researcher from Brookhaven National Lab
NERSC is best partner for energy science. I'm very happy with the NERSC allocation process and continued support over the years.	A research from SLAC National Accelerator Lab at Stanford
The application process is nicely streamlined and pretty straightforward. We complement NERSC for making a system that is not a huge burden on users.	Alexander Austregesilo, a researcher from Thomas Jefferson National Accelerator Facility
Our experience with NERSC has been very positive and the impact of NERSC on our scientific research has been critical; without NERSC, our publications would not have been possible.	A research from University of Chicago
We appreciate what a super-efficient organization NERSC is for supporting world-class research. It's amazing to see how such a complex enterprise can facilitate world-class research. It's a real jewel for the computational sciences and engineering community.	Manos Mavrikakis, a Chemical Engineering researcher

Quotes from Researchers (continued)

Quote	Attribution
NERSC will remain a really important resource for us.	Ruby Leung, an Earth Systems researcher from PNNL
NERSC provides very powerful and accessible capabilities for research, successful support for using the machines, and is a very effective place to work.	A researcher from Columbia University
Perlmutter and NERSC have been a tremendous asset to our project both from the standpoint of code development on GPU systems as well as running large regional cases of ground motion and infrastructure response.	David McCallen a researcher from the Energy Geosciences Division at Berkeley Lab
I cut my teeth in HPC on NERSC allocations that in retrospect helped to launch me as a computational astrophysicist.	Adam Burrows a researcher from Princeton
I am beyond grateful - we honestly could not have done this research without NERSC.	A researcher from ORNL
I am extremely grateful for the support provided by NERSC. Much of what we have done would not have been possible.	Puru Jena, a Chemical Physics researcher from Virginia Commonwealth University
What makes NERSC different from other global HPCs, it's not run just as a research facility but is the easiest to use. Documentation is excellent and support is good. It's HPC being run with the researchers in mind.	Paolo Calafiura, a researcher from LBNL

Quotes from Researchers (continued)

Quote	Attribution
NERSC has been a stable computing platform for my entire career and has been phenomenal in terms of consistency and increasing capabilities.	Stephen Jardin, a Fusion researcher from the Princeton Plasma Physics Laboratory
I cannot overstate how important NERSC has been to my career and my research. From establishing the research, performing the work, and providing training, NERSC has been invaluable to my career. It's such a well-run organization and a pleasure to work with.	Eddie Baron, an Astrophysics researcher from the University of Oklahoma
NERSC by far, of all the HPC resources used in conjunction with this research, has the best infrastructure and the most responsive staff. The research couldn't have been done without NERSC.	Diana Qiu, a physics researcher from Yale
By far NERSC is the best HPC resource I've worked with for my research in terms of on-line documentation, performance of the computing systems and the unbelievable staff who provide help whenever I need it - and they do it quickly. I've never had to wait more than half a day to get some problem resolved.at NERSC	Masao Sako, a cosmology physics researcher from University of Pennsylvania
NERSC has constantly provided incredibly useful resources and support to my research in climate modeling and analysis for the past 15 years	Hailong Wang, an Earth Scientist from PNNL
I had a great experience with NERSC. NERSC has enabled research that I couldn't do anywhere else. I'm a big fan of NERSC.	Anonymous

Constructive feedback (paraphrased)

- **Sometimes difficult to identify and connect with correct researcher for support on how to get older Fortran codes re-compiled to run on GPUs**
- **Difficulty managing queue time (which can be up to a week) to run multi-day jobs, and then wait up to another week to re-run**

The Next 50 Years…

…looking forward to what a century's worth of NERSC accomplishments and impact!

HYPERION RESEARCH

Questions?

mnossokoff@hyperionres.com
jludema@hyperionres.com
ejoseph@hyperionres.com
mthorp@hyperionres.com