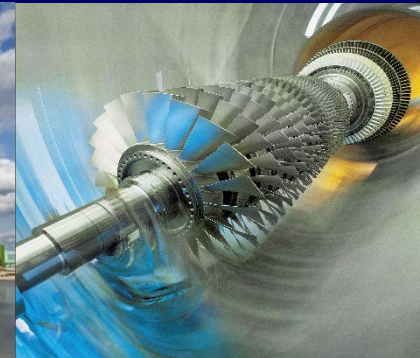


U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Fossil Energy



## Fossil Energy Crosscutting Research

March 20, 2017

**Doug Hollett**

Acting Assistant Secretary  
for Fossil Energy

## Industry Snapshot

- Low gas prices, large gas reserves, U.S. exports; dramatic changes in generation makeup – coal/gas/renewables
- Oil price volatility, OPEC discipline (?)
- O&G Industry differentiation (shales vs offshore vs international); Permian
- Defining the global demand curve for all energy sources
- Infrastructure gaps across multiple sectors – plants, grid, pipelines
- Strong CCUS interest across all FE industry sectors
- Increased EOR focus as prices stabilize

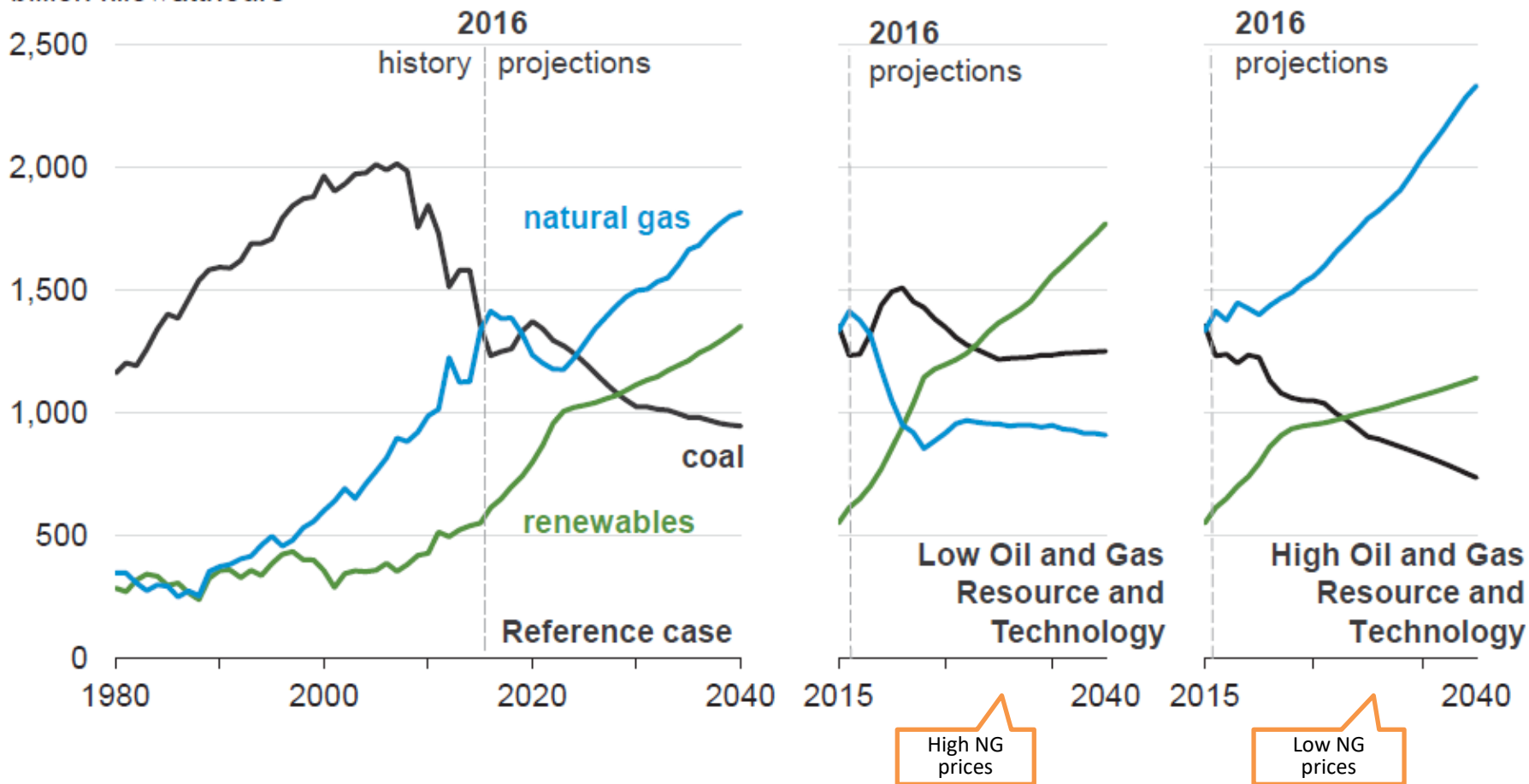


What are the next game changers and disrupters?

# Price of Natural Gas a Key Factor in Projecting Future Mix

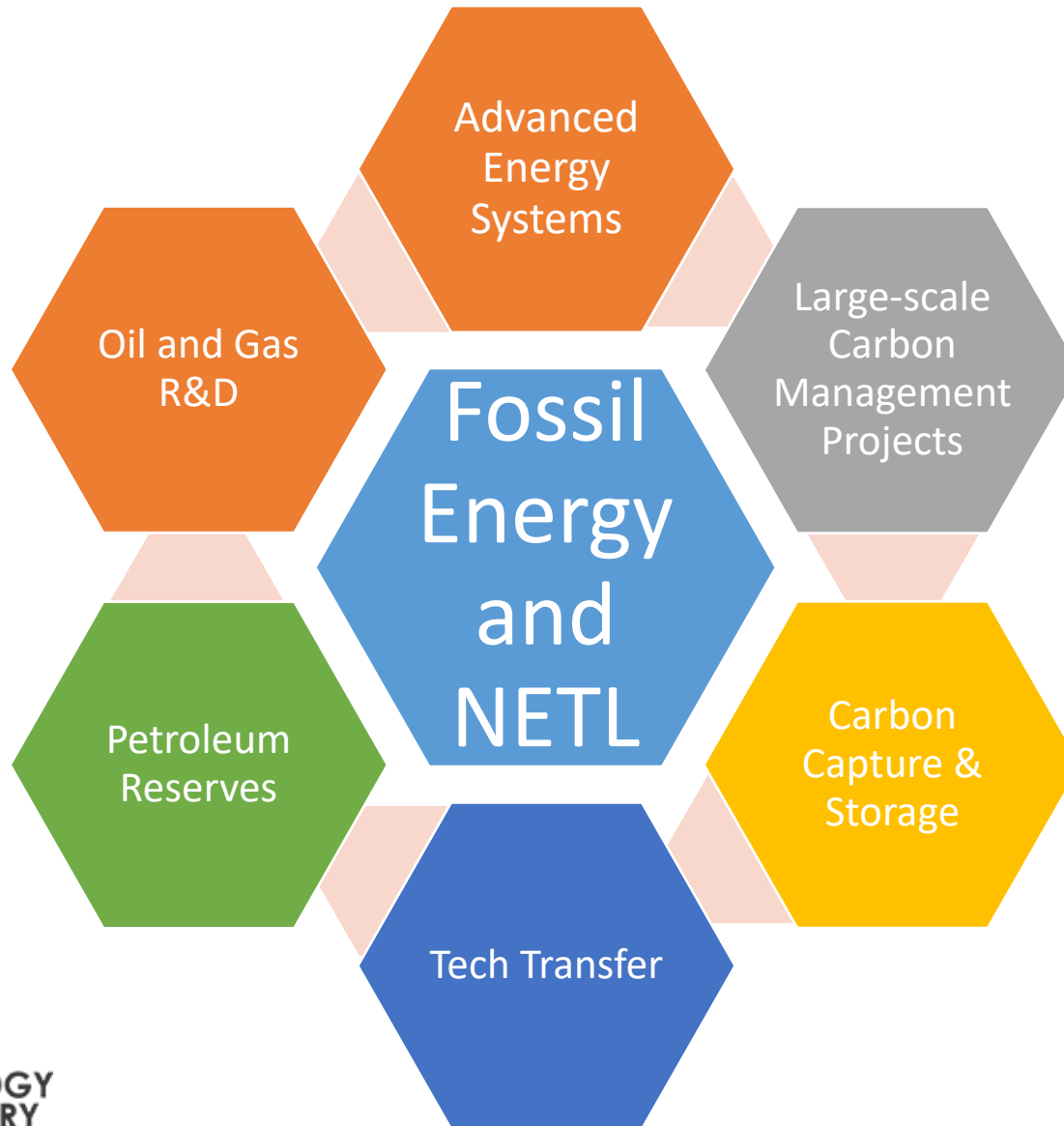
**Electricity generation from selected fuels**

billion kilowatthours



Source: EIA Annual Energy Outlook 2017

# DOE Fossil Energy Office Focus Areas



# Advanced Fossil Technology Systems



## Major Demonstrations

First Generation fossil energy technology systems built to validate first-of-a-kind fully integrated projects at full scale for the power and industrial sectors



## Advanced Energy Systems

Technologies that greatly improve plant efficiencies, reduce costs, increase plant availability, and maintain the highest environmental standards



## Carbon Capture

R&D and scale-up technologies for capturing CO<sub>2</sub> from new and existing industrial and power-producing plants



## Carbon Storage

Safe, cost-effective, and permanent geologic storage of CO<sub>2</sub> in depleted oil and gas fields and other formations

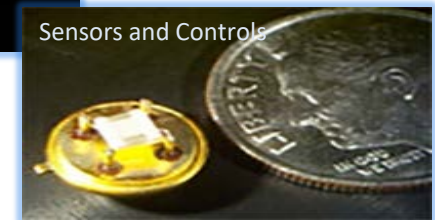
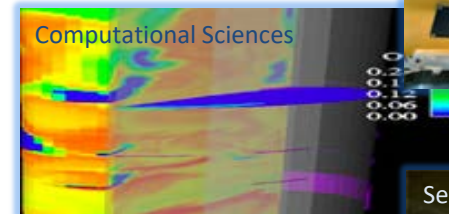
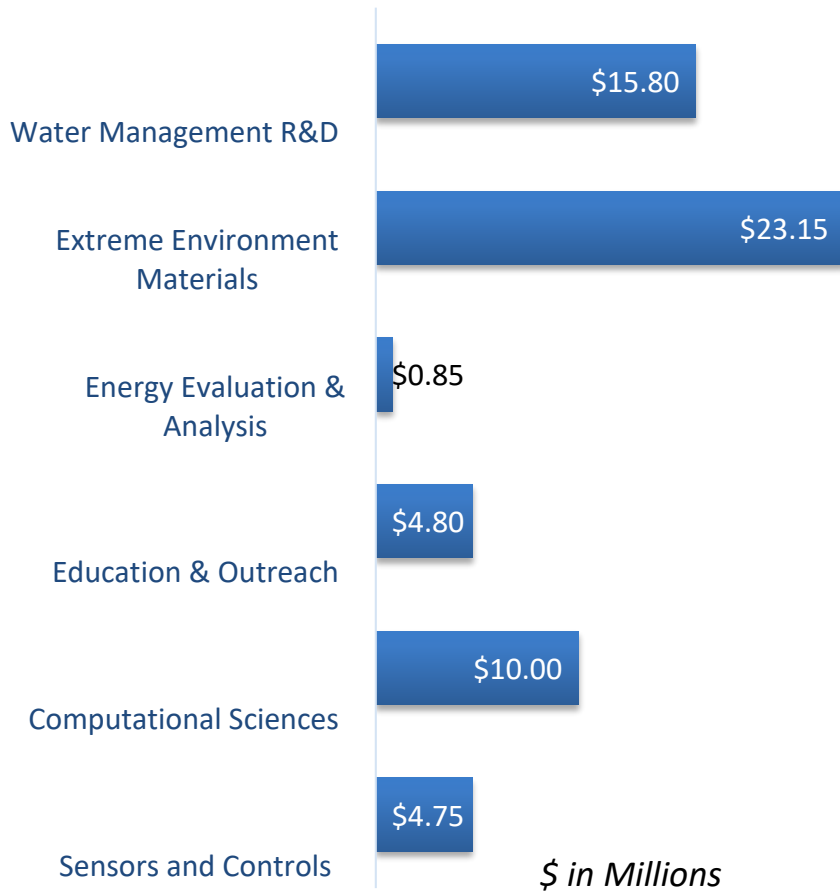


## Cross Cutting Research

Materials, sensors, and advanced computer systems for future power plants and energy systems

# Crosscutting Research

**\$59.35M FY17 Request**



*Development of new materials, catalysts, instrumentation and sensors, and advanced computer systems that will be used in future power plants and energy systems*

# Successes are Applicable to Multiple Programs

## Advanced Combustion

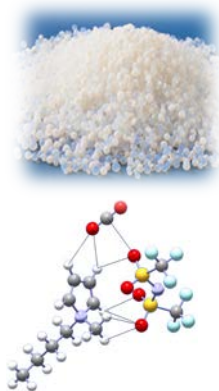


5 MWE Oxycombustion Pilot

- Pressurized
- O<sub>2</sub> membrane
- Chemical looping
- USC Materials
- Gasification
- Turbines
- Supercritical CO<sub>2</sub>
- Direct Power Extraction

*Efficiencies > 45%*  
*↓ Capital Cost by 50%*  
*\$40/tonne CO<sub>2</sub> Captured*  
*Near-zero GHGs*  
*Near-zero criteria pollutants*  
*Near-zero water usage*

## Advanced CO<sub>2</sub> Capture and Compression



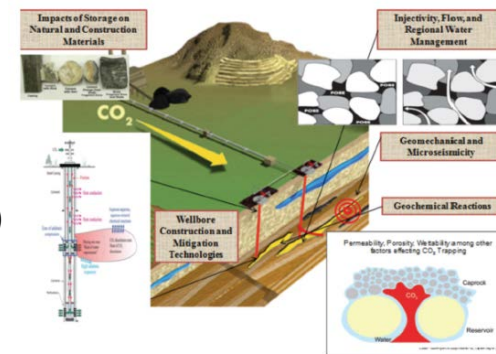
- Solvents
- Sorbents
- Membranes
- Hybrid
- Process Intensification
- Cryogenic Capture
- Carbon Utilization (EOR)
- Infrastructure (RCSPs)
- Geological Storage
- Monitoring, Verification and Accounting

## Advanced Energy Systems



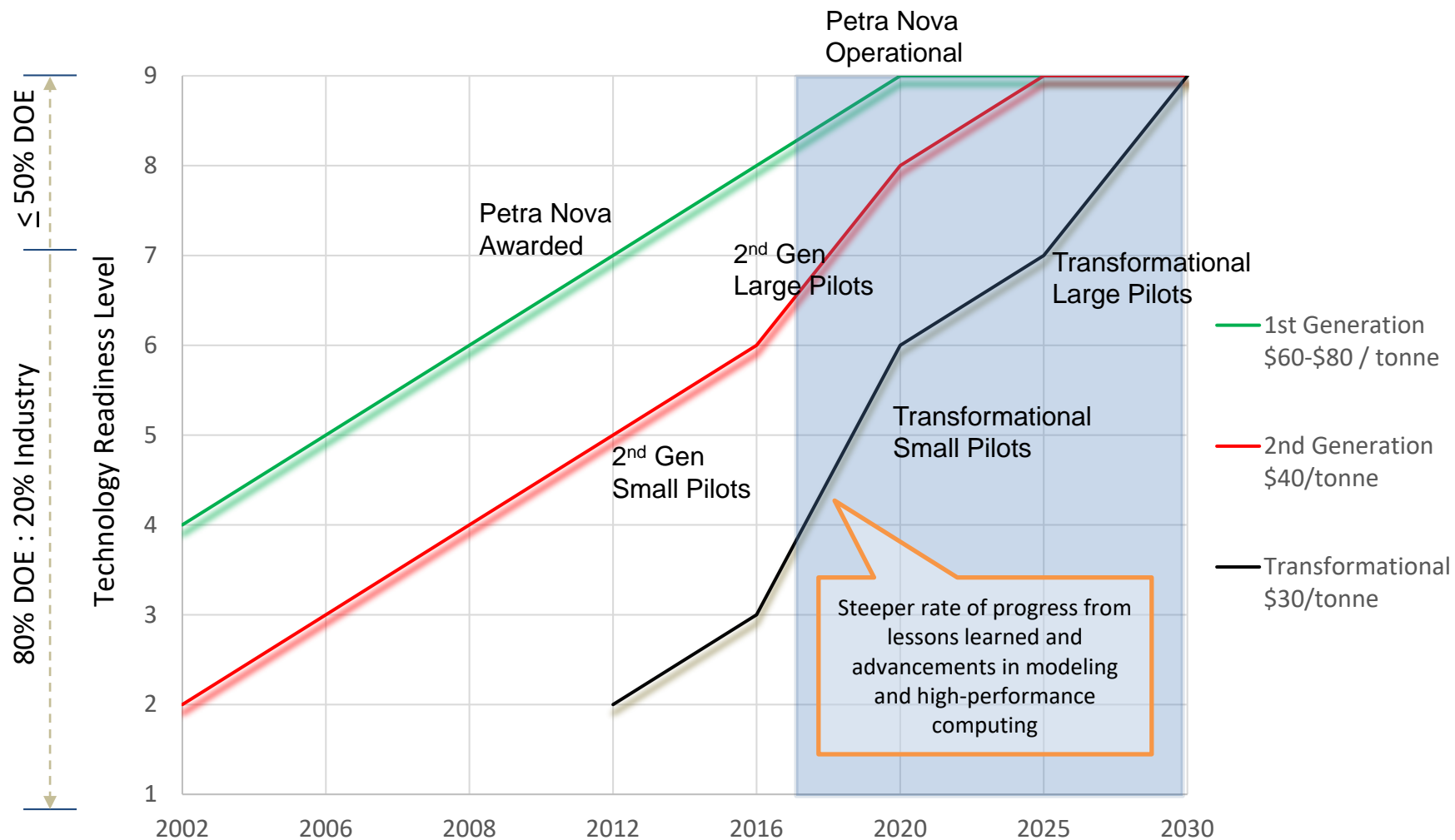
Advanced Turbines

## CO<sub>2</sub> Storage



# Carbon Capture Technology Development

FE Investments Advance Commercial Readiness





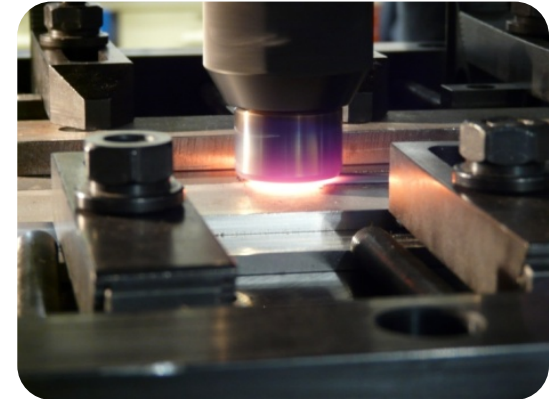
# Advanced Materials

## The Problem

New high temperature structural alloy development and commercialization is **time consuming** and **expensive**: >10 years and multi-million dollars for a single alloy

## The Vision

- Reduce the cycle time, cost and failure rate of advanced FE materials development by at least a factor of 2X by:
  - Use of integrated High Performance Computational materials design and long term predictive behavior tools coupled with smarter, more efficient experimental techniques and
  - Use of data analytics to leverage existing data and knowledge to its maximum possible extent.



Friction stir welding of ¼" thick dispersion strengthened Sandvik APMT plate

### Advanced FE systems

- Extreme environments
- Long service life (>100,000 h)
- Large components

### Opportunity

- New Phase Stable Alloys
- Manufacturing of Alloys, Materials Systems & Components
- Build upon DOE-FE successes with Integrated Computational Materials Engineering (ICME) environments

# Water Management

*Innovation Priorities:* Advancing cooling technologies, and applying novel water treatment and waste heat concepts to improve efficiency and reduce water use

Our work has broad and deep implications:

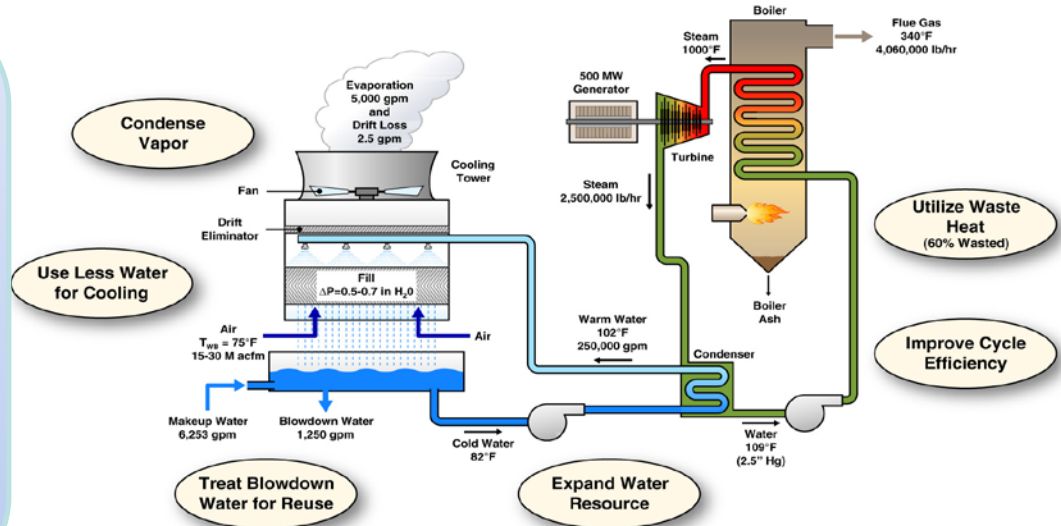
- User-driven analytic tools for national decision-making supporting energy resilience with initial focus on the water-energy nexus
- Solutions through technology RDD&D, policy analysis, and stakeholder engagement

## R&D Areas:

- Advanced / Novel Heat Transfer and Cooling Systems
- Water Treatment and Reuse
- Process Efficiency and Heat Utilization
- Data, Modeling and Analysis






## Innovation Priorities:

- Advancing cooling technologies
- Applying novel water treatment and waste heat concepts to improve efficiency and reduce water use



# Supercritical CO<sub>2</sub> Power Cycles

**Supercritical CO<sub>2</sub>:**  
A highly efficient working fluid

-  COAL
-  SOLAR
-  NUCLEAR
-  WASTE MFG. HEAT
-  NATURAL GAS

**Diverse fuel/  
heat sources**



**Higher thermal efficiencies,  
smaller physical footprint, and  
lower capital costs**  
(than conventional steam-based  
power generation)



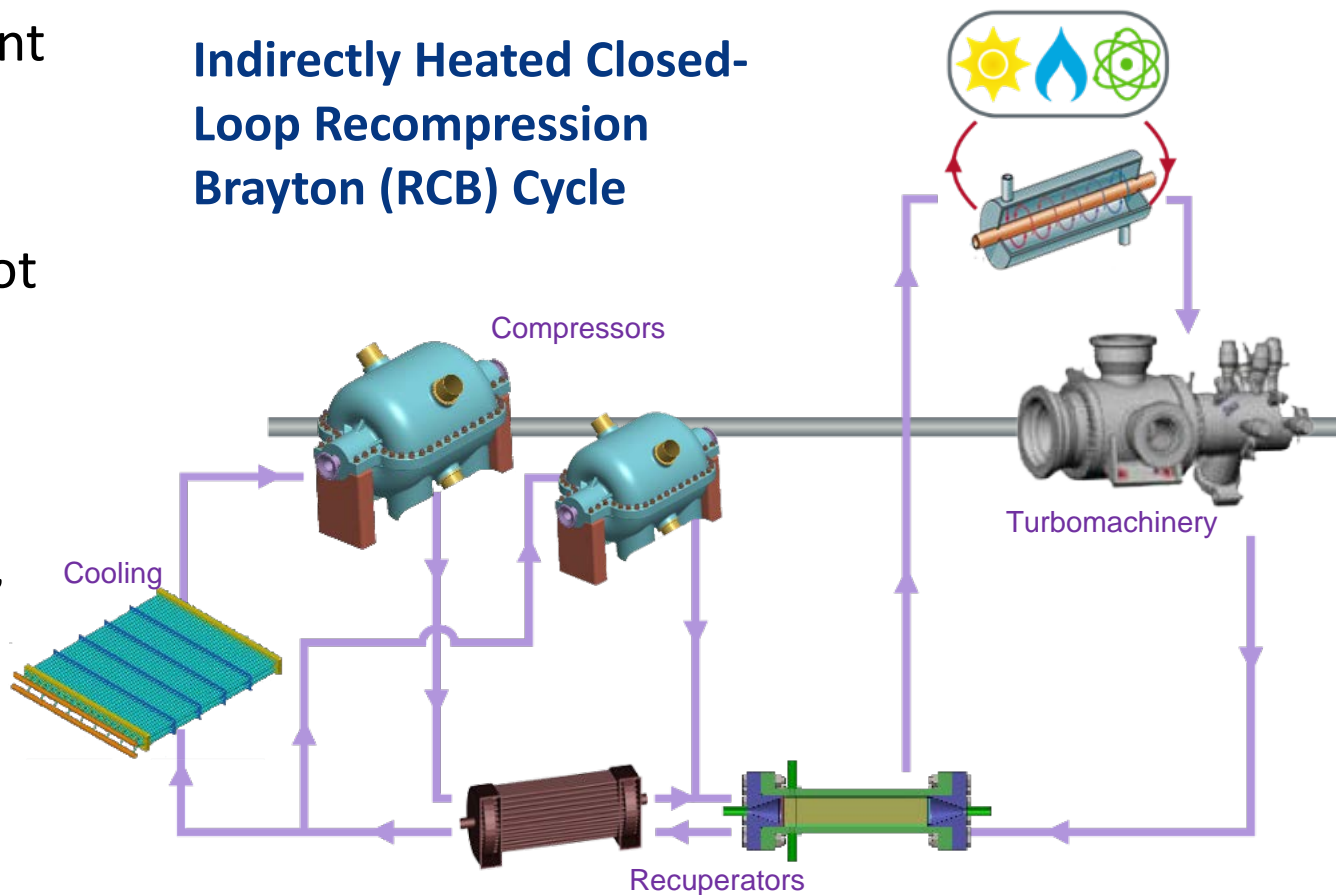
**Cleaner, more  
affordable electricity**

# DOE sCO<sub>2</sub> Crosscut Initiative

## 10 MW<sub>e</sub> STEP Pilot Facility

- \$80M DOE investment
- Six-year project to design, build, and operate 10-MWe pilot plant test facility in San Antonio, TX.
- Team led by the Gas Technology Institute, Southwest Research Institute, and General Electric Global Research

### Indirectly Heated Closed-Loop Recompression Brayton (RCB) Cycle

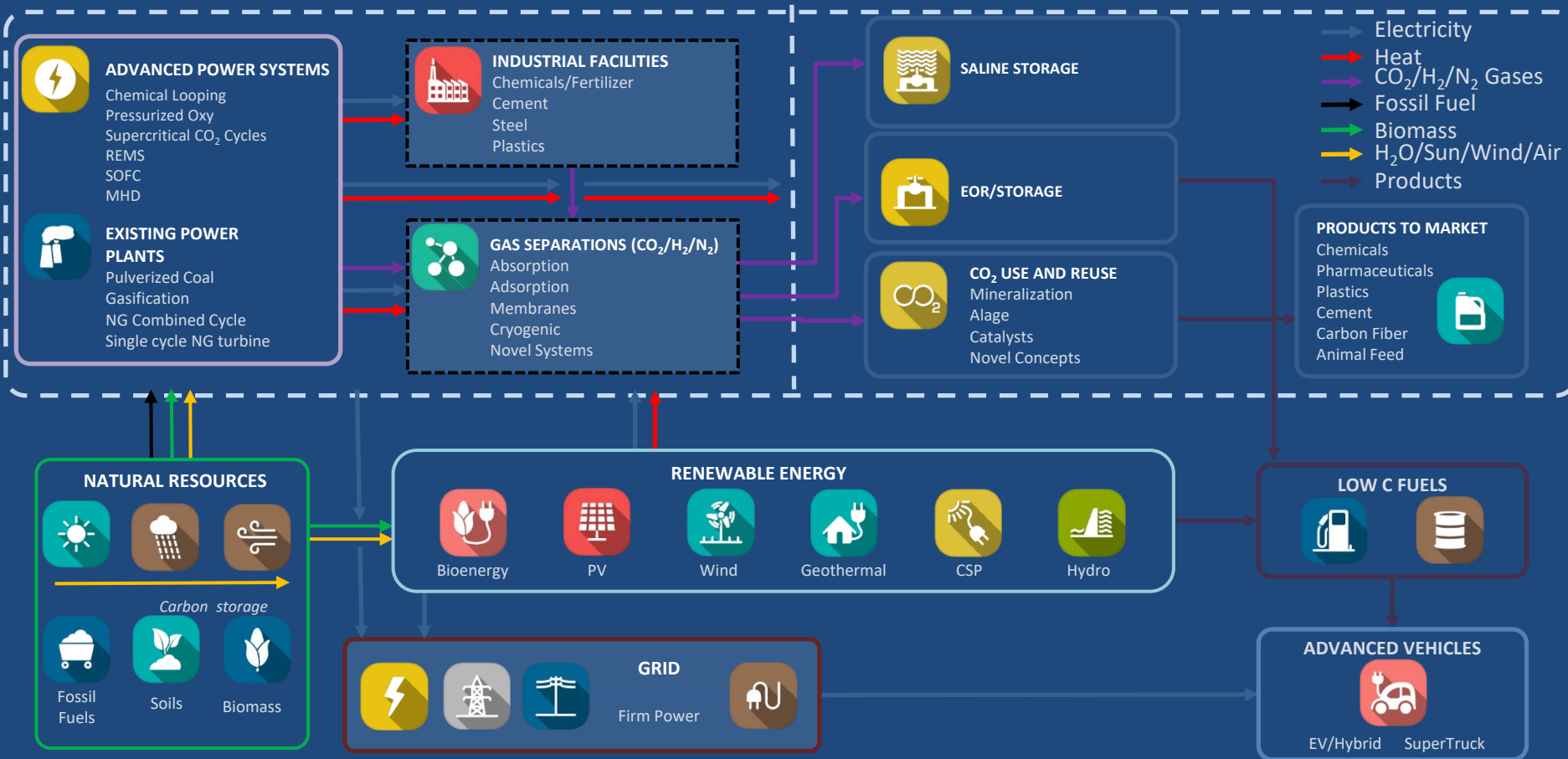


GE Global Research

# Integrated System Approach

## Advanced Energy Systems

## Carbon Capture, Utilization, and Storage



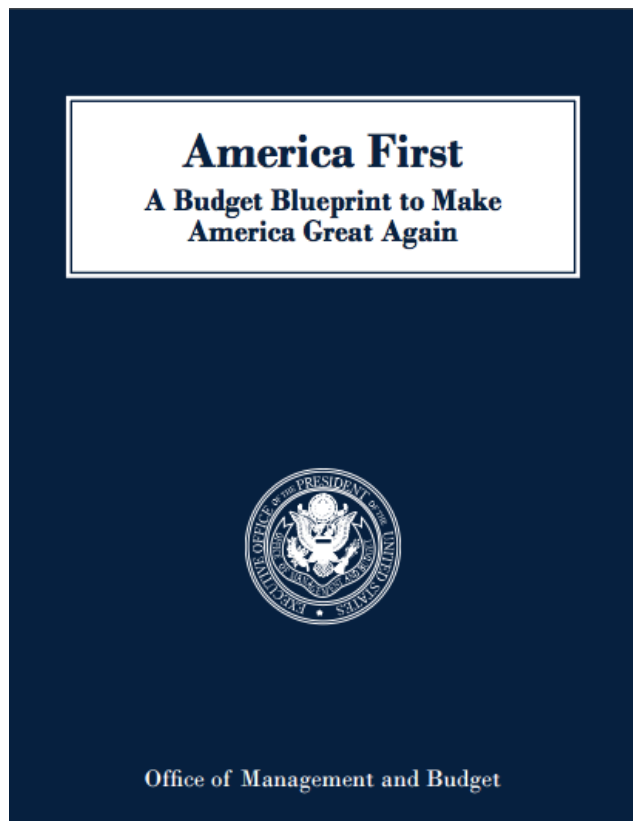
# Collectively Telling the Fossil Energy R&D Story

## *Critical Questions*

1. **Is there a Proper Role for Government to Play Here? How is this in the National Interest?**
2. **What is the Problem and Why is it Important to Solve?**
3. **If We Solve it, Will it Matter?**
4. **What is the Enduring Economic Benefit?**
  - i. Energy independence, near to mid-term economic impact
5. **How is the Government's Role Different from/Additional to what Industry is Already Doing?**
  - I. Focused early-stage applied R&D
  - II. Look to private sector for later-stage RD3



# FY17 Status and Preview of FY18 Budget



**“Focuses funding for the Office of Energy Efficiency and Renewable Energy, the Office of Nuclear Energy, the Office of Electricity Delivery and Energy Reliability, and the Fossil Energy Research and Development program on limited, early-stage applied energy research and development activities where the Federal role is stronger....Collectively, these changes achieve a savings of approximately \$2 billion from the 2017 annualized CR level.”**

[https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/budget/fy2018/2018\\_blueprint.pdf](https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/budget/fy2018/2018_blueprint.pdf)



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Fossil Energy

**Questions?**