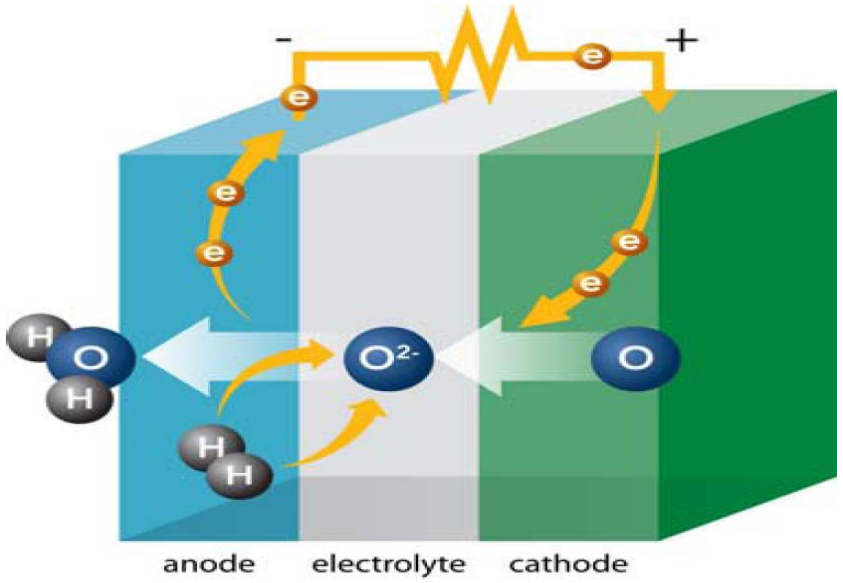
11th Annual SECA Workshop
Pittsburgh, PA
July 27-29, 2010



Samuel Tam
Director
Division of Clean Coal Energy Research

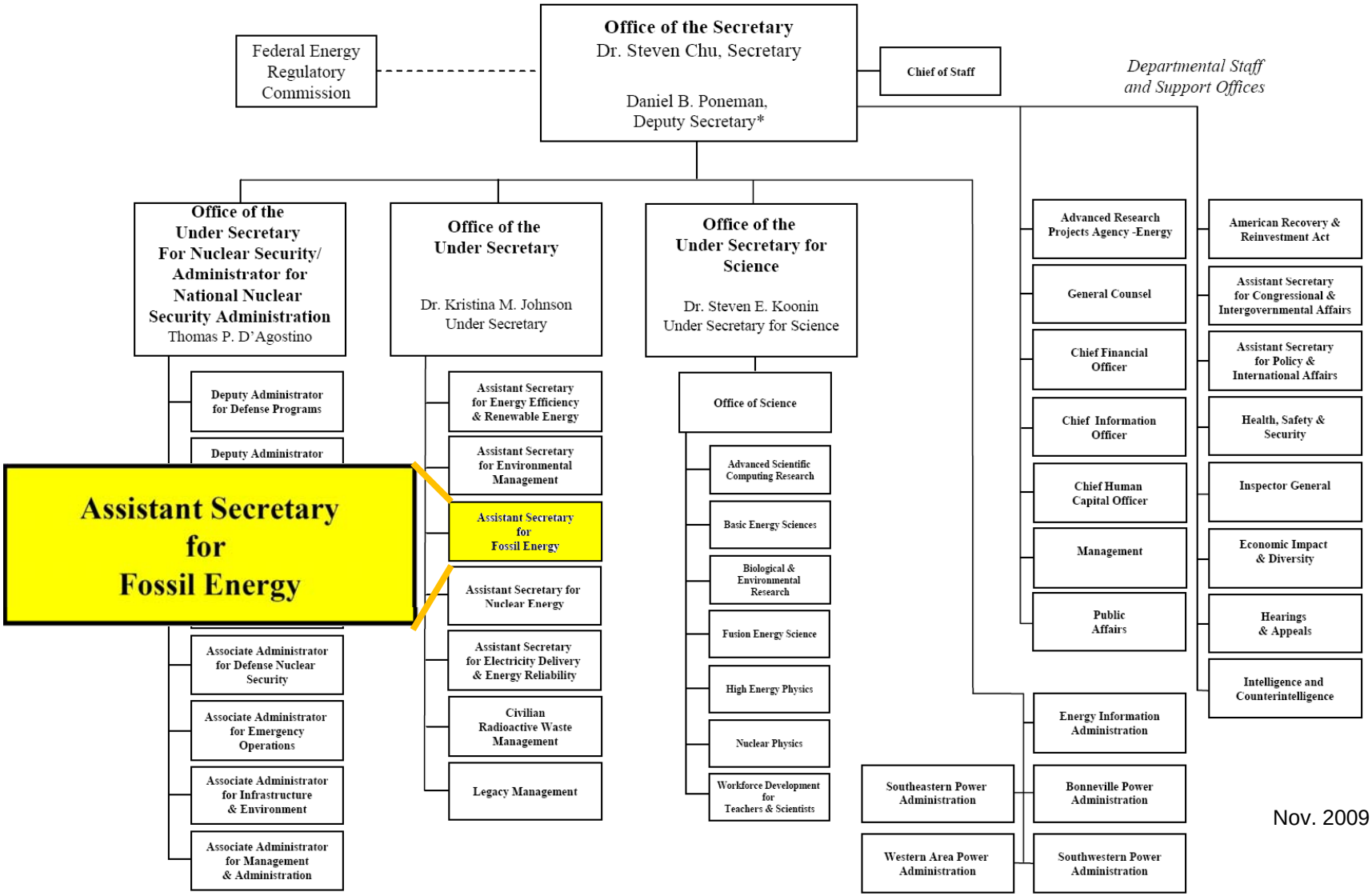
Outline

- DOE Organization – Missions
- Fossil Energy Coal Program
- FE RD&D Activities
- Challenges & Opportunities
- Visions

DOE Missions

- To advanced the national, economic, and energy security of the United States
- To promote scientific and technological innovation in support of that mission
- To ensure the environmental cleanup of the national nuclear weapons complex

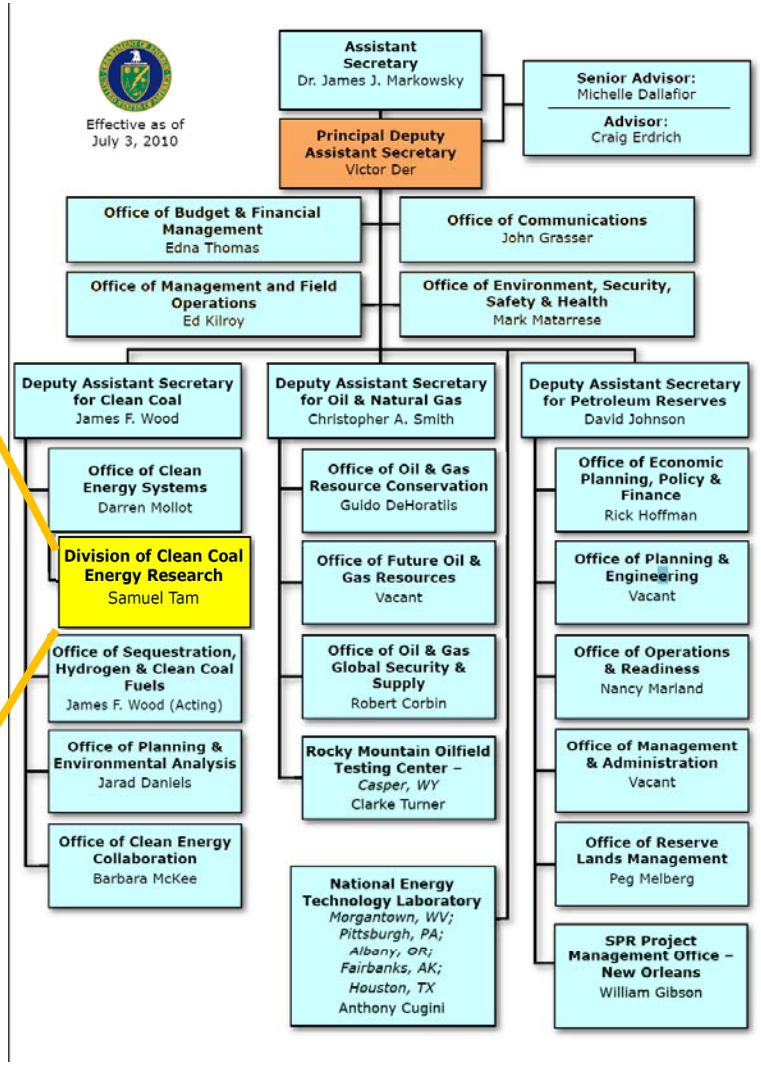
U.S. Department of Energy



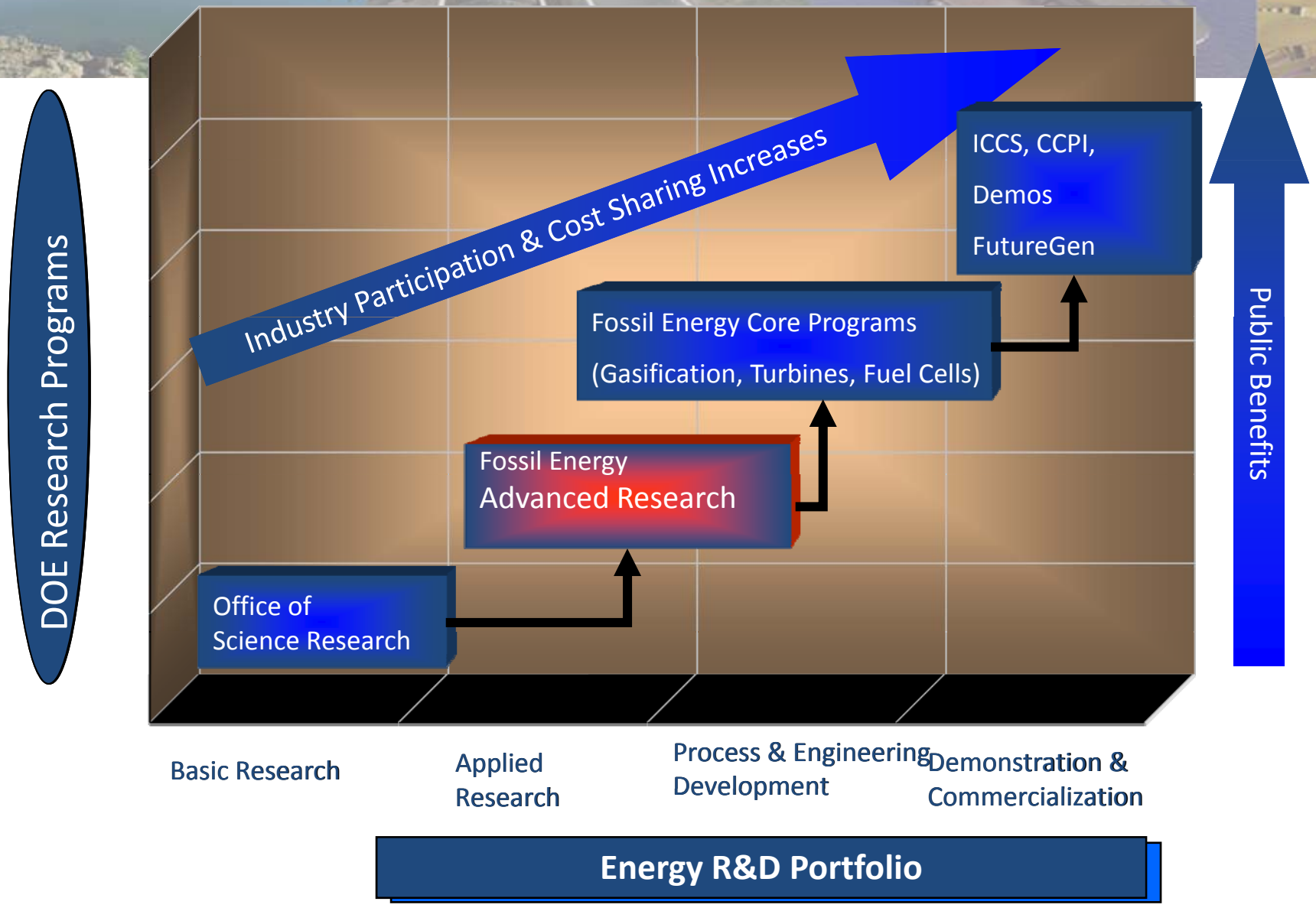
DOE, Office of Fossil Energy

Division of Clean Coal Energy Research

Adv. IGCC
Adv. Turbines
Innovations for Existing Plants
Fuel Cells



Fossil Energy Program Outline

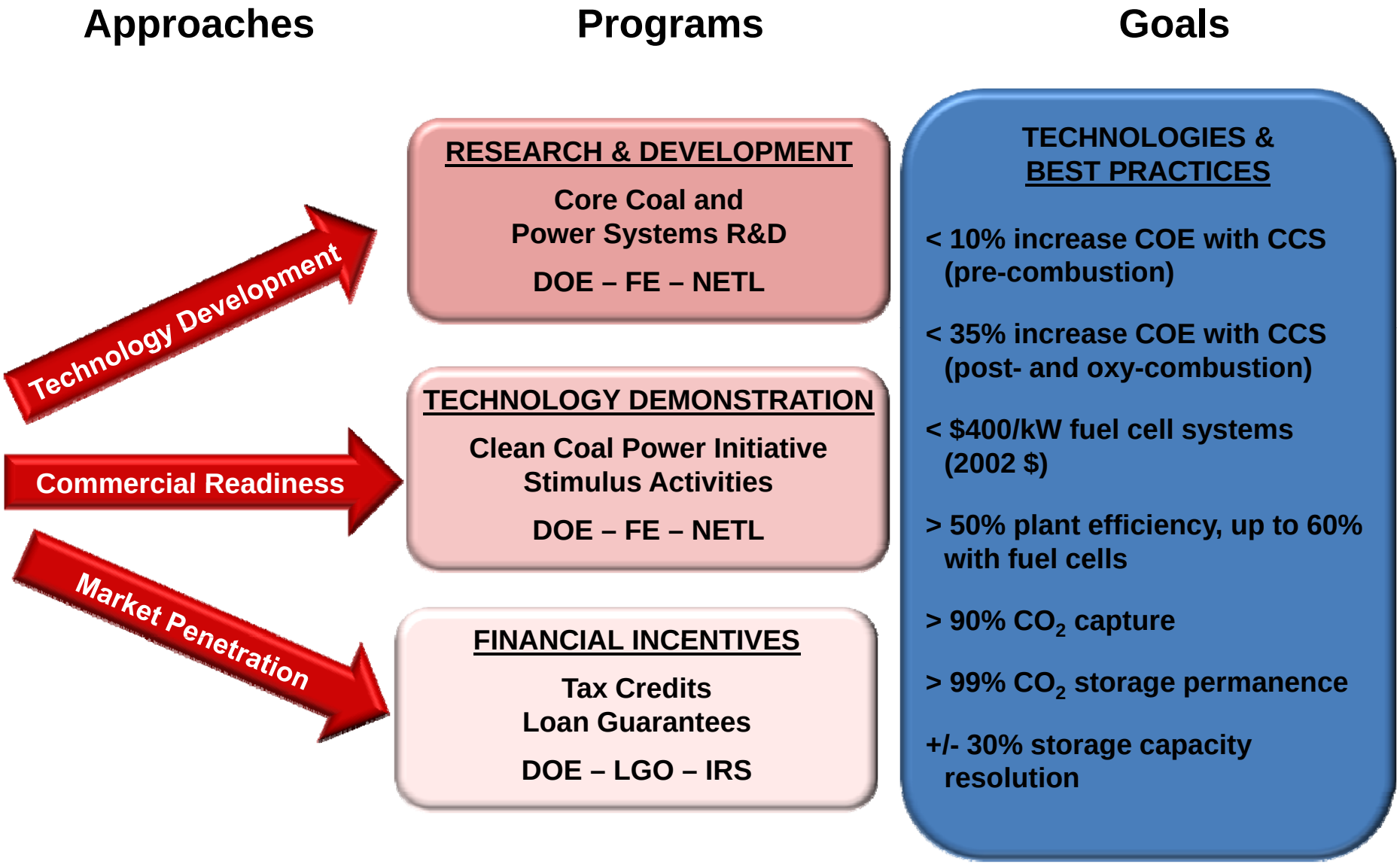


6

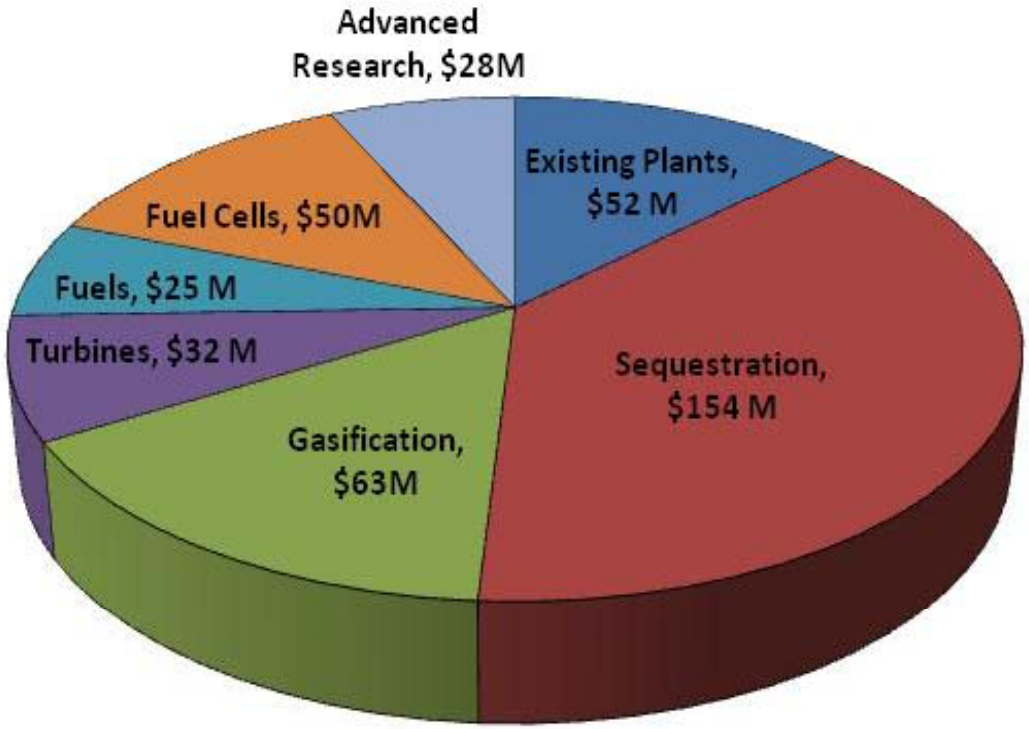
Fossil Energy Focus

- Reduce penalty of carbon capture
- Prove capability, permanence, & capacity for geologic storage
- Gain public acceptance of storage
- Identify & develop viable beneficial end uses for carbon dioxide
- Deploy cost competitive CCS technology for both existing & new fossil power plants by 2020

Government's Coal RD&D Investment Strategy



DOE's Coal Research is Divided Among Seven Core R&D Programs



Total: $404 M (FY11 request)

Innovations for Existing Plants
CO_2 capture research for new and existing pulverized coal plants

Sequestration
CO_2 storage and monitoring

Gasification
Coal gasification for production of synthetic hydrogen gas

Turbines
Advanced hydrogen and high efficiency gas turbines

Fuels
Production of liquid and gaseous fuels from coal

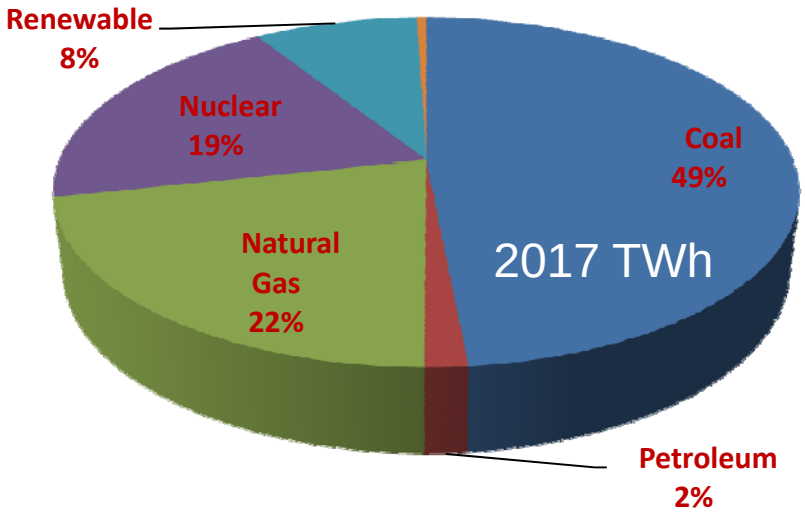
Fuel Cells
Large scale energy production from fuel cells

Advanced Research
Materials, sensors and controls, and computational energy science

Total USA Electricity Growth Predicted

2007

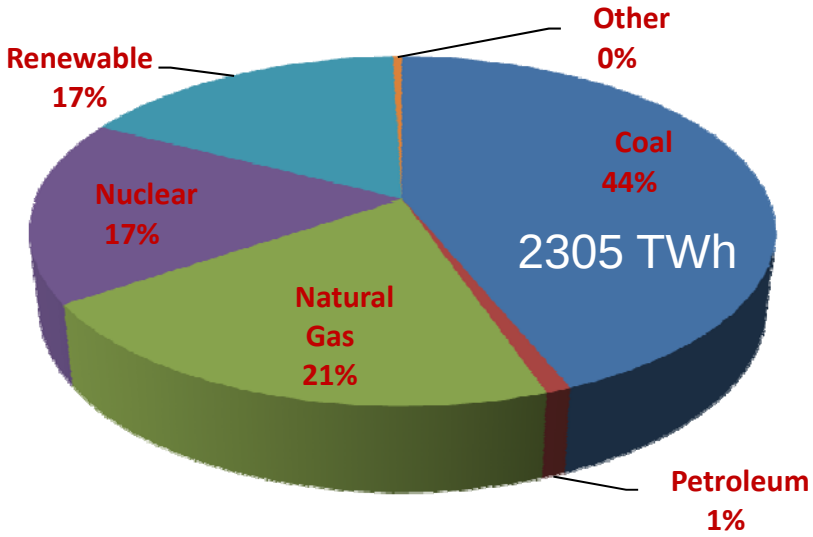
4159 TWh
>73% Fossil Energy



28 Yrs.
+0.9%/Yr.
+28.5%

2035

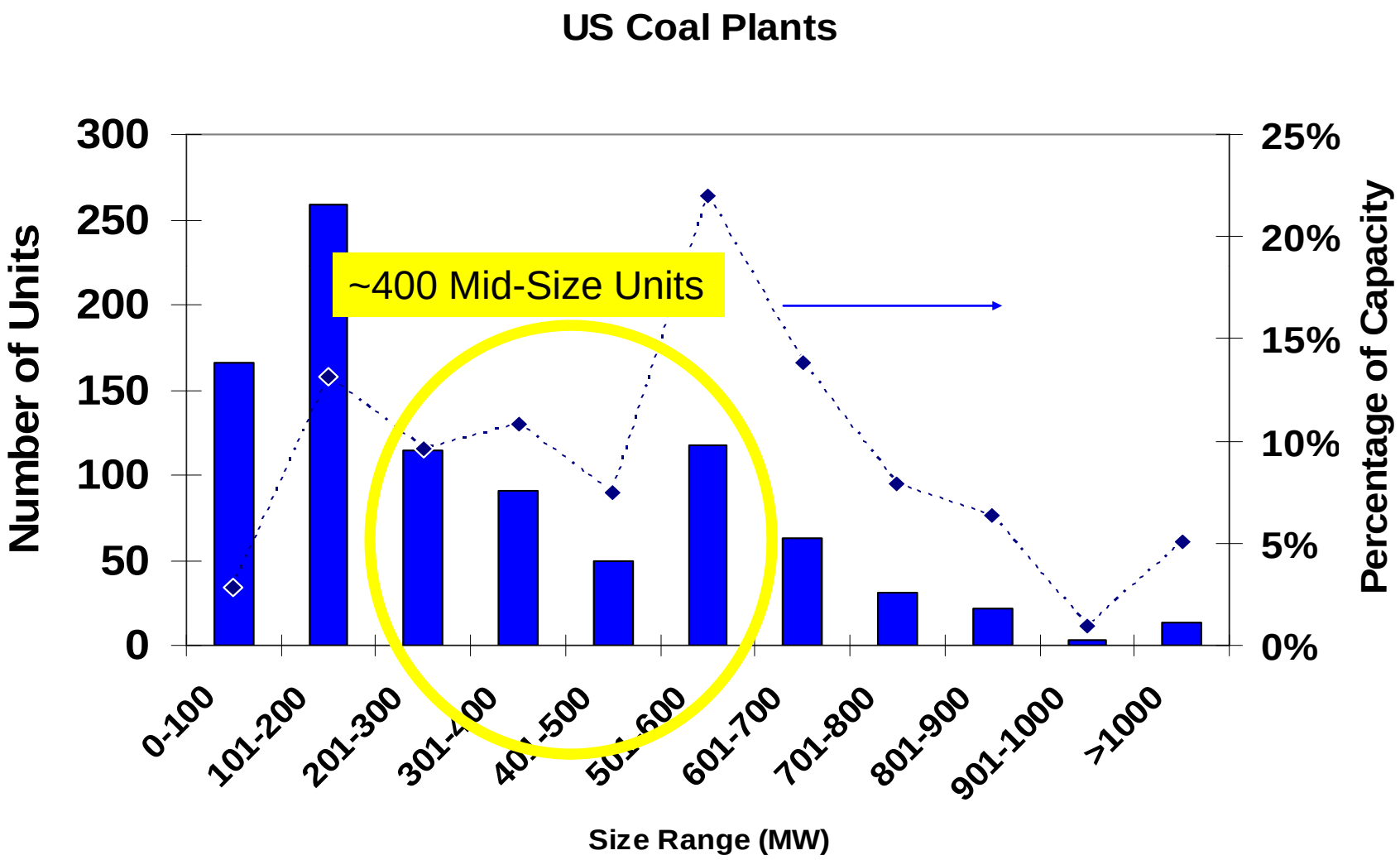
5259 TWh
>66% Fossil Energy



FC relevant to potentially tighter constraints on CO_2, water and NOx as well as greater efficiency requirements to make-up for anticipated CCS parasitic loads.

Source: EIA AEO 2010r .d11809a Spreadsheet

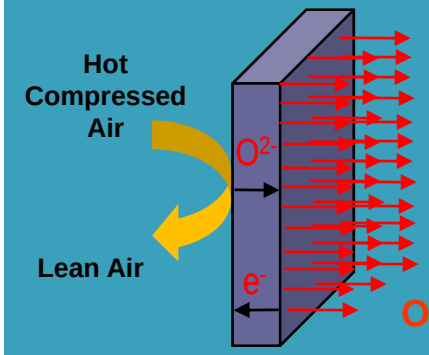
U.S. Coal Plant Size



Source: Electric Power Research Institute

Key Gasification R&D Areas

APCI Oxygen Membrane

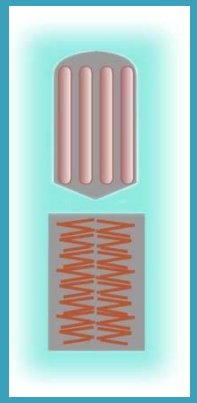


Oxygen

Reduces Capital Cost by 1/3
- 5.0% reduction in COE

Fuel Gas

RTI Warm Gas Cleaning

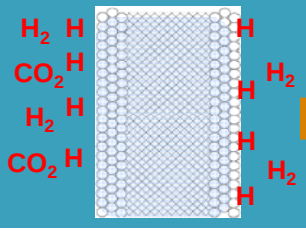


- Efficiency increases by 2.9 %pt
- COE decreases by 12.0%

Low-rank Coal*
Alternative Feedstocks*
- Energy security
- Carbon footprint reduction

Water-Gas Shift*
Process improvement and intensification

Eltron H_2/CO_2 Membrane



H_2 Rich Stream

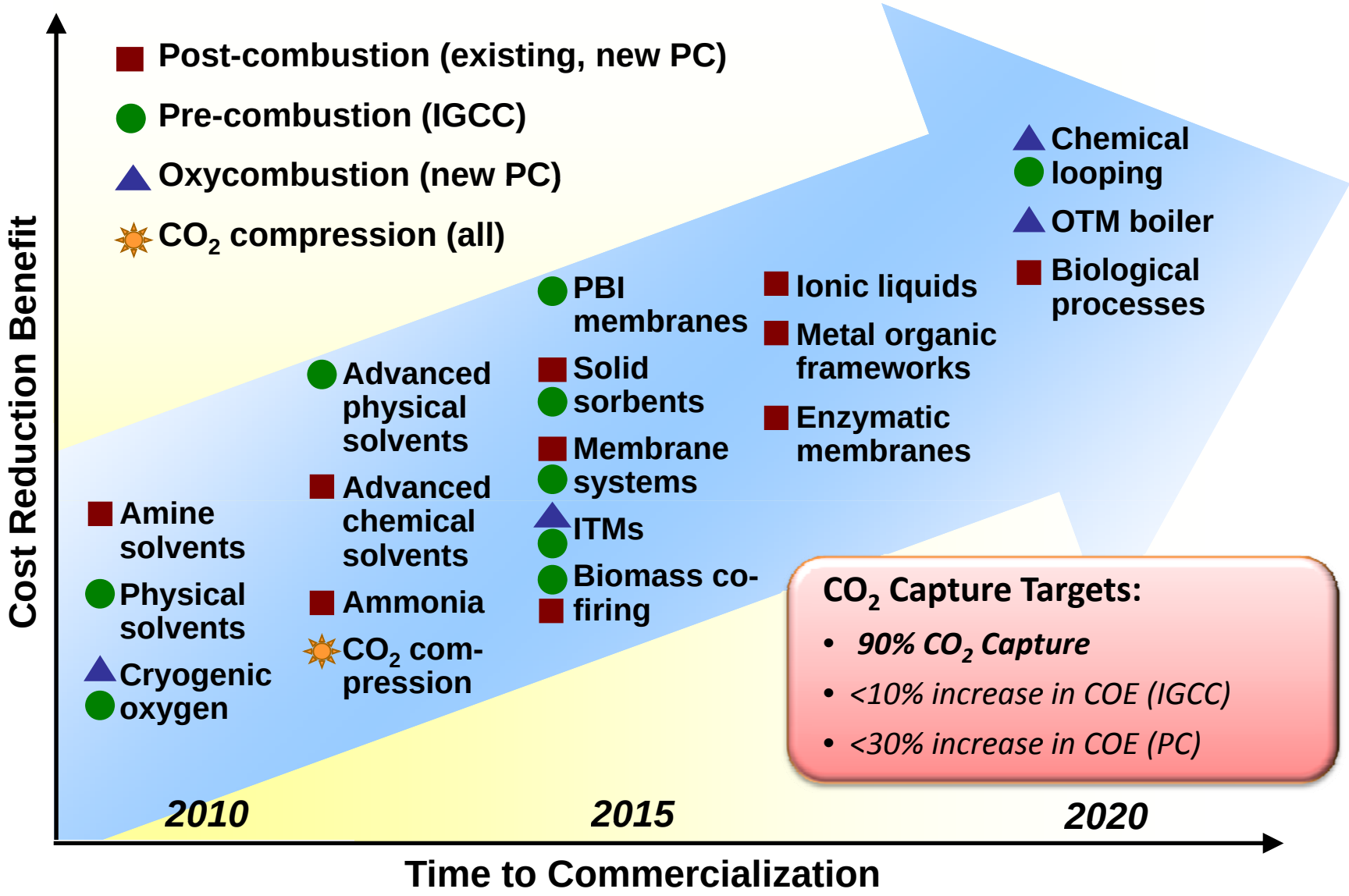
CO_2

Improve RAM*
- Refractory durability
- Feed system reliability
- Heat removal/integration
- Temperature measurement & control
- Dynamic simulator
- CFD gasifier modeling
- Slag model development

3 projects; 45% of budget

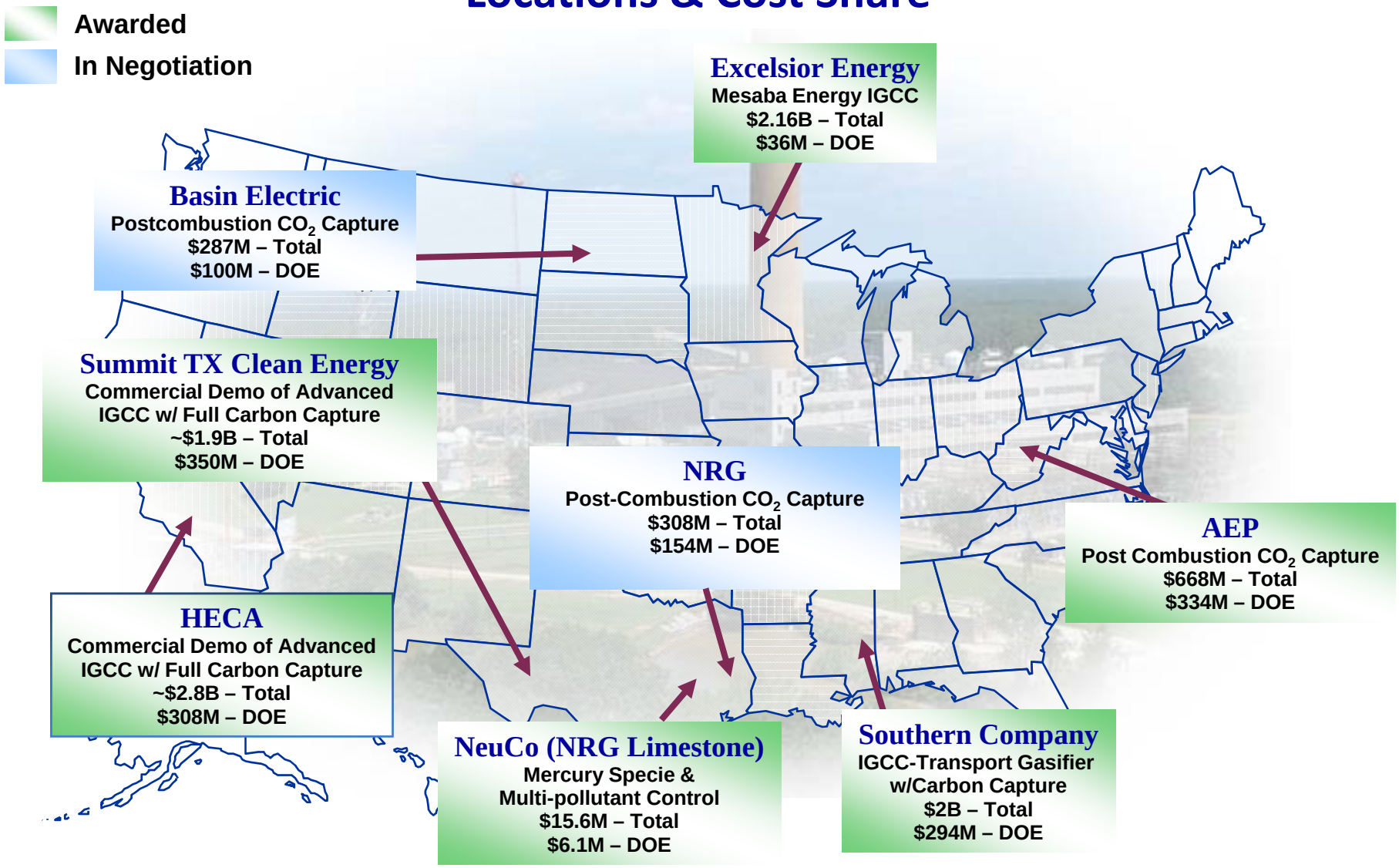
* Advanced Gasification

Fossil Energy CO_2 Capture Solutions



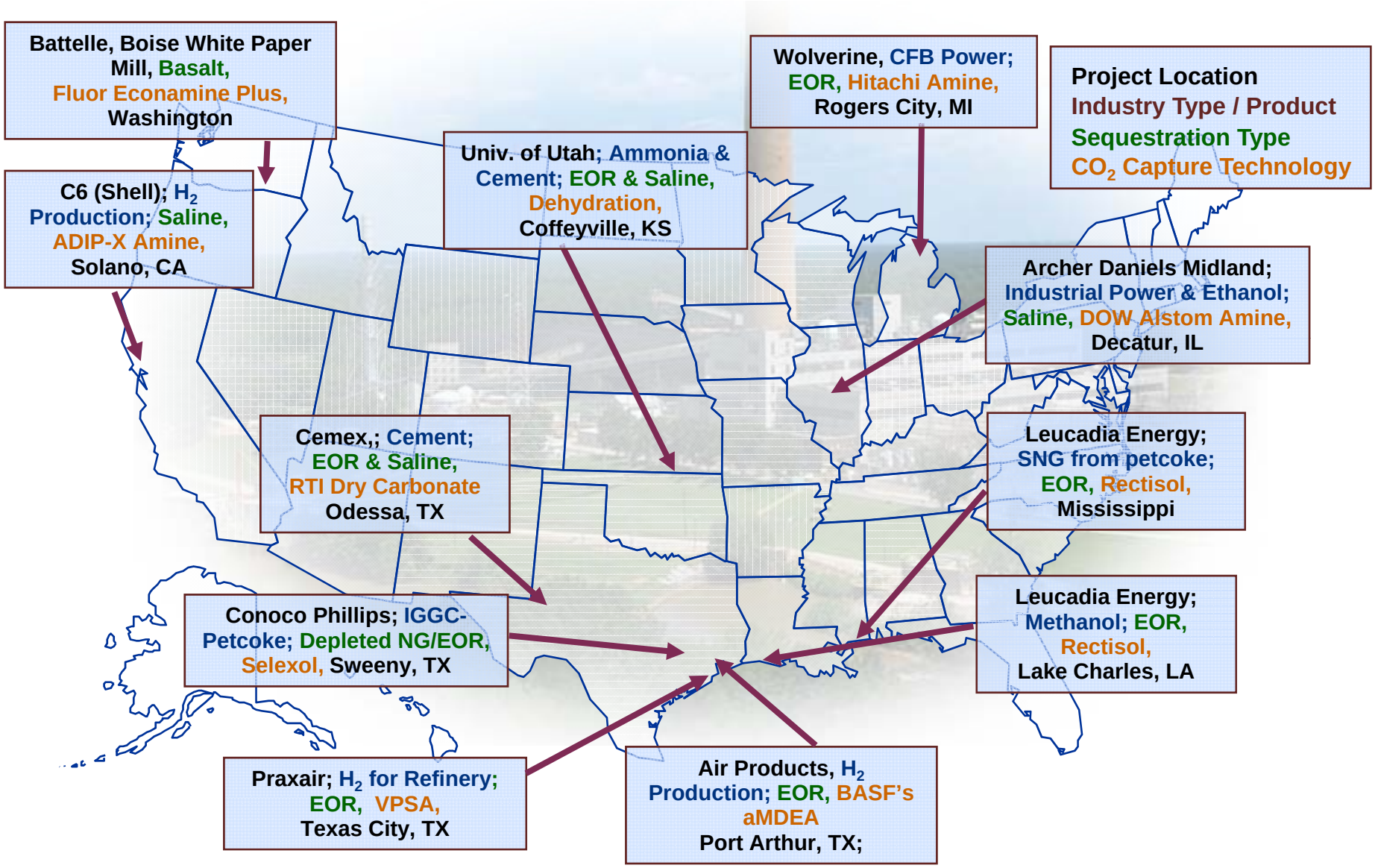
OTM – O_2 Transport Membrane (PC)
ITM – O_2 Ion Transport Membrane (PC or IGCC)

Active CCPI Demonstration Projects
Locations & Cost Share



Project Locations for ICCS Area 1

Carbon Capture and Storage from Industrial Sources



Fossil Energy Coal R&D Program
A History of Innovative Solutions

1970's	1980's	1990's	2000's
Clean Air Act	Oil Embargo	Acid Rain	Utility Deregulation	Climate Change

- National response to address air quality concerns
- Profound impact on existing (and future) coal burning power plants

- Exposed the Nation's vulnerability to oil supply disruptions
- U. S. imposes price controls on domestic oil – search for alternatives

- National trans-boundary response to natural resource preservation
- Identifies SO_2 and NOX from fossil energy use as principal culprits

- Changed utility business model
- Competitive pricing drives investment efficiency - private sector investment in R&D reduced

- A global issue
- President targets 80% reduction in CO_2 by 2050
- Congress considers cap-and-trade

✓ New power system technology (CFBC)
✓ Emission control technologies for existing plants target NOX, SO_2, and Particulates
• Installed on 75% of U.S. coal plants; 1/2 to 1/10 cost of older systems

✓ Coal processing technology advances - but markets fail to develop
• Successful demonstrations (coal liquids, SNG, chemicals)
• First gasification-based pioneer plants – Dakota Gasification

✓ Integrated CCS energy systems (highly efficient, zero emission, affordable)
• CCS (pre & post-combustion capture, site characterization, MVA, Best Practices)
• Fuel processing & separation (gasifiers, O_2/H_2 membranes, feed-pump, gas cleaning
• Power generation (H_2 turbines, SECA-SOFC, oxy-combustion, chemical looping)

… fossil's programs made a significant contribution to the well-being of the United States, lead to realized economic benefits, energy options for the future, and significant knowledge …
National Academy of Sciences 2001: "Energy Research at DOE (1978-2000) - Was it Worth it?

… technology advancements were achieved that can provide energy security benefits and are available to be deployed if market conditions materialize … the ability to use the nation's large coal reserves in an efficient manner was improved substantially …
National Academy of Sciences 2001: "Energy Research at DOE (1978-2000) - Was it Worth it?

…the Regional Partnerships is an excellent program that will achieve significant results for CCS in the United States, Canada and internationally … the Partnerships Programme will significantly advance and accelerate the CCS field. The individual projects will together build a comprehensive and expansive research programme, the size and scope of which is unique throughout the world …
IEA 2008: "Expert Review of Regional Carbon Sequestration Partnerships Phase III".

Vision

- A new round of advanced CCS demonstration in the 2016 timeframe
- Accelerate R&D on 2nd generation technologies that can be ready demonstration by 2020
- A 250-MW SOFC stationary power plant by 20XX??