Solutions for Today…

Fueling the Future

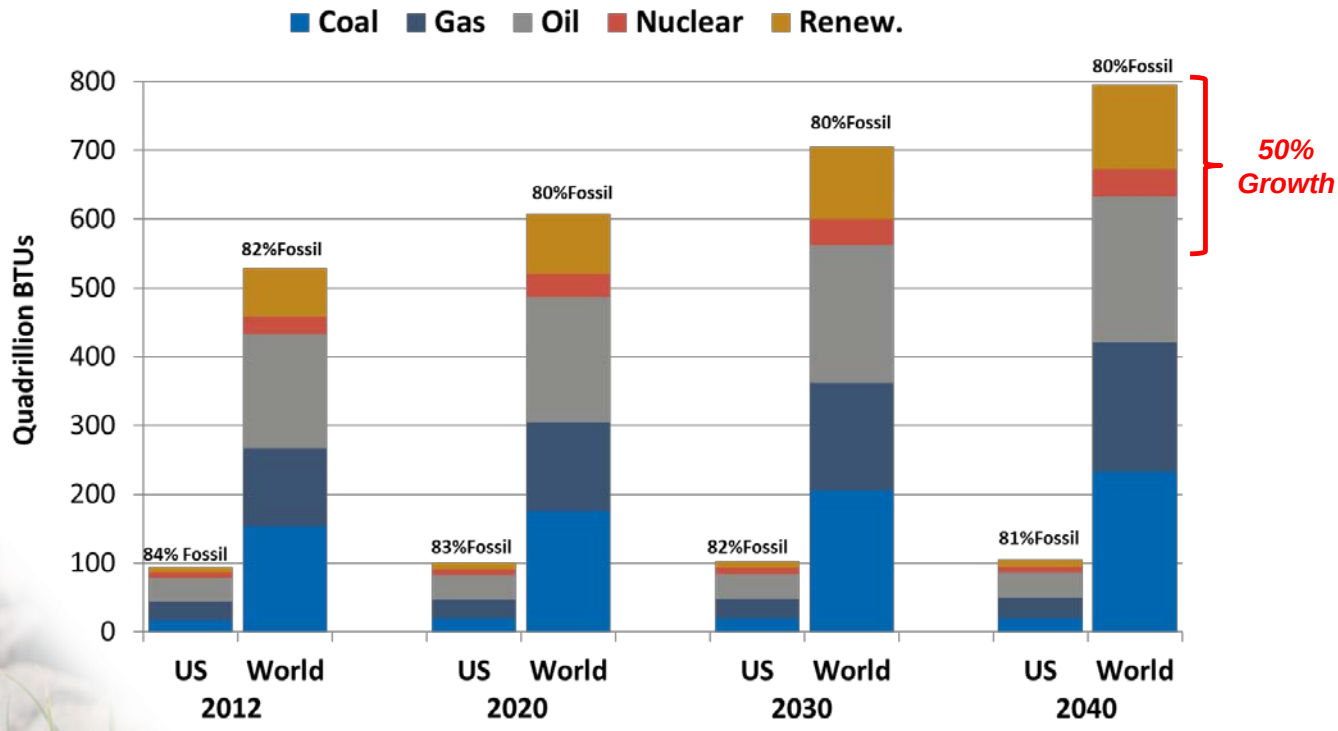
Safe, Affordable, Secure Energy

Sean I. Plasynski, Ph.D.
Director, Strategic Center for Coal

NETL

…Options for Tomorrow

“All of the Above” Fossil Energy Future



~80% FE Today and Tomorrow…

Dominated by Global Growth

U.S. DEPARTMENT OF ENERGY | Fossil Energy

EIA, Annual Energy Outlook 2015; IEA, World Energy Outlook 2014, Current Policy Scenario

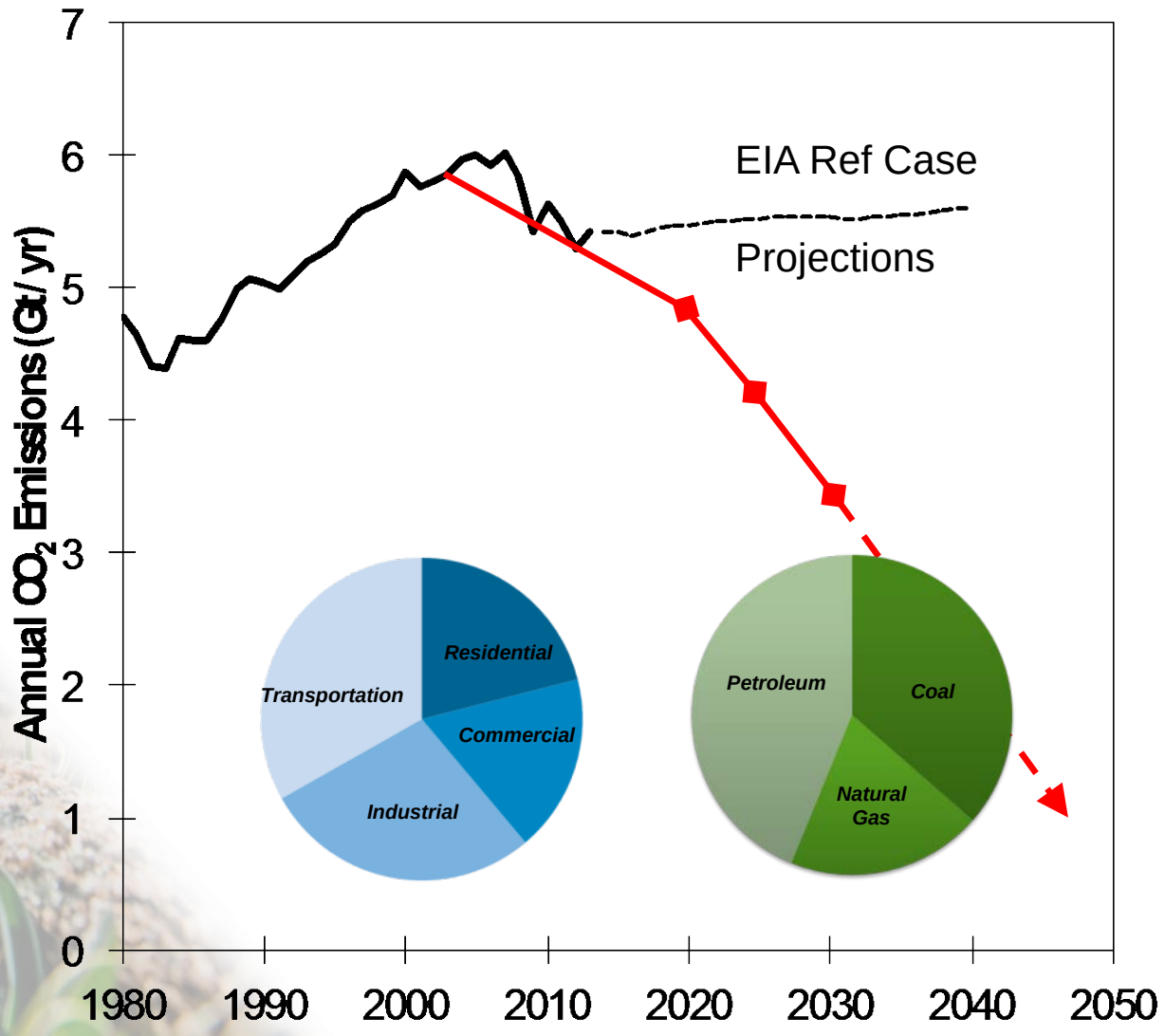
"All of the Above" Carbon Management Strategy

Increase Energy Efficiency

Reduce Carbon Emissions

All Sectors, All Fuels

Lead Global Efforts



U.S. DEPARTMENT OF ENERGY | Fossil Energy

White House, Fact Sheet: U.S. Reports its 2025 Emissions Target to the UNFCCC
EIA, Annual Energy Outlook 2015, Monthly Energy Review

Enduring FE Mission Elements

Effective Resource Development

Efficient Energy Conversion

Environmental Sustainability

Faster
Cheaper
Safer

Coal

Petroleum

Natural Gas

Hydrates

The National Technology Laboratory

NETL's mission is to discover, integrate and mature technology solutions to protect the environment and enhance the Nation's energy foundation for future generations

U.S. DEPARTMENT OF ENERGY | Fossil Energy

Accelerating Technology

Extramural

Intramural & Extramural

Technology Demonstration

TRL 8-9

Process Engineering & Integration

TRL 5–7

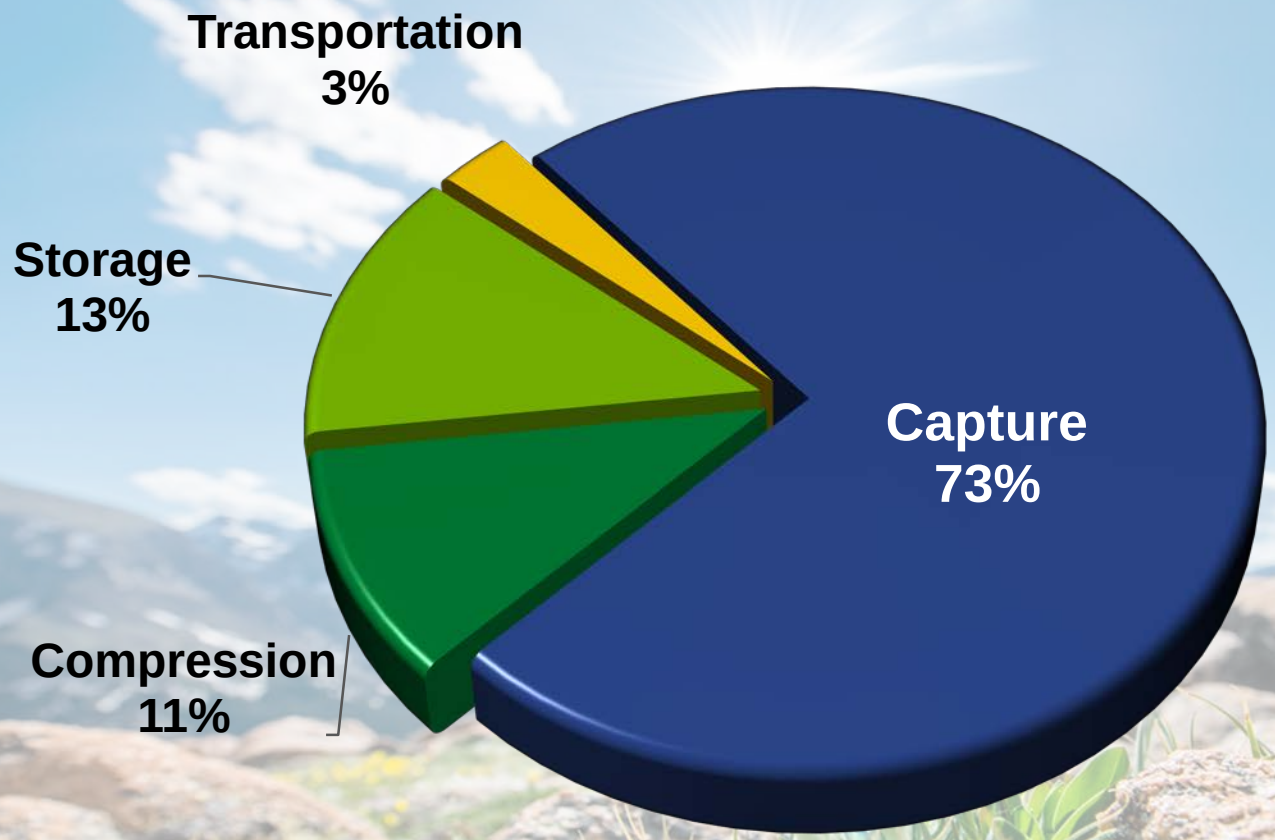
Applied Research

TRL 2-4

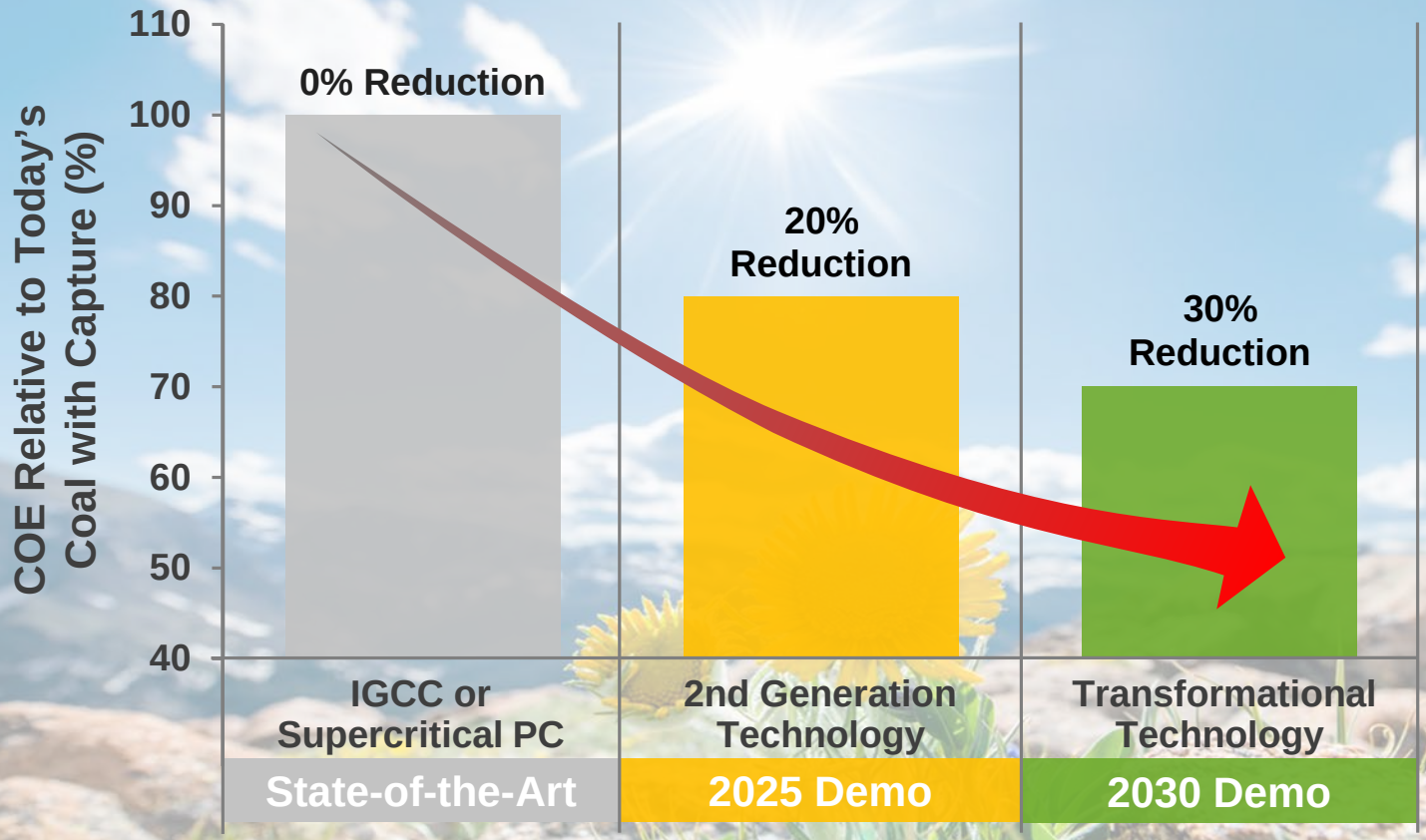
Energy Solutions for Today

Energy Options for Tomorrow

The Cost of CCS



Driving Down the COE with CCS



Goals are for greenfield plants. Costs are nth-of-a-kind and include compression to 2215 psia, but exclude CO_2 transport and storage costs.

Successfully Demonstrating CCS

Extramural

Intramural & Extramural

Technology Demonstration
TRL 8-9

Process Engineering & Integration
TRL 5–7

Applied Research
TRL 2-4

Commercial Demo of Adv. IGCC w/ Full Carbon Capture; EOR in Permian Basin

EOR – ~1.84 MMTPY

Summit TX Clean Energy
2018 Start

CO_2 Capture from Ethanol Plant CO_2 Stored in Saline Reservoir

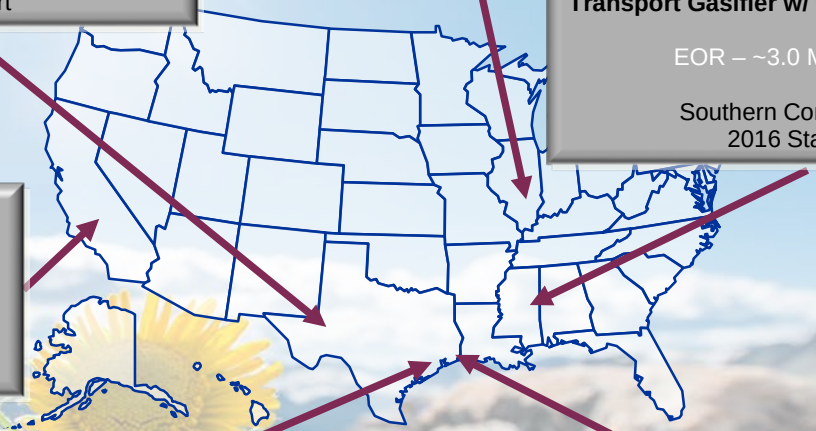
SALINE– ~0.9 MMTPY

Archer Daniels Midland
2015 Start

Kemper County IGCC Project Transport Gasifier w/ Carbon Capture

EOR – ~3.0 MMTPY

Southern Company
2016 Start



Commercial Demo of Advanced IGCC w/ Full Carbon Capture

EOR – ~2.6 MMTPY

HECA
2020 Start

W.A. Parish Generating Station Post Combustion CO_2 Capture

EOR – ~1.4 MMTPY

Petra Nova
2017 Start

CO_2 Capture from Steam Methane Reformers EOR in Eastern TX Oilfields

EOR – ~0.93 MMTPY
1.8 MMT stored as of March 2015

Air Products and Chemicals, Inc
Started 2012

National Carbon Capture Center

Extramural

Intramural & Extramural

Technology Demonstration
TRL 8-9

Process Engineering & Integration
TRL 5–7

Applied Research
TRL 2-4

Pilot Solvent Test Unit

TRIG Gasifier

World Class Carbon Capture Technology Test Facility

Post Combustion

- ❑ PC4 Facility – 4.3MWe
- ❑ Real PC flue gas
- ❑ Bench through pilot scale
- ❑ ~25,000 hours of testing
- ❑ 15 Technologies tested
- ❑ "Tech-Flexible"

Pre Combustion

- ❑ 6.3MWe Trig gasifier
- ❑ Air- or O_2 fired syngas
- ❑ Bench through pilot scale
- ❑ ~20,000 hours of testing
- ❑ 13 gasifier runs
- ❑ "Tech-Flexible"

U.S. DEPARTMENT OF ENERGY | Fossil Energy

Mitigating Emissions

Extramural

Intramural & Extramural

Technology Demonstration

TRL 8-9

Process Engineering & Integration

TRL 5–7

Applied Research

TRL 2-4

R&D and scale-up technologies for capturing CO_2 from new and existing industrial and power-producing plants

Solvents

Advanced amine at 1MWe slipstream at NCCC

BASF & Linde, LLC

Sorbents

Advanced amine at 1MWe slipstream at Southern Co.'s Plant Miller

ADA Env. Solutions, LLC

Membranes

Spiral-wound membrane at 1MWe slipstream at NCCC

MTR

Pipeline of Emerging Technologies

Extramural

Intramural & Extramural

Technology Demonstration

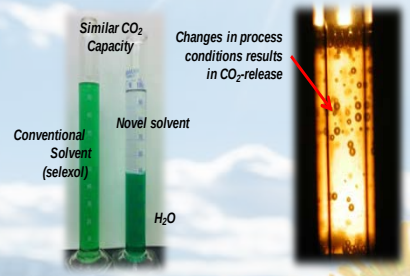
TRL 8-9

Incubator for disruptive technologies exhibiting a step change in material and process performance

Process Engineering & Integration

TRL 5–7

Phase-Change Materials



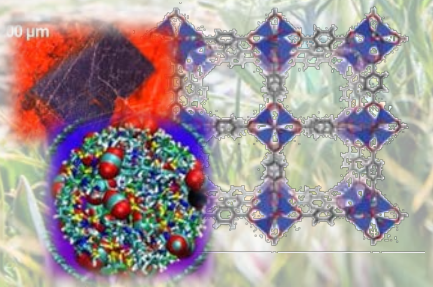
Hydrophobic Solvents

Micro-encapsulated Sorbents

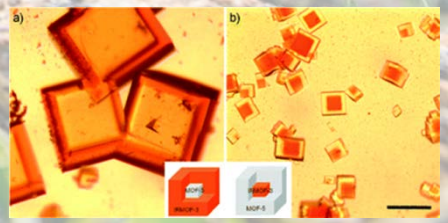
Applied Research

TRL 2-4

Atomically Engineered Composites



Core-shell MOFs



Enabling Rapid Deployment

CCSI
Carbon Capture Simulation Initiative

National Labs

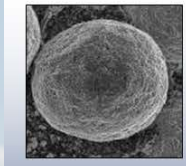
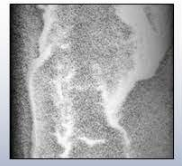
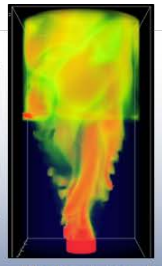
Lawrence Livermore National Laboratory

Academia

Carnegie Mellon
PRINCETON UNIVERSITY
West Virginia University
BOSTON UNIVERSITY
TEXAS

Industry

ADA, ALSTOM, B&W, GE, EPRI, FLUOR, PHILLIPS 66, AEP American Electric Power, Southern California Edison, Southern Company, ExxonMobil, Chevron, URS, Air Products, Eastman, aspentech, ANSYS, Schneider Electric, PSE


Rapidly synthesize optimized processes to identify promising concepts → Better understand internal behavior to reduce time for troubleshooting → Quantify sources and effects of uncertainty to guide testing & reach larger scales faster → Stabilize the cost during commercial deployment

Develop

Demonstrate

Deploy

CCSI^2
Carbon Capture Simulation for Industry Impact

U.S. DEPARTMENT OF ENERGY | Fossil Energy

We Need to Do This Together….

- **Provide Global Leadership**
- **More Demonstrations**
- **Push to Test in Real Environments**
- **Develop Transformational Materials & Processes**
- **Develop & Implement Tools Enabling Faster Maturation**

Solutions for Today…Options for Tomorrow




National Energy Technology Laboratory

@NETL_News