## Index to Charts: Guidance to DOE Funding

Information garnered from DOE Budget Submission Presentations & Detailed Justifications and webpages

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Continuum of Research, Development, and Deployment

**Discovery Research**
- Goal: new knowledge / understanding
- Focus: phenomena
- Metric: knowledge generation

**Use-Inspired Basic Research**
- Basic research for fundamental new understanding on materials or systems that may revolutionize or transform today's energy technologies

**Applied Research**
- Basic research for fundamental new understanding, usually with the goal of addressing scientific showstoppers on real-world applications in the energy technologies
- Proof of new, higher-risk concepts
- Prototyping of new technology concepts
- Explore feasibility of scale-up of demonstrated technology concepts in a "quick-hit" fashion.

**Technology Maturation & Deployment**
- Research with the goal of meeting technical milestones, with emphasis on the development, performance, cost reduction, and durability of materials and components or on efficient processes
- Scale-up research
- Small-scale and at-scale demonstration
- Cost reduction
- Manufacturing R&D
- Deployment support, leading to market adoption
- High cost-sharing with industry partners

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Office of Science
- Focus: phenomena
- Metric: knowledge generation

ARPA-E*
- Focus: performance
- Metric: milestone achievement

*ARPA-E: targets technology gaps, high-risk concepts, aggressive delivery times
# Energy Innovation Hubs
- **Investigators and their institutions**: Large set of investigators spanning multiple science and engineering disciplines and possibly including other non-science areas such as energy policy, economics, and market analysis. May be led by Labs or universities. The model is the three existing SC Bioenergy Research Centers.

- **Central location for investigators?**: Yes, there is a central location (building) housing many/most of the investigators. A significant aspect of the Hubs is the collocation of researchers. Collaborators at other institutions may partner with the Hub leader. Industries may also be associated with Hubs.

- **Diversity of Disciplines**: Many

- **Period of Award and Management**: 5 years with one 5-year renewal possible. “The bar is significantly higher” for further renewals. Managed by Offices across DOE. A Board of Advisors consisting of senior leadership will coordinate across DOE.

- **Award Amount**: $25M/year with $10M additional in the 1st year for CE or building mods.

- **Core Motivation**: Purpose-driven research, spanning fundamental, transformational science to commercialization. The breadth and emphasis of activities will be influenced greatly by the nature of the Hub. For example, the topics of some Hubs are ready for commercialization or improved manufacturing methods (solar photovoltaics). Other Hubs address topics that may require greater emphasis on fundamental research.

  In general, DOE determines the topical areas of the Hubs, and FOAs are specific.

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# Energy Frontier Research Centers
- **Investigators and their institutions**: Self-assembled group of ~6-12 investigators. May be led by Labs or universities. About 2/3 of EFRCs are led by universities.

- **Central location for investigators?**: Ideally, each EFRC will have a lead institution, home to many/most of the investigators, but there is flexibility.

- **Diversity of Disciplines**: Several

- **Period of Award and Management**: 5 years with 5-year renewals possible. Managed by SC/BES

- **Award Amount**: $2-5M/year

- **Core Motivation**: Fundamental, transformational research with a clear link to new energy energy technologies or technology roadblocks.

  In general, the investigators propose the subject matter from among a large set of general energy-relevant topics, and FOAs are broad.

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# ARPA-E
- **Investigators and their institutions**: Single investigator, small group, or small teams.

- **Central location for investigators?**: No

- **Diversity of Disciplines**: Few

- **Period of Award and Management**: 1-3 years. Managed by ARPA-E, which reports to the Secretary of Energy

- **Award Amount**: $0.5 -10M/year

- **Core Motivation**: High risk research driven by the potential for significant commercial impact.

  In general, DOE determines the area of interest.
Basic Research
Office of Science

BESAC presentations in February project plans for subsequent fiscal year
Adv Scientific Computing Research Program (ASCR)
(http://science.energy.gov/ascr/)
To discover, develop, and deploy computational and networking capabilities to analyze, model, simulate, and predict complex phenomena.

Basic Energy Sciences Program (BES)
(http://science.energy.gov/bes/)
To understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels thereby providing the foundations for new energy technologies. Two divisions manage the University research portfolio: Materials Sciences and Engineering; and Chemical Sciences, Geosciences, and Biosciences.

Biological and Environmental Research Program (BER)
(http://science.energy.gov/ber/)
To understand biological, climate, and environmental systems by: exploring the frontiers of genome-enabled biology; discovering the phys, chem, and bio drivers of climate change; and seeking the bio, geochem and hydrological molecular determinants of environmental sustainability and stewardship.

Fusion Energy Science Program (FES)
(http://science.energy.gov/hep/)
To advance the fundamental understanding of matter at very high temperatures and densities, and to develop the scientific foundations needed for a fusion energy source.

High Energy Physics Program (HEP)
(http://science.energy.gov/hep/)
To understand how our universe works at its most fundamental level by discovering the elementary constituents of matter and energy; probing the interactions between them; and exploring the basic nature of space and time.

Nuclear Physics Program (NP)
(http://science.energy.gov/np/)
To discover, explore and understand all forms of nuclear matter and to understand how the fundamental particles—quarks and gluons—fit together and interact to create different types of matter in the universe.

Workforce Development for Teachers and Scientists
(http://science.energy.gov/wdts/)
To help DOE and the Nation have a sustained pipeline of highly trained science, technology, engineering, and mathematics (STEM) individuals for the U.S. workforce.
All Office of Science Core Programs

ASCR / BER / BES / FES / HEP / NP / WDTS

What:

- Prior to submission of an application for a research grant, the PI is encouraged to contact the program manager whose areas of expertise and responsibilities most closely match the topic of the proposed research activities to learn about current funding opportunities and the nature of the work.
- Based on the interaction with a program manager, the PI may be encouraged to submit a pre-application.
- Based on a review of the proposed research, the principal investigator will be either encouraged or discouraged to submit a full application.
- All grants that are funded undergo external peer review.
- The usual term for a new award is three or four years, divided into one-year budget periods.

When:

Applications may be submitted at any time. However, it is recommended that a full application be sent between June 1st and November 30th in order that a funding decision can be made by June of the following year, which is necessary to obtain funding under that particular fiscal year.

How much: Varies with the program

Where:

BAA DE-FOA-0001968 for FY2019
https://www.energy.gov/science/office-science-funding/office-science-funding-opportunities

Applications must be submitted through Grants.gov to be considered for award.

Resource:

DOE Office of Science Award Search Website
https://pamspublic.science.energy.gov/WebPAMSEditExternal/interface/awards/AwardSearchExternal.aspx

The award search returns lists of

1. grants,
2. cooperative agreements, and
3. interagency awards currently funded by the DOE Office of Science.
Office of Science Early Career Research Program

**What:** To support individual research programs of outstanding scientists early in their careers and to stimulate research careers in the disciplines supported by the Office of Science

**Who:** Within 10 years of receiving a Ph.D., either untenured academic assistant professors on the tenure track or full-time DOE national laboratory employees

**How Much:**
- Univ. grants $150/yr for 5 years to cover summer salary and expenses
- National Lab awards $500K/year for five years to cover full salary and expenses

**When:** For FY2019 pre application (white paper) due 06 Feb 2019

**Where:** DE-FOA-0002019

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<th>FY 2018</th>
<th>84 awardees (55 Univ)</th>
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<td>FY 2017</td>
<td>700 full proposals reviewed, 59 awardees (39 Univ)</td>
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<td>FY 2016</td>
<td>720 full proposals reviewed, 52 awardees (30 Univ)</td>
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<td>FY 2015</td>
<td>609 full proposals reviewed; 50 awardees (32 Univ)</td>
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Office of Science User Facilities

27 world-leading facilities serving over 36,000 researchers annually

- supercomputers,
- high intensity x-ray, neutron, and electron sources,
- nanoscience facilities,
- genomic sequencing facilities,
- particle accelerators,
- fusion/plasma physics facilities, and
- atmospheric monitoring capabilities.

- Open access; allocation determined through peer review of proposals

- Free for non-proprietary work published in the open literature

- Full cost recovery for proprietary work
THE OFFICE OF
ADVANCED SCIENTIFIC COMPUTING RESEARCH

Functional Organization Chart
### Acquiring Topic/Program Manager Information

**Advanced Scientific Computing Research (ASCR)**

[https://www.energy.gov/science/ascr/advanced-scientific-computing-research](https://www.energy.gov/science/ascr/advanced-scientific-computing-research)

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Energy Frontier Research Centers

**What:** Integrated, multi-investigator Centers that conduct fundamental research focusing on one or more of several “grand challenges” and use-inspired “basic research needs” recently identified in major strategic planning efforts by the scientific community. The Centers integrate the talents and expertise of leading scientists in a setting designed to accelerate research toward meeting our critical energy challenges.

**How Much:** Funded at ~$3M/yr for five years, with an additional 5 year extension possible.

**When:** Every two years starting in FY2016

**Where:** https://science.osti.gov/bes/efrc
BES User Facilities

Xray Sources
- Advanced Photon Source, Argonne
- Advanced Light Source, Lawrence Berkeley
- National Synchrotron Light Source II, Brookhaven
- Stanford Synchrotron Radiation Light Source, Stanford
- Linac Coherent Light Source, SLAC

Neutron Scattering Facilities
- Spallation Neutron Source, Oak Ridge
- High Flu Isotope Reactor, Oak Ridge

Nanoscale Science Research Centers
- Center for Functional Materials, Brookhaven
- Center for Integrated Nanotechnologies, Sandia
- The Molecular Foundry, Berkeley
- Center for Nanophase Materials Sciences, Oak Ridge
- Center for Nanoscale Materials, Argonne
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## Acquiring Topic/Program Manager Information

### Fusion Energy Sciences

[Link](https://science.osti.gov/fes/About/Staff)

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Acquiring Topic/Program Manager Information
High Energy Physics Program
https://science.osti.gov/hep/About/Staff

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Acquiring topic/PO information
Nuclear Physics Program
https://science.osti.gov/np/About/Staff

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Applied Research Programs

Electricity (OE)
https://www.energy.gov/oe/office-electricity
The mission is to lead national effort to modernize the electric grid, enhance security and reliability of the energy infrastructure, and facilitate recovery from disruptions to the energy supply. In addition to develop new technologies for the storage of energy and the transmission of energy.

Energy Efficiency and Renewable Energy (EERE)
https://www.energy.gov/eere/office-energy-efficiency-renewable-energy
EERE works to strengthen the United States' energy security, environmental quality, and economic vitality in public-private partnerships. Programs include biomass, buildings, geothermal, hydrogen and fuel cells, solar, vehicles, wind & hydropower and industry.

Fossil Energy (FE)
https://www.energy.gov/fe/office-fossil-energy
Ensuring that we can continue to rely on clean, affordable energy from our traditional fuel resources is the primary mission. Programs include clean coal and natural gas power systems, carbon sequestration, hydrogen and other clean fuels, and oil and natural gas supply and delivery.

Nuclear Energy (NE)
https://www.energy.gov/ne/office-nuclear-energy
The primary mission is to advance nuclear power as a resource capable of making major contributions in meeting the nation's energy supply, environmental, and energy security needs by resolving technical, cost, safety, security and regulatory issues through research, development, and demonstration.
Office of Electricity (OE)

Organization Chart Not Available July 2019
Office of Electricity
Priorities

• North American Energy Resiliency Model (NAERM)
  Working with the national labs and relevant stakeholders, OE will develop an integrated North American Energy Resiliency Model (NAERM) to conduct planning and contingency analysis to address vulnerabilities in the North American energy system.

• Megawatt Scale Grid Storage
  OE will pursue megawatt scale storage capable of supporting frequency regulation, ramping, and energy management for bulk and distribution power systems.

• Revolutionize Sensing Technology Utilization
  OE will pursue integration of high-fidelity, low-cost sensing technology for predictive and correlation modeling for electricity.

• Transmission
  OE will pursue electricity-related policy issues by carrying out statutory and executive requirements, while also providing policy design and analysis expertise to states, regions, and tribes.
Electricity Delivery and Energy Reliability
From JoAnn Milliken presentation to Association of American Universities Jan 11, 2010

Power Systems Engineering Research Center (PSERC)
- 40 researchers in 3 research areas—13 Universities and over 30 Industry Members
  • Multidisciplinary, specializing in:
    ▶ power systems, applied mathematics, non-linear systems, power electronics, control theory, computing, operations research
    ▶ economics, industrial organization and public policy.
  • Strong synergy between research and education
    ▶ Some 85 graduate students working on PSERC research projects
    ▶ Research improves quality of education experience
    ▶ Research required of faculty
  • Quality power programs (grad and undergrad)
    ▶ Students receiving quality and diverse education
    ▶ Interaction with industry invaluable
  • Employment search assistance
    ▶ Faculty available for consultation
    ▶ Creation of PES-Careers (www.PES-Careers.org)
    ▶ Job opportunities web site folder
    ▶ Student listserv for contacting students

PSERC - http://www.pserc.wisc.edu/
EERE R&D Programs
https://energy.gov/eere/office-energy-efficiency-renewable-energy

EERE programs support research and development of energy efficiency or renewable energy technologies in the areas:

Office of Energy Efficiency
- Buildings
  https://www.energy.gov/eere/buildings/building-technologies-office
- Government Energy Mgmt
  https://www.energy.gov/eere/efficiency/government-energy-management
- Advanced Manufacturing
  https://www.energy.gov/eere/amo/advanced-manufacturing-office

Office of Renewable Power
- Geothermal
  https://www.energy.gov/eere/geothermal/geothermal-energy-us-department-energy
- Solar
  https://www.energy.gov/eere/solar/solar-energy-technologies-office
- Wind
- Water Power
  https://www.energy.gov/eere/water/water-power-technologies-office

Office of Transportation
- Bioenergy
  https://www.energy.gov/eere/bioenergy
- Hydrogen and Fuel Cells
  https://www.energy.gov/eere/fuelcells/fuel-cell-technologies-office
- Vehicles
  https://www.energy.gov/eere/vehicles/vehicle-technologies-office

EERE Funding Opportunity Exchange:  https://eere-exchange.energy.gov/
Mission

- Develop and demonstrate new, energy-efficient processing and materials technologies at a scale adequate to prove their value to manufacturers and spur investment.
  - Develop *broadly applicable* manufacturing processes that reduce energy intensity and improve production.
  - Develop and demonstrate *pervasive* materials technologies, enabling improved products that use less energy throughout their lifecycles.
- Conduct technical assistance activities that promote use of advanced technologies and better energy management to capture U.S. competitive advantage.

**AMO: Bridging the Innovation Gap**

AMO Investments leverage strong Federal support of basic research by partnering with the private sector to accelerate commercialization.

R&D Investment level ($ log) vs. Technology Maturity Level

- **Governments and Universities**
  - DOE Energy Innovation Hubs
  - NSF Engineering Research Centers
  - NSF Industry-University Cooperative Research Centers
  - SBIR/STTR

- **Private sector**
  - AMO projects
  - NIST Manufacturing Extension Partnership

Concept → Proof of Concept → Lab scale development → Demonstration and scale-up → Product Commercialization

https://www.energy.gov/eere/amo/research-development
Innovative Process and Materials Technologies
These cost-shared projects are selected through a competitive process from exceptional research teams working on foundational process and materials technologies.

Next Generation Manufacturing Processes
https://www.energy.gov/eere/amo/next-generation-manufacturing-processes
New manufacturing processes, simulation tools, and technologies are pursued in four key areas - reactions and separation, high temperature processing, waste heat minimization and recovery, sustainable manufacturing - to lower the energy intensity of manufacturing.

Next Generation Materials
https://www.energy.gov/eere/amo/next-generation-materials
Innovative materials can open new design spaces for high-performance and renewable energy technology manufacturing. Projects focus on three areas with clean energy, carbon, and economic benefits. Current projects are in thermal and degradation resistant materials, highly functional, high-performance materials, and lower-cost materials for energy systems.

Next Generation Electrical Machines
https://www.energy.gov/eere/amo/electric-machines
Leverage recent technology advancements in power electronics and motors to develop a new generation of energy efficient, high power density, high speed integrated MV drive systems for a wide variety of critical energy applications.

Combined Heat & Power (CHP)
https://www.energy.gov/eere/amo/combined-heat-and-power-chp
Develop, test, and validate advanced CHP and distributed energy systems to pave the way for accelerated deployment in manufacturing and other applications. Current projects are in advanced reciprocating engine systems, packaged CHP systems, high-value applications, fuel-flexible CHP, and demonstrations.
Industrial Technologies Program
Industrial Assessment Centers

- DOE's 28 university-based Industrial Assessment Centers (IACs) train engineering students for careers in industrial energy efficiency.
- IACs serve 300+ plants per year (under 1 TBtu/yr) and typically identify savings of 8%-10% or $115,000/plant.
- Database of 13,500 assessment results: http://iac.rutgers.edu/database
DOE Office of Fossil Energy

Organization Chart Not Available July 2019
DOE Office of Fossil Energy
Research and Development Programs

The Office of Fossil Energy seeks to advance technologies related to the reliable, efficient, affordable and environmentally sound use of fossil fuels as well as manage the Strategic Petroleum Reserve and Northeast Home Heating Oil Reserve to provide strategic and economic security against disruptions in U.S. oil supplies.

Research and Development Areas:
• Carbon Capture, Utilization and Storage
• Advanced Energy Systems
• Cross-cutting Research

Research and Development Opportunities
Most R&D procurements for the Office of Fossil Energy are coordinated by the National Energy Technology Laboratory (NETL).

• The U.S. Department of Energy’s (DOE’s) Office of Fossil Energy (FE) is announcing selections of seven projects to receive $5.4 million in federal funding for university-based research and development under funding opportunity announcement (FOA) DE-FOA-0001993, University Turbine Systems Research (UTSR). (June 2019)

• The U.S. Department of Energy’s (DOE) Office of Fossil Energy (FE) has selected 10 projects to receive nearly $4 million in federal funding for strategic fossil energy and coal technology research and development (R&D) projects at U.S. colleges and universities. The projects are supported through funding opportunity announcement (FOA) DE-FOA-0001991, University Training and Research for Fossil Energy Applications. (May 2019)
University Coalition for Fossil Energy Research
NETL and PSU
http://www.energy.psu.edu/ucfer/

What: A University Coalition for Basic and Applied Fossil Energy Research and Development (UCFER) has been established to advance basic and applied fossil energy research through mechanisms that promote collaboration among the Department of Energy (DOE) and the universities that are members of the Coalition by the coordination of research and the sharing of data. Its collaborative research will focus on coal, natural gas, and oil and on five core competencies:

- Geological and Environmental Systems, consisting of research on geomaterials, fluid flow in geologic media, and geospatial and strategic field monitoring.
- Materials Engineering and Manufacturing, consisting of research on the design, development, and deployment of advanced functional and structural materials for use in extreme service environments.
- Energy conversion Engineering, consisting of the evaluation, integration, control and performance modeling of processes and components for developing innovative energy conversion processes and transformational technologies.
- Systems Engineering and Analysis, consisting of analysis and design of advanced energy systems such as power plants, energy markets, and energy-environment interactions.
- Computational Science and Engineering, consisting of research involving high-performance computing and data analytics that enable the generation of information and insights through the integration of experimental data and engineering analyses.

The current members for UCFER:
- Massachusetts Institute of Technology (MIT)
- The Pennsylvania State University
- Princeton University
- Texas A&M University
- University of Kentucky
- University of Southern California
- University of Tulsa
- University of Wyoming
- Virginia Tech
DOE Office of Nuclear Energy
R&D Programs

**Nuclear Energy Enabling Technologies**
https://www.energy.gov/ne/nuclear-reactor-technologies/nuclear-energy-enabling-technologies
Develop innovative and crosscutting nuclear energy technologies to resolve U.S. industry nuclear technology development issues.

**Advanced Modeling and Simulation**
https://www.energy.gov/ne/nuclear-reactor-technologies/advanced-modeling-simulation
Using supercomputers to advance nuclear energy technologies.

**Fuel Cycle Technologies**
https://www.energy.gov/ne/initiatives/fuel-cycle-technologies
Working to solve nuclear waste and proliferation issues.

**Nuclear Energy University Program**
https://www.energy.gov/ne/nuclear-reactor-technologies/nuclear-energy-university-program
https://neup.inl.gov/SitePages/Home.aspx
NEUP engages U.S. colleges and universities to conduct research and development (R&D), enhance infrastructure and support student education thereby helping to sustain a world class nuclear energy and workforce capability.

**Nuclear Energy Enabling Technologies**
Develop crosscutting technologies that directly support and complement the Office of Nuclear Energy’s (NE) development of new and advanced reactor concepts and fuel cycle technologies.
Fulfilling ARPA-E’s Mission

- Find and fund high-risk, high-impact projects
- Identify and promote revolutionary advances in fundamental sciences
- Accelerate transformational technologies or create new technologies where none currently exist
- Translate scientific discoveries and cutting-edge inventions into technological innovations
- Bridge gaps in the energy innovation pipeline
ARPA-E WAS CREATED WITH A VISION TO BRIDGE GAPS IN THE ENERGY INNOVATION PIPELINE

what ARPA-E will do
- Seek high impact science and engineering projects
- Invest in the best ideas and teams
- Will tolerate and manage high technical risk
- Accelerate translation from science to markets
- Proof of concept and prototyping

what ARPA-E NOT will do
- Incremental improvements
- Basic research
- Long term projects or block grants
- Large-scale demonstration projects
Figure: ARPA-E’s Program Development Process

Establish

Award Announcements

Contract Negotiation and Awards

Proposal Selection

Program Conception (Idea/Vision)

FOA Announced

Program Execution

Evaluate

Proposal Rebuttal Stage

Technical Deep Dive

Full Proposal Panel Review

Workshop

Engage

Concept Paper Review

Internal Debate

Further Refinement & FOA Development

Timeline: 6-8 Months from Program Conception to Execution
DOE ARPA-E
Funding Announcements

**What:** ARPA-E issues periodic Funding Opportunity Announcements (FOAs), which are focused on overcoming specific technical barriers around a specific energy area. ARPA-E also issues periodic OPEN FOAs to identify high-potential projects that address the full range of energy-related technologies, as well as funding solicitations aimed at supporting America’s small business innovators.

All ARPA-E applicants are required to first submit a Notice of Intent and Concept Paper. ARPA-E will review the concept paper and provide early feedback on whether the idea is likely to form the basis of a successful full application. Only after ARPA-E has provided a notification on the concept paper will the applicant be permitted to submit a full application.

**When:** Periodic with specified deadlines

**Where:** For information on ARPA-E’s current FOAs and detailed information on the ARPA-E funding application process:

https://arpa-e.energy.gov/?q=programs/apply-for-funding

https://arpa-e-foa.energy.gov/
What:
The SSAA Program was developed to support state-of-the-art research at U.S. academic institutions in areas of fundamental physical science and technology of relevance to the Stockpile Stewardship Program mission. The Office of Research, Development, Test and Evaluation annually invests in the Stewardship Science Academic Programs (SSAP).

Consideration will be given to proposals that emphasize experimental efforts, although proposals to advance theory that have a strong, demonstrable connection to experimental efforts will be considered.

- Topic 1  Properties of Materials under Extreme Conditions and/or Hydrodynamics
- Topic 2  Low Energy Nuclear Science
- Topic 3  Radiochemistry

Restricted to a citizen of the United States or an alien lawfully admitted for permanent residence.

How Much: A research grant is awarded for up to three years at a funding level appropriate for the proposed scope, typically $50K to $300K per year. Total funding up to $6M annually is anticipated.

When: proposals due 26 Mar 2018

Where: DE-FOA-0001831
What: The centers are either Multidisciplinary Simulation Centers (MSC), Single-Discipline Centers (SDC) or Focused Investigatory Center (FIC) solving a problem that advances basic science/engineering; verification and validation/uncertainty quantification; and contributing towards achieving effective exascale computing, to demonstrate predictive science in a HPC environment.

The NNSA Office of Advanced Simulation and Computing (ASC), in collaboration with LLNL, LANL and SNL, funded the Predictive Science Academic Alliance Program II (PSAAP II) focused on three major integrated areas:

• Discipline-focused research needed to further predictive science and enabled by effective extreme scale computing.
• Developing and demonstrating technologies and methodologies to support effective extreme computing in the context of science/engineering applications.
• Predictive science based on verification and validation and uncertainty quantification for large-scale simulations.

How Much: An estimated total of $20M per year, over a five year period. Up to $3M annually for each MSC, $2M annually for each SDC for five years. Up to $1M annually for each FIC

When: 31 May 2019

Where: DE-FOA-0002068