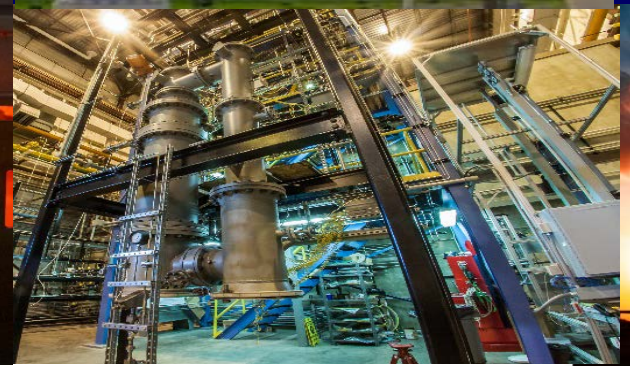
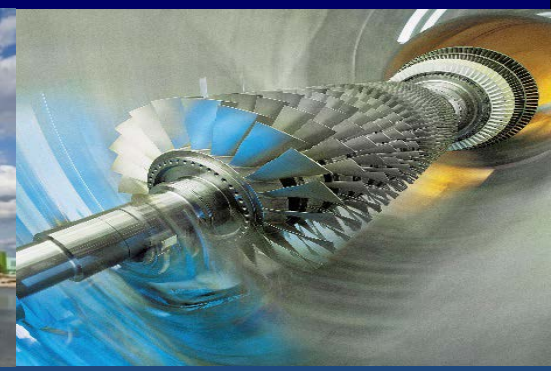




U.S. DEPARTMENT OF ENERGY | Office of Fossil Energy

Energy Storage for Fossil Fuel Energy Systems

Angelos Kokkinos

Associate Deputy Assistant Secretary

Office of Clean Coal and Carbon Management

Thermal-Mechanical-Chemical Energy Storage Workshop | Pittsburgh, PA | February 4, 2020

ANNOUNCEMENT: ENERGY STORAGE GRAND CHALLENGE (ESGC)

"Through this Grand Challenge, we will deploy the Department's extensive resources and expertise to address the technology development, commercialization, manufacturing, valuation, and workforce challenges to position the U.S. for global leadership in the energy storage technologies of the future" ***– Secretary Brouillette***

ENERGY STORAGE GRAND CHALLENGE PARTICIPANTS

* Participating Offices

Energy Secretary

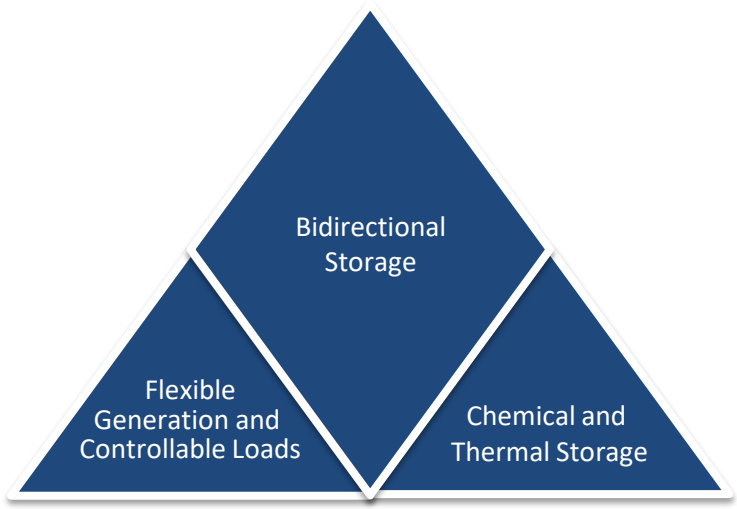
Under Secretary of Energy (S3)

- EERE*
- FE*
- NE*
- OE*
- LPO*

Under Secretary of Science (S4)

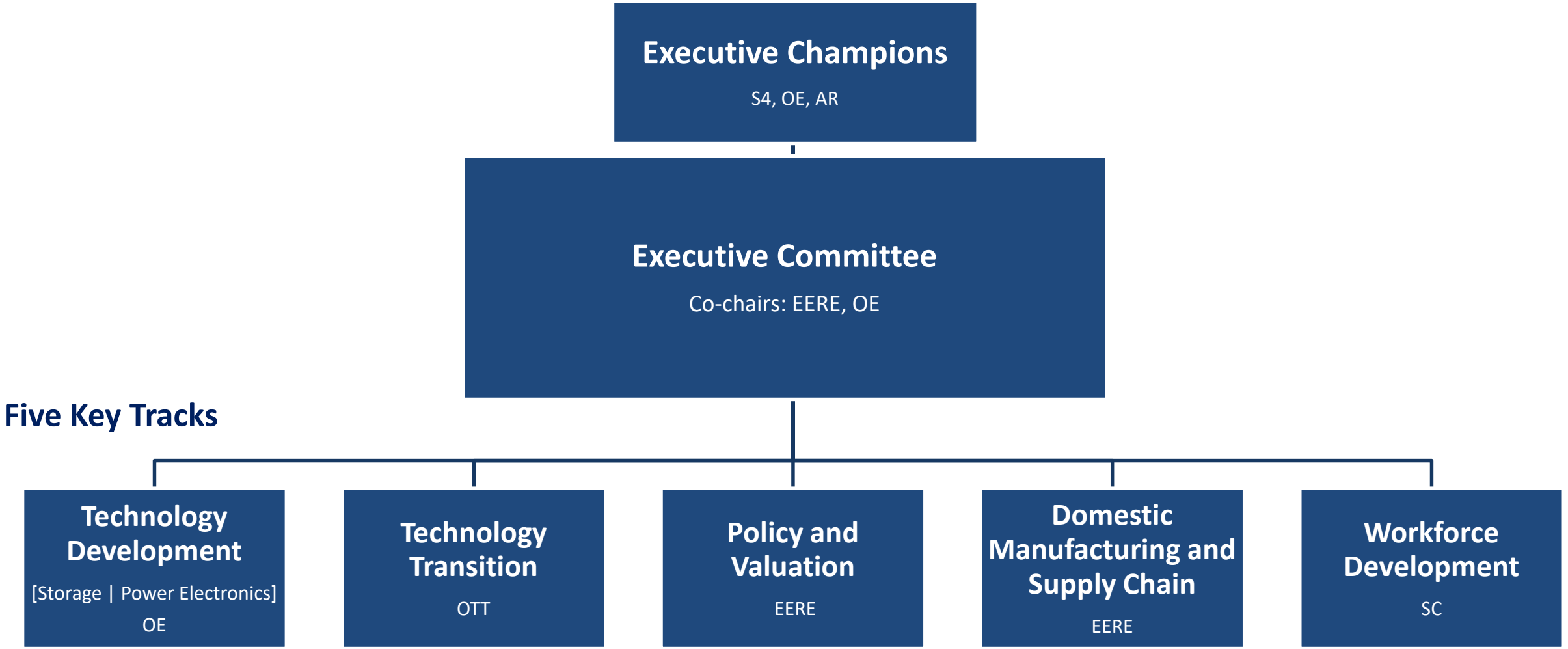
- Science*
- OTT*

- ARPA-E*



Basic Science Research & Discovery → Application Driven Materials Development → Applied Device and System R&D → Cost & Performance Metrics, Targets → Demonstration and Performance Validation → Systems Analysis and Valuation → Commercialization Strategy

RTIC ENERGY STORAGE SUBCOMMITTEE STRUCTURE



ENERGY STORAGE GRAND CHALLENGE

Vision

By 2030, U.S. world leader in energy storage utilization and exports

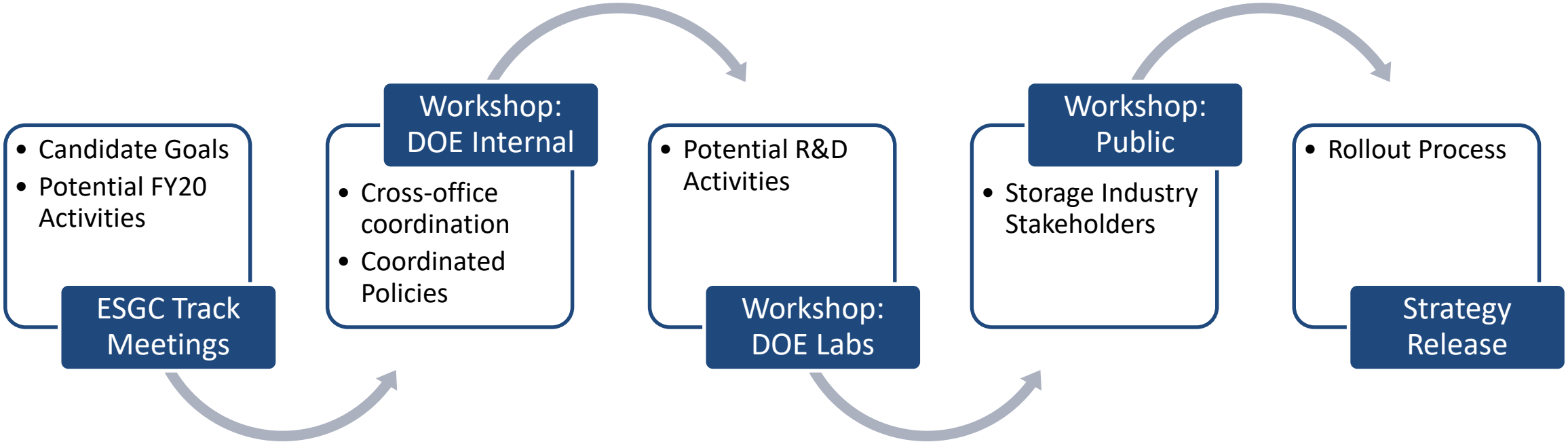
Mission

Accelerate the development and commercialization of next-generation energy storage technologies and sustain U.S. global leadership

DOE Action Items

Technology Development	• Ambitious, achievable performance goals • Comprehensive R&D portfolio.
Technology Transition	• Accelerate the technology pipeline
Policy and Valuation	• Develop best-in-class models, data, and analysis
Domestic Manufacturing and Supply Chain	• New U.S. manufacturing, recyclability technology
Workforce and Technical Assistance	• Next generation grid workforce

ESGC STRATEGY DEVELOPMENT PROCESS



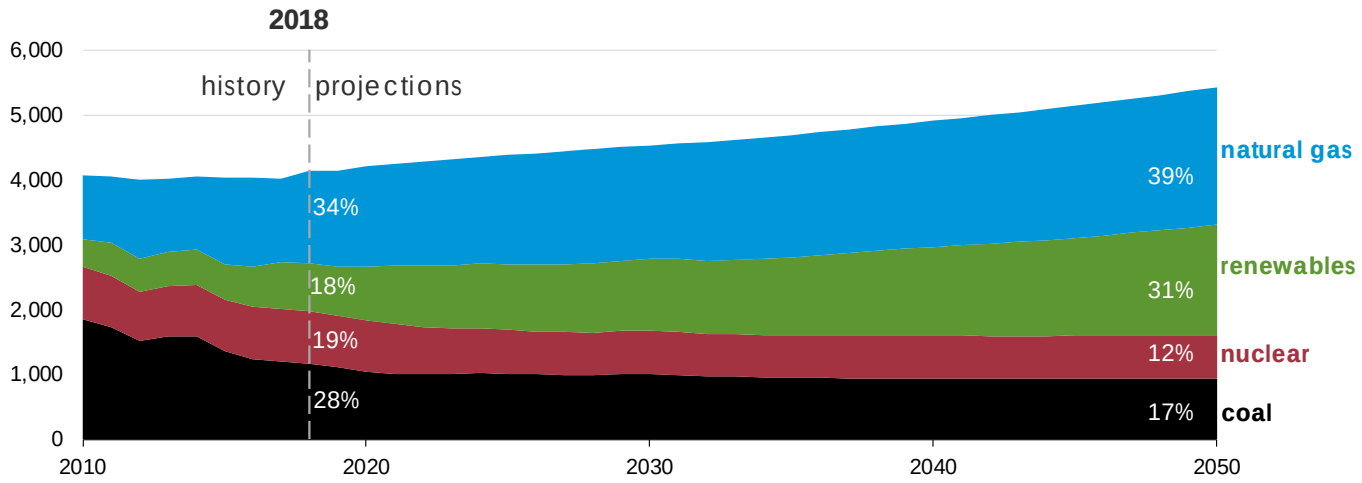
THE CURRENT ENERGY LANDSCAPE

- **Fossil-fuel plants will continue to satisfy a majority of U.S. electricity demand in next several decades**
- **Energy storage at the generation site will be essential as variable renewable energy penetration increases**

Energy Storage in Fossil Applications Offer:

- ✓ *Improved plant economics,*
- ✓ *Improved efficiency and environmental performance,*
- ✓ *Reduced maintenance costs,*
- ✓ *Improved response system demands for flexible operation, and*
- ✓ *Extended the life of the Nation's fossil energy assets*

Electricity Outlook



EIA, Annual Energy Outlook 2019, Reference Case

NEW DOE OFFICE OF FOSSIL ENERGY PROGRAM: ENERGY STORAGE

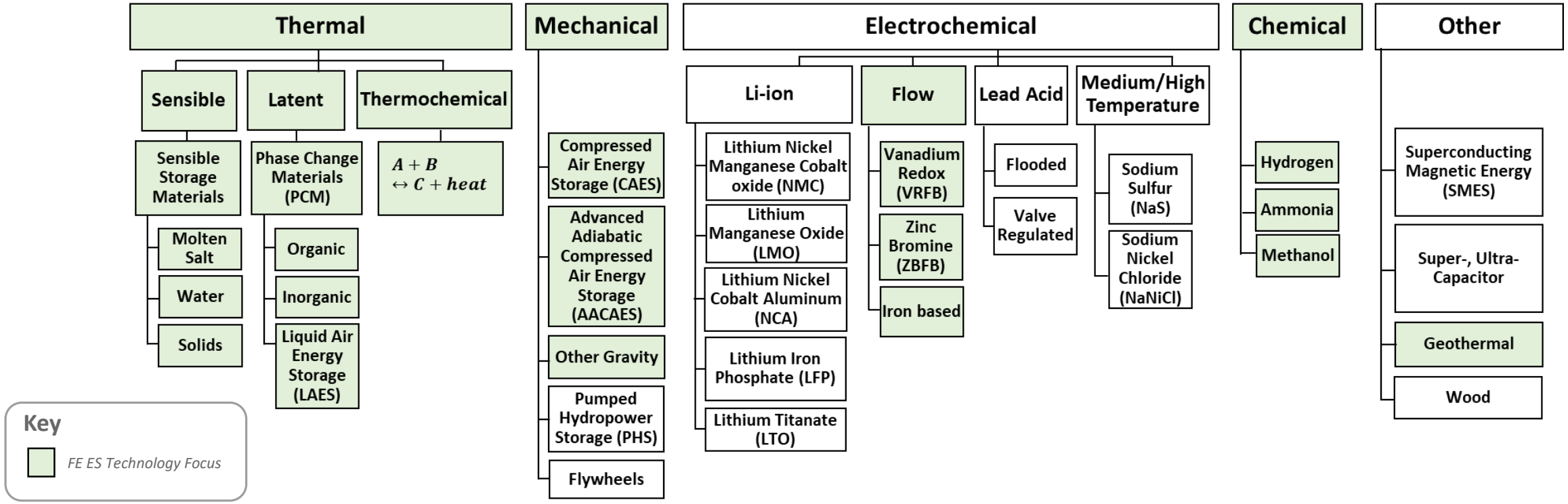
High-Level Program Goals

- **Leverage over a century of fossil energy infrastructure investments**
- **Extend the lifetime of existing fossil energy assets**
- **Enhance the role of fossil assets**
    - contributors to grid stability and reliability
- **Leverage and extend ongoing energy storage technology development**
    - OE, EERE, ARPA-E, INL, NREL, ARL, NASA and DOD

Approach

- **Develop a comprehensive strategy to expand FE's current portfolio of technologies and programs to include an FE Energy Storage Technology Research Program in order to continue to extract maximum economic value from the Nation's fossil-fueled energy system assets (both coal and natural gas)**

TECHNOLOGY LANDSCAPE



Energy Storage in Fossil Plants Permits:

- Arbitrage
- Asset management
- Faster electricity generation ramping rates
- Improved plant efficiency

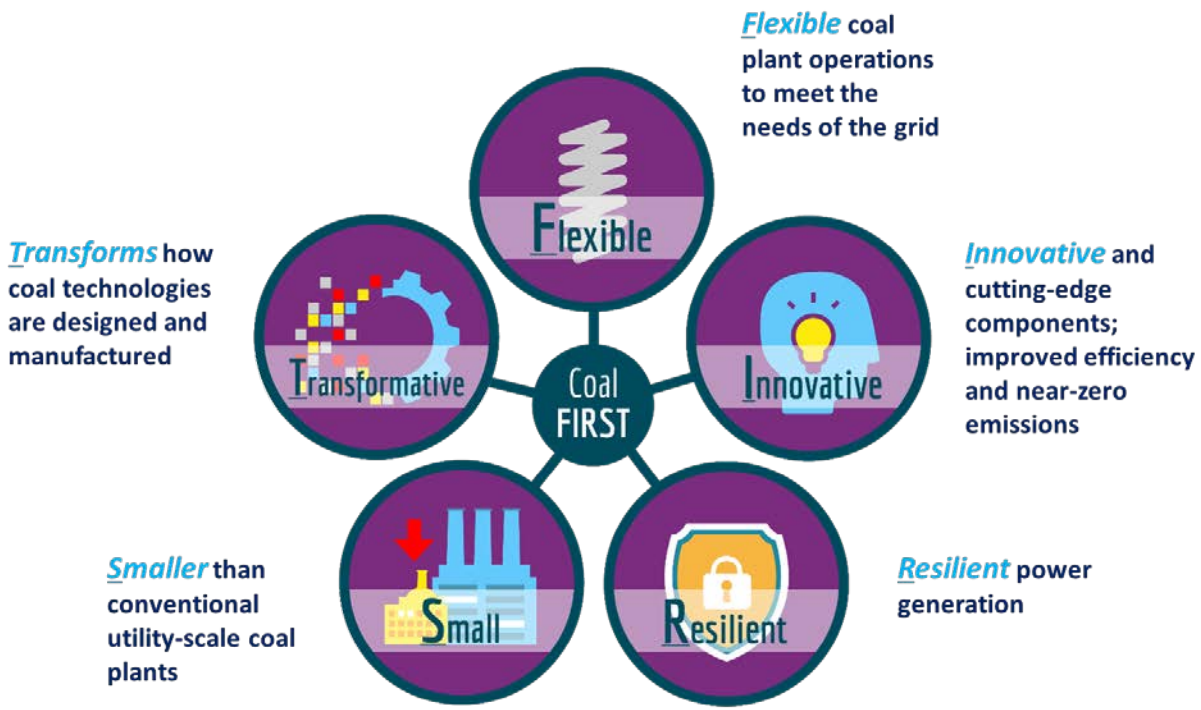
Source: NETL

COAL FIRST - THE FUTURE OF POWER GENERATION

(Flexible, Innovative, Resilient, Small, Transformative)

Goal: Develop the coal plant of the future needed to provide secure, stable, and reliable power.

- Provides a **zero or near zero CO_2 emissions**
- Provides **low cost power generation**; economically competitive
- Uses advanced materials and processes; **maximizes efficiency**
- **Meets IEA solution for CO_2 emissions** -- carbon capture
- **Only** zero or near zero CO_2 emissions power plant **R&D effort in the world**
- Potential to **revive the US coal industry**; provide a source of **high value exports**
- Provides stability and reliability to the grid of the future, and offer both **"firm and flexible" operations**



Funding 7 concepts for a pre-FEED studies at >$1M each as a part of the Coal FIRST initiative.

REQUEST FOR INFORMATION (RFI)

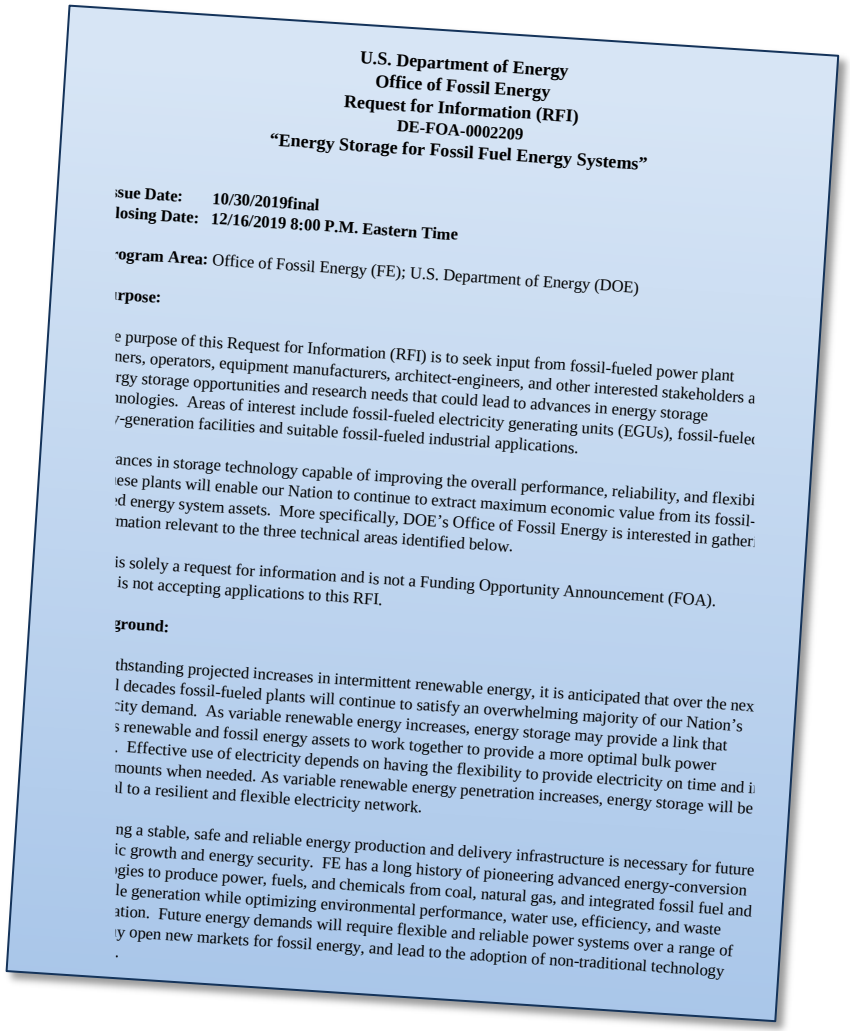
Request for Information
DE-FOA-0002209
Issue Date: 10/30/2019
Closing Date: 12/16/2019

Areas of Interest

1. Existing fleet of fossil-fueled power plants *(both coal and natural gas)*
2. New flexible fossil fueled power plants of the future
3. Non-traditional FE System Platforms beyond electric power *(e.g., industrial, DG, poly-generation, waste heat recovery, etc.)*

Purpose

- Input from fossil-fueled power plant owners, operators, equipment manufacturers, architect-engineers, and other interested stakeholders
- Energy storage opportunities
- Energy storage research needs



U.S. Department of Energy
Office of Fossil Energy
Request for Information (RFI)
DE-FOA-0002209
"Energy Storage for Fossil Fuel Energy Systems"

ssue Date: 10/30/2019final
losing Date: 12/16/2019 8:00 P.M. Eastern Time

rogram Area: Office of Fossil Energy (FE); U.S. Department of Energy (DOE)

rpose:

e purpose of this Request for Information (RFI) is to seek input from fossil-fueled power plant
ners, operators, equipment manufacturers, architect-engineers, and other interested stakeholders a
rgy storage opportunities and research needs that could lead to advances in energy storage
nologies. Areas of interest include fossil-fueled electricity generating units (EGUs), fossil-fuele
r-generation facilities and suitable fossil-fueled industrial applications.

ances in storage technology capable of improving the overall performance, reliability, and flexibi
ese plants will enable our Nation to continue to extract maximum economic value from its fossil-
d energy system assets. More specifically, DOE's Office of Fossil Energy is interested in gather
mation relevant to the three technical areas identified below.

is solely a request for information and is not a Funding Opportunity Announcement (FOA).
is not accepting applications to this RFI.

ground:

thstanding projected increases in intermittent renewable energy, it is anticipated that over the nex
l decades fossil-fueled plants will continue to satisfy an overwhelming majority of our Nation's
city demand. As variable renewable energy increases, energy storage may provide a link that
s renewable and fossil energy assets to work together to provide a more optimal bulk power
. Effective use of electricity depends on having the flexibility to provide electricity on time and i
mounts when needed. As variable renewable energy penetration increases, energy storage will be
l to a resilient and flexible electricity network.

ng a stable, safe and reliable energy production and delivery infrastructure is necessary for future
ic growth and energy security. FE has a long history of pioneering advanced energy-conversion
gies to produce power, fuels, and chemicals from coal, natural gas, and integrated fossil fuel and
le generation while optimizing environmental performance, water use, efficiency, and waste
ation. Future energy demands will require flexible and reliable power systems over a range of
y open new markets for fossil energy, and lead to the adoption of non-traditional technology
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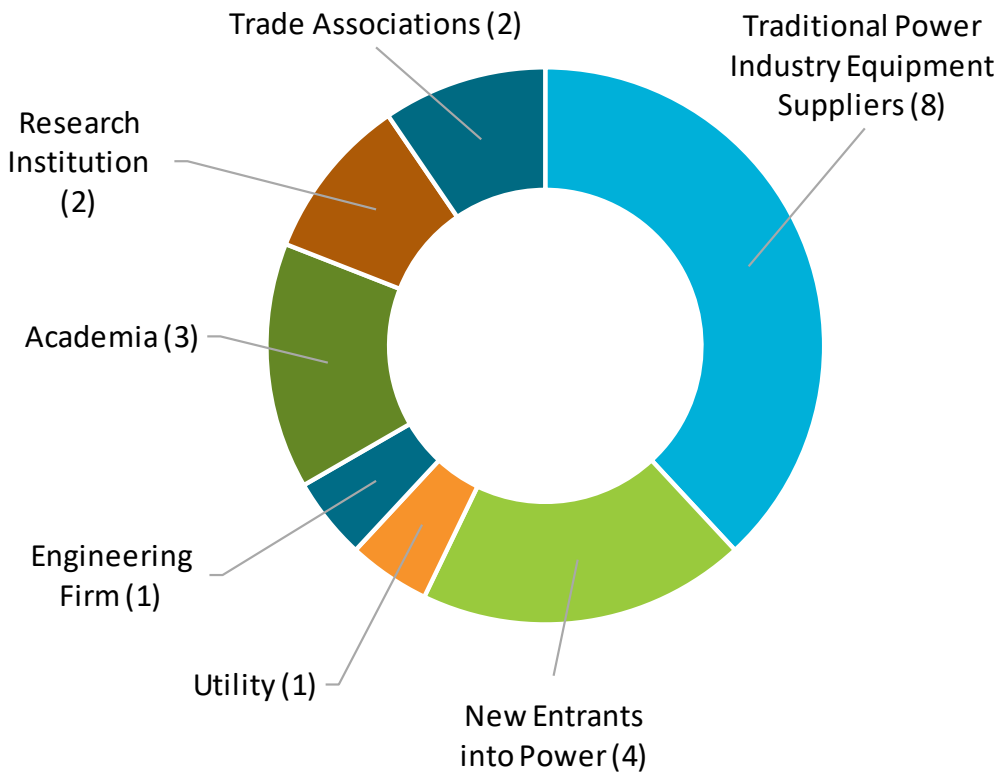
RFI RESPONSE SUMMARY

RFI Responses - Breakdown by Responder Type



Notable absence of responses from:

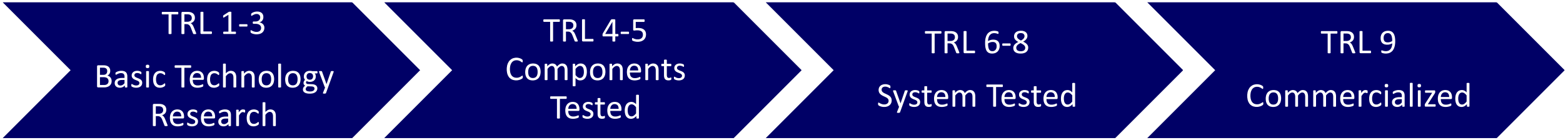
- Owner/operator companies
- ISOs / state legislation
- Industry (e.g. oil & gas, steel)
- Coal companies

R&D Opportunities Identified

- Energy Storage Technology Needs
  - Testing of subsystems and field demonstration of systems
  - Modeling, simulation and optimization tools for standalone and integrated performance
  - Advanced materials with respect to chemical reactivity, strength, energy density, and lifetime/stability

- Fossil Fueled Power Plant (FFPP) Integration Needs
  - Identification of appropriate sites for integration
  - Methods and means to integrate new technology into existing fossil-fueled units
  - Advanced controls for system dynamics and transient operation optimization

TECHNOLOGY CONCEPTS FROM RFI RESPONSES GROUPED BY TRL



- Sensible Heat Storage (integrated w/ FFPP)
- Latent Heat: Other Phase Change Materials
- Formic Acid Production
- Thermal-chemical Hybrid (TCES)
- Forest Waste Wood
- Electro-thermal Hybrid
- Geothermal
- Hydrogen Production
- Latent Heat: Liquid Air Energy Storage (LAES)
- Compressed Air Energy Storage
- Redox Flow Battery

Key

- *Thermal Energy Storage*
- *Chemical Energy Storage*
- *Mechanical Energy Storage*
- *Other Technology Type*

NEXT STEPS

- **Fossil Energy is supporting the Energy Storage Grand Challenge**
  - Creating a new Energy Storage Program
- **Evaluating the energy storage landscape**
- **Identifying large-scale energy storage and steady-state plant operation solutions**
- **UCR/HBCU University-focused Energy Storage Analysis funding opportunities**
- **Additional Funding Opportunity Announcements**