1. Budget Updates
Robust FY 2019 and FY 2020 enacted budgets

Enacted FES appropriations for FY 2019 ($564M) and FY 2020 ($671M) enable accelerated progress throughout the program:

- **U.S. Contributions to ITER**: Testing of the first superconducting central solenoid magnet module was completed. Cash contributions were allocated for FY 2019 and FY 2020. Fabrication of the remaining six modules and other U.S. in-kind hardware will continue in FY 2020.

- **DIII-D**: In FY 2019, DIII-D operated for 12 run weeks following completion of the Long Torus Opening. The world’s first toroidally steerable, off-axis neutral beam injector was installed on schedule and successfully operated. In FY 2020, during 20-run-week operation, DIII-D research will utilize the new neutral beam and other heating and current drive systems to investigate steady-state plasma scenarios.

- **NSTX-U**: In FY 2019, the Recovery project successfully achieved SC approval of its baseline cost and schedule, and authorization of long-lead procurements. In FY 2020, Recovery is making strong progress, including completion of all final design reviews and fabrication/testing of at least four (of six) poloidal field replacement coils.

- **Materials Plasma Exposure eXperiment (MPEX)**: This MIE project completed preliminary design and attained Critical Decision-1 approval in FY 2020. Engineering design activities will continue, with preparation for baseline approval and long-lead procurements.

- **Matter in Extreme Conditions (MEC)**: The Petawatt Upgrade achieved approval of its Mission Need (CD-0) in FY 2019. Engineering design activities are continuing for the achievement of Critical Decision-1 approval.

- **Quantum Information Science**: FES made six awards with its first-ever solicitation in FY 2019 and issued another FOA in FY 2020.

- **International collaborations**: The portfolio was re-competed in FY 2019; ten multi-institutional awards were made for collaborative research on long and short pulse tokamak facilities in Asia and the EU. Stellarator research in Germany and Japan continued.

- **Private-public partnerships**: In FY 2019, FES established the Innovation Network for Fusion Energy (INFUSE) program and made twelve awards to six private companies. Another Request for Assistance was published in FY 2020, with expanded eligibility.

- **Artificial Intelligence & Machine Learning**: FES held a workshop in FY 2019, jointly with ASCR, to identify priority research opportunities. A follow-up solicitation has been issued in FY 2020 to competitively select awards in this area.
• The Administration’s Budget Request to Congress for FY 2021 was released on February 10
• It marks the first step in an iterative process between the Executive and Legislative branches of the U.S. Government
• The Budget Request for FES is $425,151,000, which is ~$246M less than the FY 2020 enacted budget
• It includes $107M for the U.S. Contributions to ITER project

2. Programmatic Updates
Healthy budgets enabled multiple FOAs and awards across the program

Getting the word out on FOAs and Awards

https://www.energy.gov/science/office-science
<table>
<thead>
<tr>
<th>FOA Title</th>
<th>Companion Lab Call</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative NSTX-U Diagnostics</td>
<td>No</td>
<td>Issued; pre-apps received</td>
</tr>
<tr>
<td>Collaborative Research on International and Domestic Spherical Tokamaks</td>
<td>No</td>
<td>Issued; pre-apps received</td>
</tr>
<tr>
<td>High-Energy-Density Laboratory Plasma Science</td>
<td>No</td>
<td>Issued; due 3/16 (now 4/6)</td>
</tr>
<tr>
<td>Scientific Machine Learning and Artificial Intelligence for Fusion Energy Sciences</td>
<td>Yes</td>
<td>Issued; LOIs due on 3/30</td>
</tr>
<tr>
<td>Measurement Innovations for Magnetic Fusion Systems</td>
<td>Yes</td>
<td>Issued; LOIs due on 3/20</td>
</tr>
<tr>
<td>Opportunities in Frontier Plasma Science</td>
<td>Yes</td>
<td>Issued; LOIs due on 4/6</td>
</tr>
<tr>
<td>Quantum Information Science Research for Fusion Energy Sciences</td>
<td>Yes</td>
<td>Submitted</td>
</tr>
<tr>
<td>Theoretical Research in Magnetic Fusion Energy Science</td>
<td>No</td>
<td>Issued; LOIs due on 3/27</td>
</tr>
<tr>
<td>Early Career Research Program</td>
<td>Yes</td>
<td>Issued; due 3/16 (now 3/30)</td>
</tr>
<tr>
<td>Galvanizing Advances in Market-Aligned Fusion for an Overabundance of Watts (ARPA-E / FES; led by ARPA-E)</td>
<td>N/A</td>
<td>Issued; Concept Papers due 3/27</td>
</tr>
</tbody>
</table>

Check [https://science.osti.gov/fes/Funding-Opportunities](https://science.osti.gov/fes/Funding-Opportunities) for updates
Enhanced inter-agency interactions

- **Advanced Research Projects Agency–Energy**
  - A joint FES and ARPA-E funding opportunity has been announced focused on a range of enabling technologies required for commercially attractive fusion energy.
  - The program, called Galvanizing Advances in Market-aligned fusion for an Overabundance of Watts (GAMOW), will prioritize R&D particularly in:
    - All the required technologies and subsystems between the fusion plasma and the balance of plant.
    - Cost-effective, high-efficiency, high-duty-cycle driver technologies; and
    - Important cross-cutting areas such as novel fusion materials and advanced and additive manufacturing.
  - GAMOW follows the ALPHA and BETHE solicitations focused on fusion energy that were issued by ARPA-E alone.

---

**Announcement Type: Initial Announcement**

**Funding Opportunity No.: DE-FG02-00ER54628**

**For Further Information, visit [www.energy.gov/gamow](http://www.energy.gov/gamow)**

**Important Dates:**
- **First Deadline for Questions to ARPA-E: March 17, 2020**
- **Second Deadline for Questions to ARPA-E: April 17, 2020**
- **Second Deadline for Proposals: May 15, 2020**

**Expected Date for Selection/notifications:**
- **July 2020**

**Total Amount to be Awarded:**
- Approximately $10 million, subject to the availability of appropriated funds.

**Anticipated Awards:**
- ARPA-E (FER) may issue one, multiple, or no awards under this FOA. Awards may vary between $500,000 and $5.5 million (Federal Share).

---

**Funding Opportunity Announcement (FOA) Issue Date:**
- Thursday, February 13, 2020

---

Questions about this FOA? Check the frequently asked questions available at [www.energy.gov/gamow](http://www.energy.gov/gamow), for questions that have not already been answered. Email ARPA-E-COB@energie.org (with FOA name and number in subject line); see FOA Sec. IV.A.

For problems with ARPA-E eXCHANGE, visit [https://www.energy.gov/exchange](https://www.energy.gov/exchange), for questions that have not already been answered. Email ARPA-E-COB@energie.org (with FOA name and number in subject line).
DIII-D is pursuing several heating & current drive upgrades to develop AT scenarios at higher density

Installed, commissioned, and demonstrated in 2019

Diagnostics ready for exploitation in 2020

Co/counter off-axis neutral beam

Top launch ECCD

Helicon antenna

HFS-LH installation planned for FY 2021

New diagnostics

High-Field Side Lower Hybrid

Novel helicon antenna installed in Feb. 2020
Feb. 2020: Novel helicon antenna has been installed in DIII-D for efficient off-axis current drive

- Antenna installed during 2020 vent period
- 1 MW klystron successfully tested
- 476 MHz modulated RF system
- RF diagnostics developed with DIII-D university collaborators (ORNL, UCLA, MIT)
SPI on JET:
- SPI tested on world’s largest tokamak (2019)
- International collaboration between ITER Organization, EUROfusion, USDOE Fusion Energy Sciences, US ITER Project Office, and ORNL, managed by UKAEA/Culham Centre for Fusion Energy

SPI on KSTAR:
- SPI tested for first time in dual-injection configuration (exactly opposite locations)
- Cryogenic D-Ne pellets (28.5 mm X 50 mm)
FES has initiated a new Major Item of Equipment project for a linear divertor simulator

- CD-1 Approval of Alternate Selection and Cost Range was obtained in January 2020
- The Material Plasma Exposure eXperiment (MPEX) will address need for expanded materials science capabilities
- MPEX will be capable of producing fusion reactor-relevant plasma conditions for materials & component-level exposures

FES is considering a Petawatt Laser Facility (PLF) project

- Mission Need (CD-0) approval obtained in FY 2019
- Addresses a recommendation in the 2017 NAS report *Opportunities in Intense Ultrafast Lasers*
- PLF will study properties of matter in extreme conditions of densities and temperatures, relativistic plasmas, planetary science and laboratory astrophysics, plasma photonics and nonlinear optics, and strong field quantum electrodynamics
New Magnet Test Stand capability

- **Magnet Test Stand** for high-critical-temperature superconductor cable and magnets
- Jointly funded by FES and High Energy Physics
- At Fermilab
- LBNL will be designing and fabricating a large superconducting dipole magnet (15 T) to be used in the Magnet Test Stand

*Right: Dr. James Siegrist (AD for HEP program)*
The nine multi-institutional projects in the FES SciDAC portfolio continue to make progress toward integration and Whole-Device Modeling

- More details can be found at: https://scidac.gov/partnerships/fusion_energy.html

The PPPL-led WDMApp project in the SC Exascale Computing Project (ECP) portfolio is making good progress toward the coupling of edge and core tokamak regions using continuum and particle codes

- The JA-US collaboration on Exascale for fusion continues

- US scientists are prepared for the first Exascale computing systems ~2021 (Frontier at ORNL and Aurora at ANL)

Edge turbulence from XGC that enhances the particle loss while confining the electron heat in the DIII-D tokamak.
NSF/DOE Partnership includes:
✓ General Plasma Science
✓ Exploratory Magnetized Plasmas
✓ and HEDLP

FY 2019 FES contribution
$7.0 M

• FES provided $7.0 million FY 2019 funds for the Partnership, supporting 11 new and 3 supplemental proposals in basic plasma, non-neutral/dusty plasma, HED plasma, and low-temperature plasma
• This includes $2.7 million for Basic Plasma Science Facility’s (BaPSF) continuing operation and collaborative research at UCLA

Annual FES Funding Profile for the Partnership

$7.7M annual average for the last 5 years

1999 2001 2003 2005 2007 2009 2011 2013 2015 2017 2019

Millions

0 1 2 3 4 5 6 7 8 9 10
The LaserNetUS website is managed by SLAC for the consortium. It has information for users about facility capabilities and proposal submission process. Advanced Laser Light Source (Quebec) joined LaserNetUS.
The Innovation Network for Fusion Energy (INFUSE) program for fusion R&D was announced in June, 2019. INFUSE accepts research applications focused on innovation for fusion energy in enabling technologies, materials science, plasma diagnostics, modeling & simulation, and MFE experimental capabilities. Awards are made to DOE national labs to help eligible private-sector companies overcome critical scientific and technological challenges in pursuing fusion energy. In FY 2019, twelve awards were made to six private companies partnering with six DOE labs. Awards are listed in: https://infuse.ornl.gov/2019-infuse-awards-2/

In FY 2020, INFUSE expands eligibility to foreign companies whose participation is beneficial to the U.S., raises the funding level and duration of awards, and relaxes limits on number of proposals per topical area. More information here: https://infuse.ornl.gov/

The first INFUSE workshop was held November 22-23, in Knoxville, TN. Attendees included the Point-of-Contacts from the 10 participating labs (BNL, INL, LANL, LBNL, LLNL, ORNL, PNNL, PPPL, SNL, and SRNL); representatives from nine private fusion companies, ARPA-E, and the Fusion Industry Association; and DOE-FES staff.
3. ITER Updates
Progress of U.S. ITER project:
Subproject-1 (First Plasma) is 63% complete

Hardware appropriations: ~ $1.45 B (through FY 2019)

>80% of fabrication awards for U.S. ITER project remain in the U.S.
• 600+ contracts to U.S. industry, universities, and national laboratories in 44 states
• 500+ direct jobs, 1100+ indirect jobs per year
Effective: March 2, 2020

Recent Experience:

Canadian Nuclear Laboratories
- Vice President for Science and Technology and Laboratory Director [oversaw staff of 650]

Idaho National Laboratory
- Director of domestic programs in INL’s Nuclear Science and Technology Directorate
- Director of the Light Water Reactor Sustainability Program Technical Integration Office
- National Technical Director for the Systems Analysis Campaign for DOE Nuclear Energy’s Fuel Cycle R&D Program

Background:
- Ph.D. in nuclear engineering (UCLA) with a major field of fusion engineering and minor fields of nuclear science and engineering and physics
- National Academy of Engineering inductee
- Awarded two American Nuclear Society presidential citations
- FESAC member 1999-2013
- US ITER technical advisory committee member 2010-2013
Examples of U.S. hardware for ITER

Tokamak Cooling Water System

- 40 km of piping in the Tokamak Cooling Water System and nearly all of it is manufactured in the U.S.
- The Tokamak Cooling Water System will have total heat removal capacity = 1,000 MW (thermal)

US tests first central solenoid module

The first production central solenoid module is currently being tested in the United States by contractor General Atomics. It will be delivered to the ITER site during FY 2020. Fabrication of each module requires multiple fabrication steps spread out over 24 months.
ITER civil construction is nearly complete and assembly phase has begun

Fully contained
The volume of the crane hall (right) is now fully framed out. When the interior partition wall is removed, the buildings will form one continuous assembly space.

26 FEBRUARY 2020

Cryostat base: grand opening soon
The huge cryostat base section will descend from above, supported by the overhead cranes as it is lowered 30 meters to the bottom of the pit.

13 FEBRUARY 2020
4. Program Planning
FES strategic choices are informed by community and Advisory Committee input.
CPP process concluded with a substantive report

Thank you!

American Physical Society Division of Plasma Physics
Community Planning Process
January 13-17, 2020 • Houston, Texas
Decadal Assessment of Plasma Science

Chairs: Prof. Mark Kushner & Prof. Gary Zank

- **Objective:** Conduct a study of the past progress and future promise of plasma science and technology and provide recommendations to balance the objectives of the field in a sustainable and healthy manner over the long term

- **Multiple federal sponsors:** DOE (FES, HEP, NNSA, ARPA-E); NSF; DOD (AFOSR, ONR)

- **Current status:**
  - Draft report was sent to the reviewers in late February
  - Committee will address reviewer input under an accelerated schedule
  - Release of final report to federal sponsors is targeted for mid-April
Congress has expressed its interest on understanding the regulatory approach for Advanced Nuclear Reactors, including nuclear fusion reactors

- *Nuclear Energy Innovation and Modernization Act*, S.512 (January 2018)

Early in 2019, FES along with ARPA-E formed an informal working group with the Nuclear Regulatory Commission to exchange information.

DOE and NRC senior management are aware of this activity and have been involved in planning future engagements.

The one-day DOE-NRC Public Forum on fusion regulation planned for this week will be rescheduled.
5. People
Dan Brouillette sworn in as the 15th Secretary of Energy, U.S. Department of Energy, on December 11, 2019

- Served as USDOE Deputy Secretary of Energy since August 2017
- Previous experience:
  - Senior Vice President and head of public policy for U.S. Automobile Association (USAA)
  - Vice President of Ford Motor Company
  - Chief of Staff to the U.S. House of Representatives Committee on Energy and Commerce
Dr. Nathan Howard (MIT) received the 2019 Nuclear Fusion award for the paper “Multi-scale gyrokinetic simulation of tokamak plasmas: Enhanced heat loss due to cross-scale coupling of plasma turbulence” [Nuclear Fusion (2016)]

- Co-authors were C. Holland, A. E. White, M. Greenwald, and J. Candy

This paper presents novel gyrokinetic simulations that capture ion and electron-scale turbulence simultaneously.

- The simulations reveal mechanisms explaining electron heat losses in the core of fusion plasmas.
- The paper compared cutting-edge simulation results to experimental findings, providing convincing physical explanations for observed anomalous heat losses.

The award will be presented at the IAEA Fusion Energy Conference, to be held in Nice, France in October 2020.
Spitzer Space Telescope

- The infrared Spitzer Space Telescope, named after Prof. Lyman Spitzer, Jr. (founder of PPPL) and considered one of NASA’s four “great observatories” (with Hubble Space Telescope, Chandra X-Ray Observatory, and Compton Gamma-Ray Observatory), was switched off on January 31 after 16 years of operation.