Solutions for Today ♦ Options for Tomorrow

Backbone of the Energy Future

2015 International Pittsburgh Coal Conference

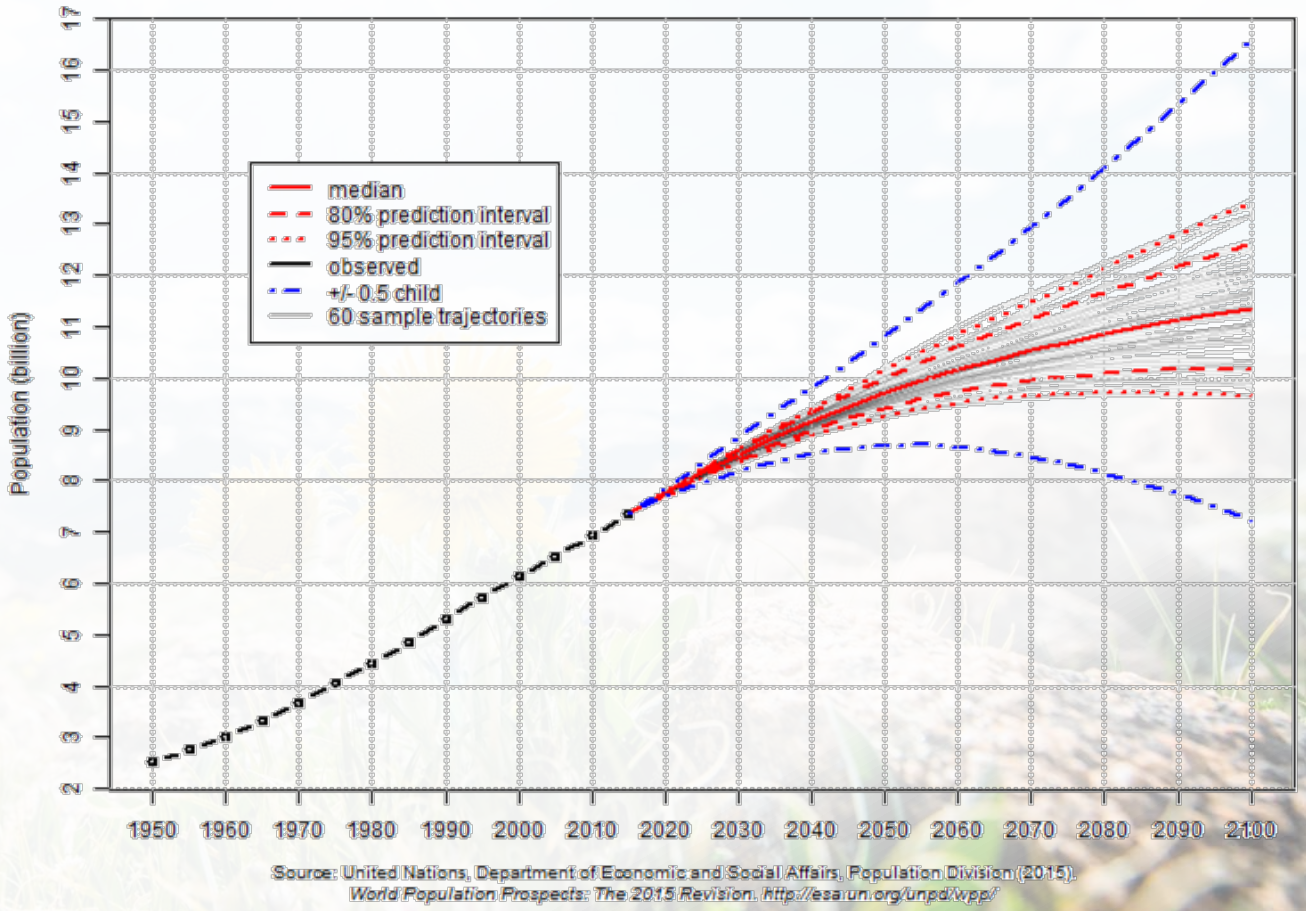
October 6, 2015

Grace M. Bochenek, Ph.D.

Director

Global Drivers

World Population



Source: United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Population Prospects: The 2015 Revision*. http://esa.un.org/unpd/wpp/

“All of the Above” Energy Future

Carbon Capture & Sequestration

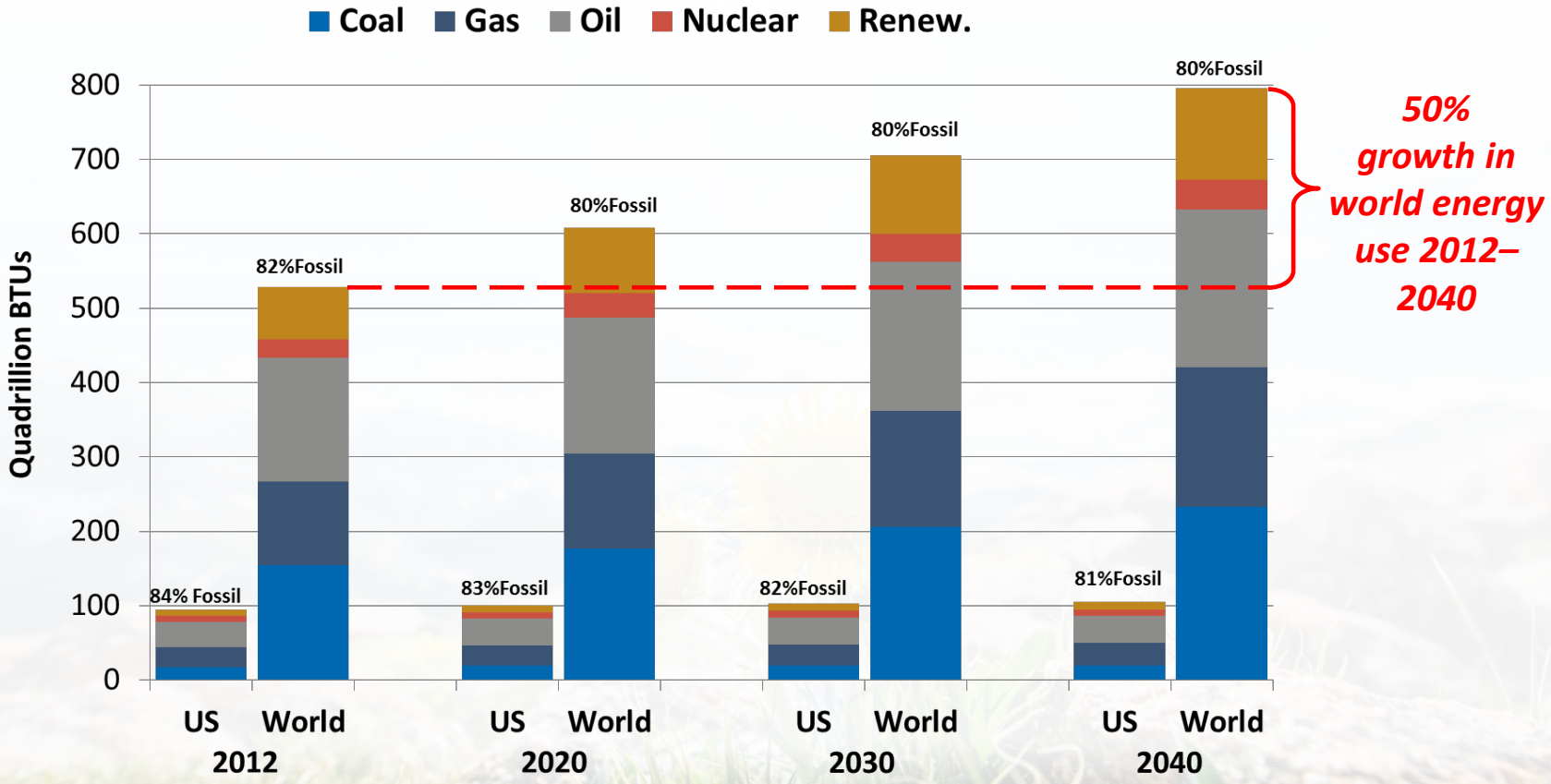
Safe & Responsible Domestic Oil & Gas Production

Advancing Clean Energy

Advancing Energy Efficiency

Developing Clean Fuels

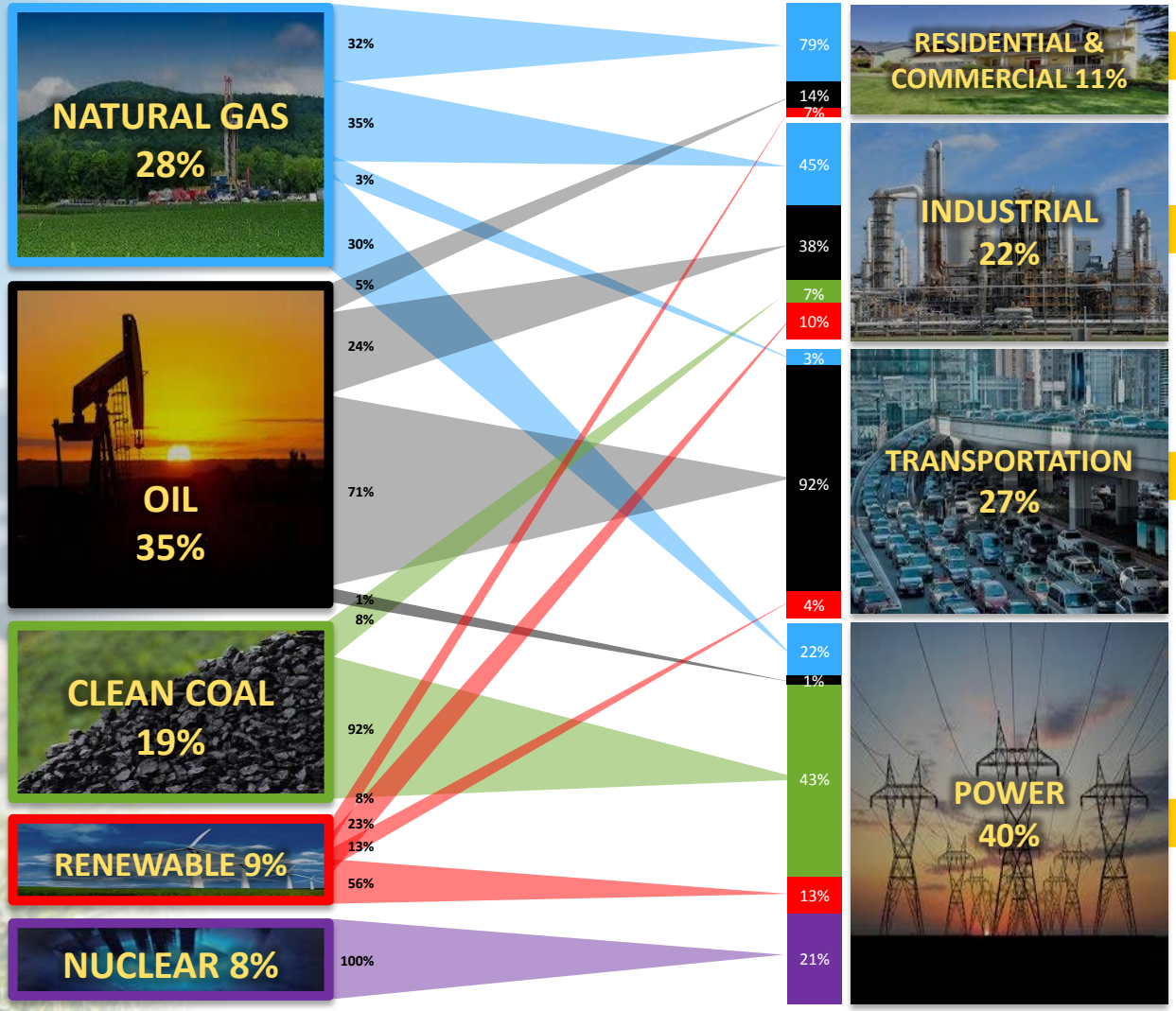
The World and U.S. Energy Future



≥80% Fossil Energy Today AND Tomorrow
Dominated by Global Growth

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

Delivering To All Domestic Sectors



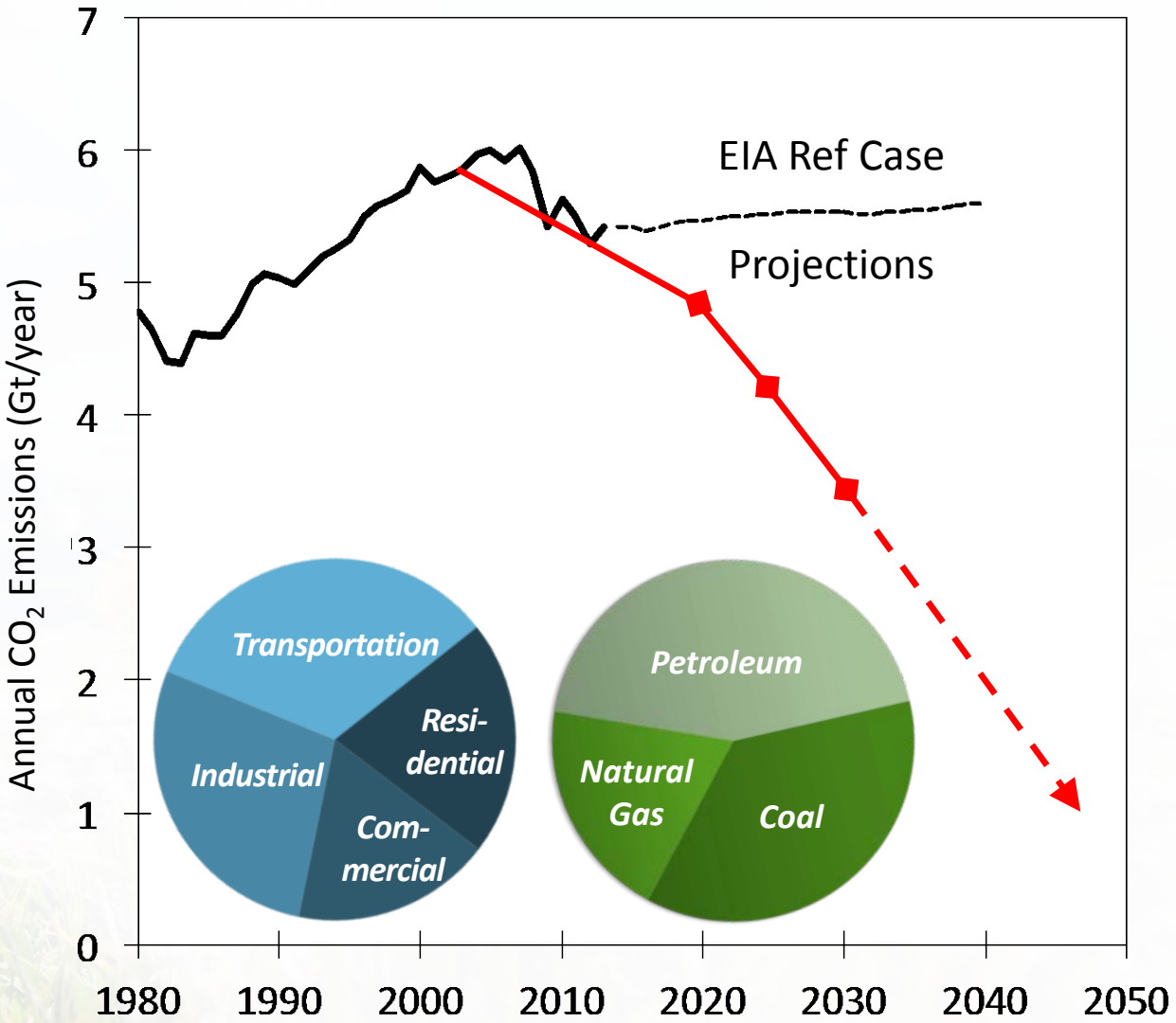
"All of the Above" Carbon Management Strategy

Increase Energy Efficiency

Reduce Carbon Emissions

All Sectors, All Fuels

Lead Global Efforts



Enduring Mission Elements

Effective Resource Development

Efficient Energy Conversion

Environmental Sustainability

Faster
Cheaper
Safer

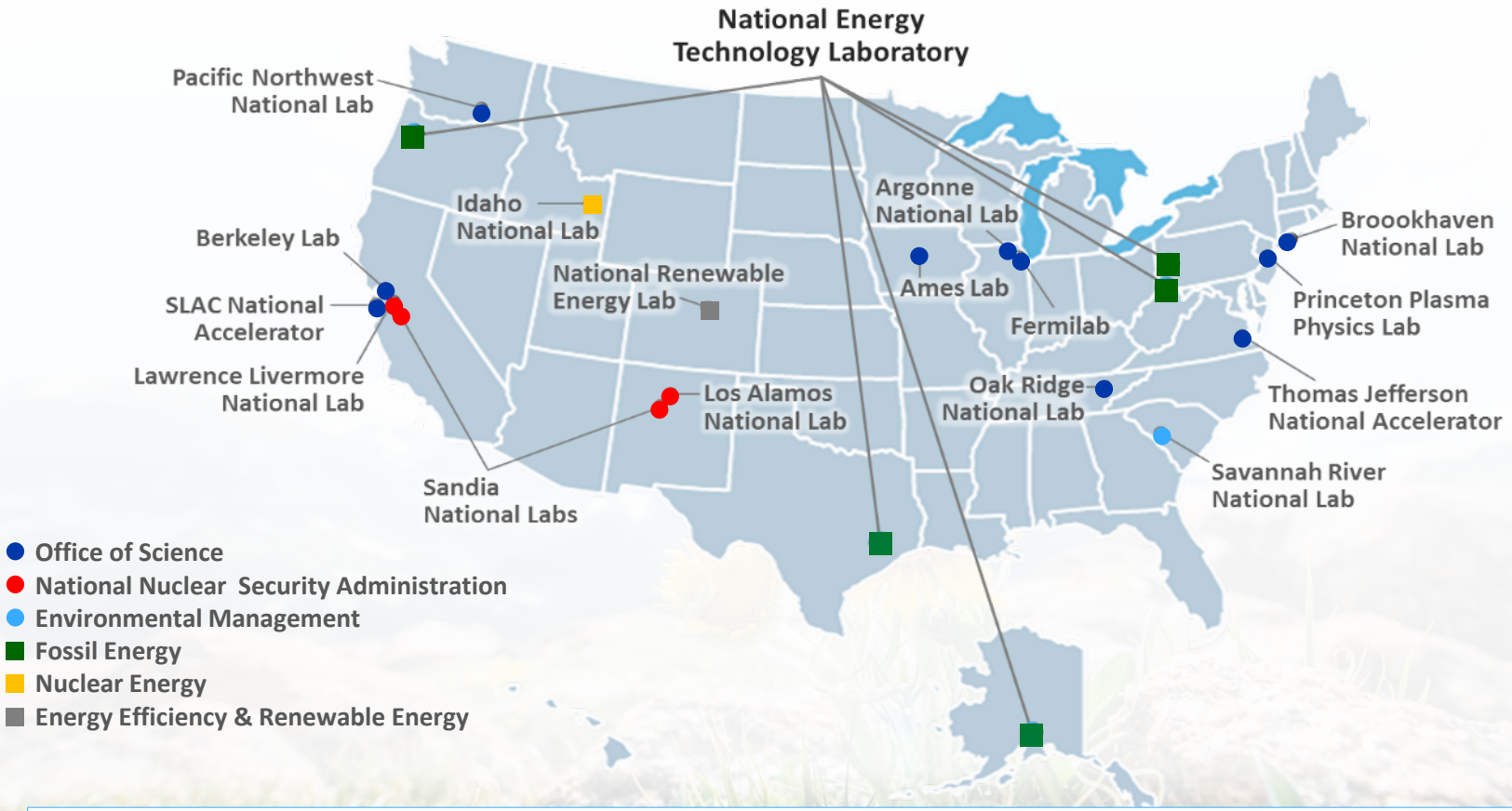
Coal

Petroleum

Natural Gas

Hydrates

NETL: THE Fossil Energy Laboratory



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

History of Enabling Fossil Fuels

40-fold Increase in Shale Gas Production

16M tons NOx avoided

37M tons SOx Avoided

10-Fold Increase in CO_2-EOR

Up to 75% Cost Reduction in Hg control

GHG Reductions

Technology Readiness…Maturing Technology

EXTRAMURAL

INTRAMURAL & EXTRAMURAL

Technology Demonstration

TRL 8-9

Process Engineering & Integration

TRL 5–7

Applied Research

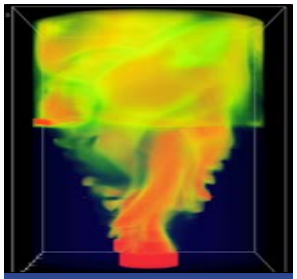
TRL 2-4

Energy Solutions for Today

Energy Options for Tomorrow

TRL=Technology Readiness Level

Enduring Core Competencies



Computational Engineering

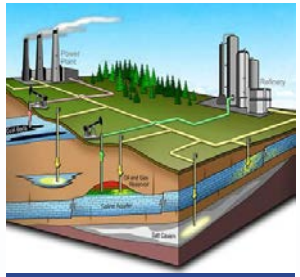
High Performance Computer

Codes & Data Management

Materials Engineering

Structural & Functional

Design, Synthesis & Performance



Environmental Engineering

Air, Water & Geology

Understanding & Mitigation

Energy Conversion

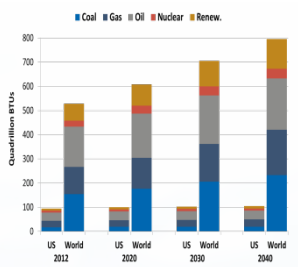
Component & Device

Design & Validation

System Engineering

Process & System

Optimization, Validation & Economics



Markets & Benefits

Technology & Resources

Assessment & Projections

Effective Resource Development

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Efficient Energy Conversion

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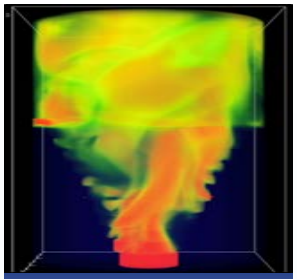
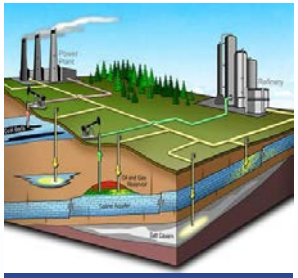
Environmental Sustainability

Core Competencies & Technical Thrusts



Computational Engineering

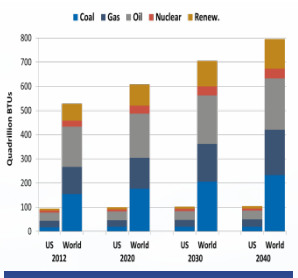
Materials Engineering



Environmental Engineering

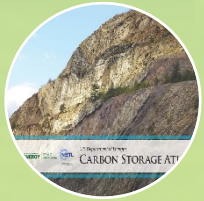
Energy Conversion

System Engineering



Markets & Benefits

Carbon Storage

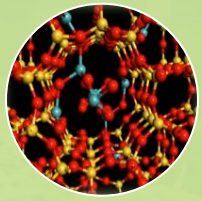


Carbon Capture

Sensors

Advanced Materials

Advanced Computing



Advanced Energy Systems

Enhanced Resource Production

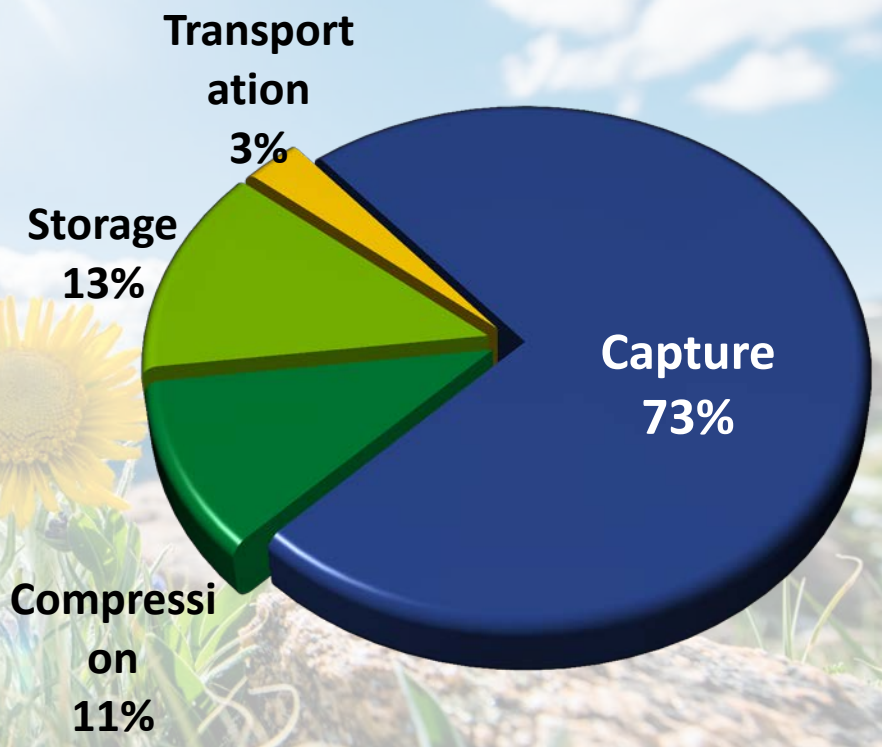
Environmentally Prudent Development

Transmission & Delivery

Methane Hydrates

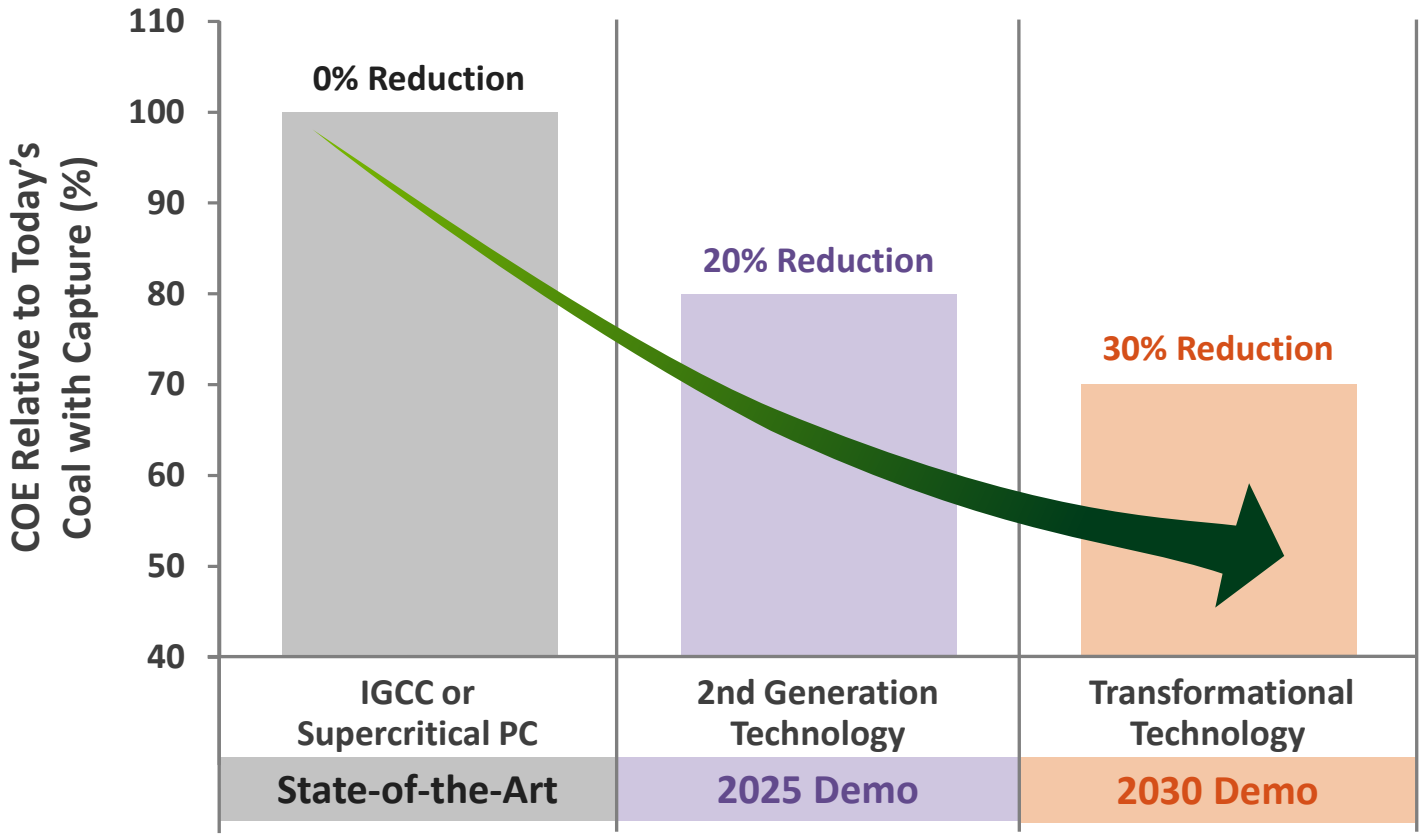
Carbon Capture Challenges

- Cost Effectiveness
- System Integration
- Scale-up
- Supply Chain
- Thermodynamics
- Parasitic Load
- CO_2 Compression
- Flue Gas Contamination
- Water Use



Driving Down the COE with CCS

Cost of Electricity (COE) Reduction Targets



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.

Changing the Paradigm

TRADITIONAL TIME TO DEPLOY NEW TECHNOLOGY IN THE POWER INDUSTRY

Laboratory Development 10–15 years

Process Scale Up 20–30 years

1 kWe | 1 MWe | 10 MWe | 100 MWe | 500 MWe

ACCELERATED DEPLOYMENT TIMELINE

Process Scale Up 15 years

1 MWe | 10 MWe | 100 MWe | 500 MWe

CCSI™ Carbon Capture Simulation Initiative

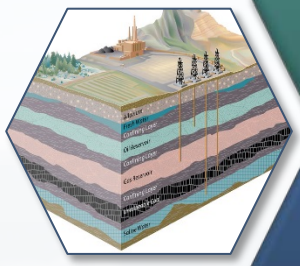
National Labs: NETL, Los Alamos, Lawrence Livermore National Laboratory, Pacific Northwest

Academia: Carnegie Mellon, Princeton University, West Virginia University, Boston University, University of Texas

Industry: ADA, Alstom, B&W, GE, EPRI, Fluor, Phillips 66, American Electric Power, Edison, Southern Company, ExxonMobil, Chevron, Air Products, Eastman, URS, aspentech, ANSYS, Schneider Electric, PSE

2010 2015 2020 2025 2030 2035 2040 2045 2050

Advancing FE Solutions



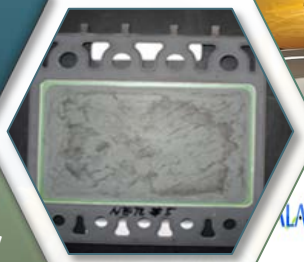
2M+ tons CO_2 Captured & Stored

8M+ tons CO_2 Injected

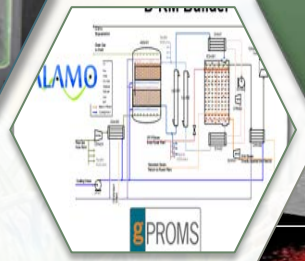
30% ↑ SOFC Power Enhance-ment

AUSC Alloy Scale Up

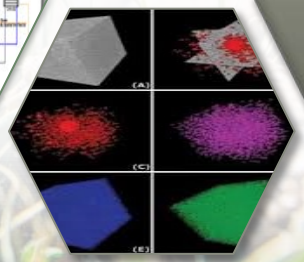
1,400+ hrs Syngas Clean-up Pilot Testing



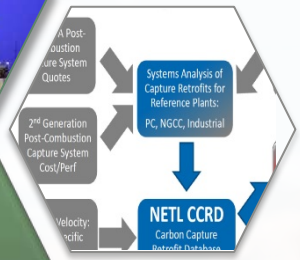
60,000+ hrs Pilot Testing



CCSI Tools Released



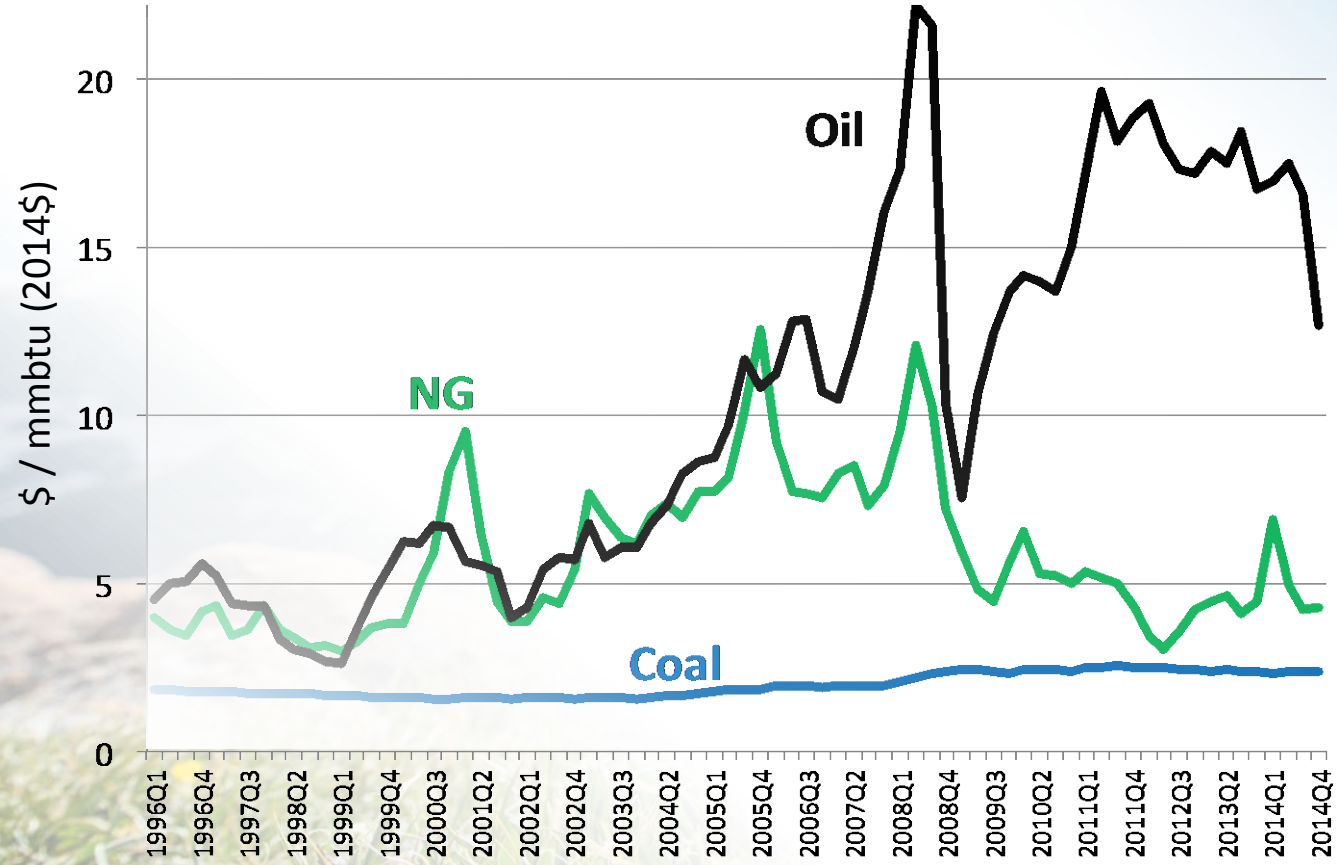
CTUS-NEMS Model



Advancing Foamed Cements

Understanding ~ Materials ~ Processes ~ Tools ~ Technology

It is Our Challenge



We do not inherit the earth from our ancestors; we borrow it from our children

Lets Do This Together

- **Partnering with NETL**

  http://www.netl.doe.gov/research/on-site-research/partnering-with-us

- **Business Opportunities with NETL**

  http://www.netl.doe.gov/business

Solutions for Today…..Options for Tomorrow




For More Information, Contact NETL

the ENERGY lab

www.netl.doe.gov