



CURC TECHNOLOGY ADVOCACY PROGRAM & FEDERAL POLICY EFFORTS

Shannon Angielski, Executive Director

Virginia Coal & Energy Alliance and Southern States Energy Board
38th Annual Conference & Expo

May 22, 2017

MeadowView Conference Resort & Convention Center, Kingsport, TN

CURC Members

Coal Producers

Arch Coal, Inc.*
Cloud Peak Energy Resources LLC
Lignite Energy Council
Peabody Energy*

Equipment Suppliers

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Global Mining
General Electric*
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NGOs

ClearPath Action
CoalBlue Project

Research Organizations

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Electric Power Research Institute (EPRI)
Gas Technology Institute
University of North Dakota Energy &
Environmental Research Center

State Organizations

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Illinois Coal Association
Kentucky Energy & Environment Cabinet
Southern States Energy Board
West Virginia Coal Association
Wyoming Infrastructure Authority

Technology Developers

LP Amina LLC
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Trade Associations

American Coal Council
American Coalition for Clean Coal
Electricity (ACCCE)
Edison Electric Institute (EEI)
National Rural Electric Cooperative
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Universities

Lehigh University
Ohio State University
Pennsylvania State University
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Utilities

American Electric Power (AEP)
Basin Electric Power Cooperative
Duke Energy Services
LG & E and KU Services Company
Southern Company
Tri-State Generation &
Transmission Association

Companies in orange indicate
Steering Committee Members

*CURC Leadership Council

Why is Technology Necessary?

Fossil fuels will continue to be relied upon even in a low carbon future. CURC believes that the responsible use of fossil fuels can be accomplished with technology that reduces the environmental impact from the use of fossil fuels, while supporting our nation's – and the global – need for reliable, secure and affordable energy.

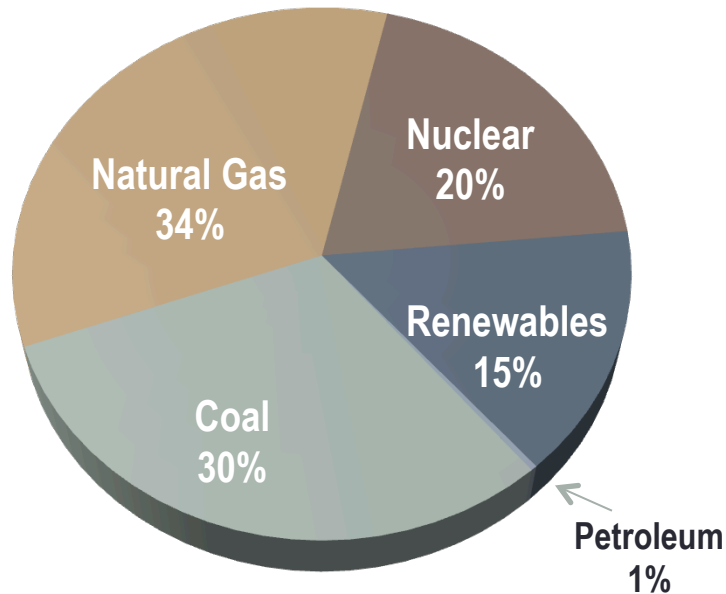
CURC recommended policy actions to support these objectives:

- A. Focus federal policies and technology R&D efforts on improvements to the efficiency, reliability, and flexible operations of the existing fleet that provides affordable, resilient and reliable electricity
- B. Incentivize new, state of the art technologies and construction of new and improved fossil fueled generating plants to ensure energy security and fuel diversity through a balanced portfolio of generation options
- C. Double down on federal RD&D to position U.S. as an international leader to fuel the global growth in the use of fossil fuels, improve the U.S. economy and energy security with low cost energy and increased domestic oil production, while reducing the environmental footprint in the use of fossil energy

Existing Fossil Fuel Generation Represents Two-Thirds of our Nation's Electric Generation at Low Cost

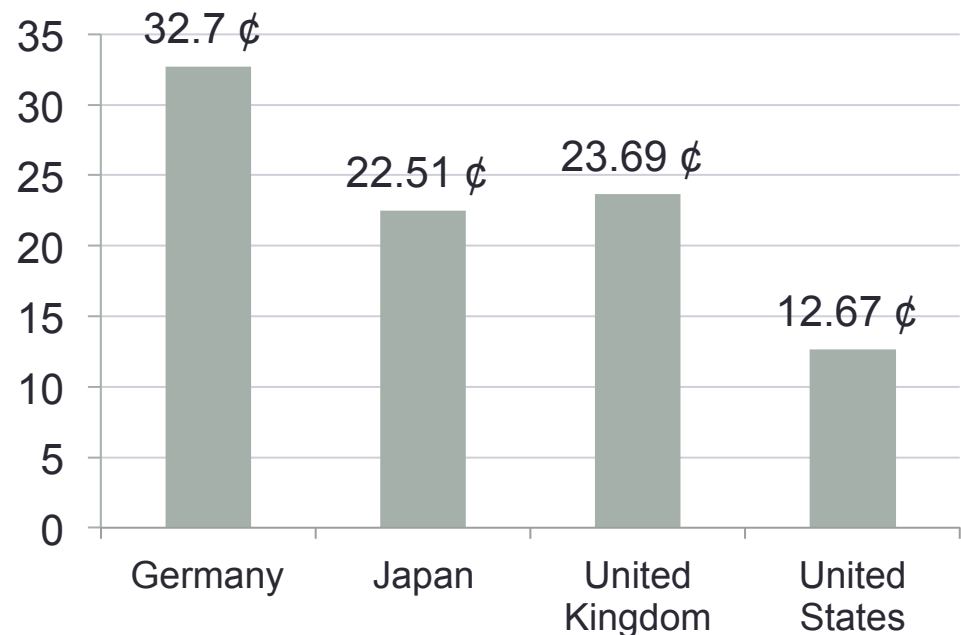
Low-cost power from the nation's existing fossil fuel fleet keeps U.S. electricity prices below those of other free market nations

Generation



Notes: Natural gas includes combined cycle, combustion turbine and other gas-fired systems. Renewables includes conventional hydro and pumped storage.

Household Electricity Costs (cents/kWh)

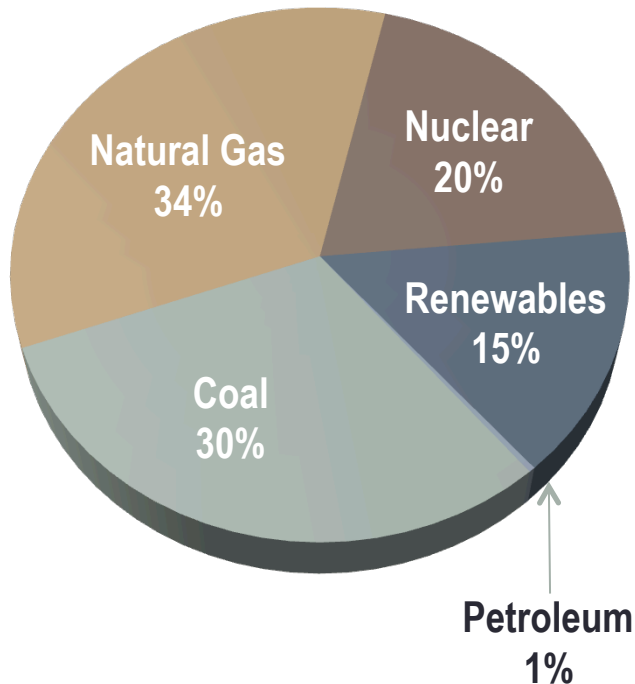


2016 Generation: https://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1.1
Electricity for Households: [IEA Key World Energy Statistics 2017](#)

Enabling New Fossil Fueled Technology Today Will Ensure a Balanced Portfolio in the Future

What is Happening Today

Electric Generation - 2016



Environmental regulations for new & existing sources

Abundant, low cost shale gas

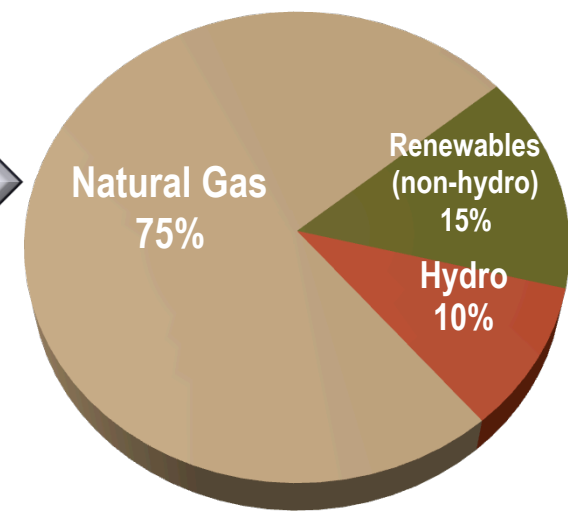
Renewable Portfolio Standards

Federal & state renewable subsidies

Aging fossil & nuclear fleet

No new coal or nuclear plants in planning to replace aging fleet

2040 Electricity Generation by Fuel (Hypothetical)



Source: EIA Annual Energy Outlook 2017 and AEP

CURC Views on Fossil Energy Technology Policy Efforts

- An industry effort and technology focus for fossil fuel power generation – both coal and gas – is needed
- Even if current GHG regulations are reformed or repealed, CO₂ technology solutions will be needed for fossil generation in the future
- Perception is that current policy champions for CCUS are focused only on the solution it offers coal and that the base of support needs to be expanded
- There is a growing need to leverage private sector investments in RD&D with federal funding and support
- CO₂ capture from fossil fuel generation should be cast as a business proposition to provide low cost CO₂ necessary to produce crude oil through EOR – enabling the U.S. to recover additional benefits from the utilization of our vast coal and natural gas reserves.

CURC-EPRI Technology Roadmap

THE CURC-EPRI ADVANCED COAL TECHNOLOGY ROADMAP

*July 2015
UPDATE*

Prepared by the Coal Utilization Research Council
and the Electric Power Research Institute

- Identifies industry RD&D priorities and the public-private sector funding needs to support technology development goals and objectives
- The Roadmap is used to inform policymakers on technology direction and annual budget needs
- Roadmap analyzes and communicates the benefits of the technology investment to the U.S.

Objectives of 2017 Roadmap Analysis

- Update the Coal Roadmap
 - Identify how coal development needs have changed, including timing of technologies
 - Show how these changes impact funding needs and timing
- Identify natural gas development issues
- Identify synergies between the coal and gas roadmaps
- Technology development pathways focused on:
 - Timing to provide candidate replacement options for potential fleet retirements (aging baseload fleet)
 - CCUS technology development key component, focused on CO₂ as a valuable commodity – i.e. technology to reduce CO₂ production costs
 - Emphasis on transformational energy conversion systems

How Do We Preserve the Value of the Existing Fossil Fuel Fleet?

- Improve the operation and flexibility of the existing fleet with the following technology focused actions:
 - Support federal efforts to enable the application of technologies to existing units that improve unit efficiency
 - Provide federal funding and support for technology R&D development necessary to improve operational flexibility and reliability of the existing fleet, as recommended and outlined in the CURC-EPRI Roadmap

How Can We Enable New Fossil Fueled Technology Today?

- Enact legislation to extend and expand the 45Q Carbon Sequestration Credits
- Provide investment tax credits and federal grants for new, highly efficient fossil fueled plants and for plants that capture and store CO₂
- Authorize price stabilization contract authority for CO₂ or electricity prices
- Provide for federal consolidation and accelerated permitting processes and timing limitations for court challenges

How Can We Position the U.S. as a Leader in the Global Fossil Fuel Market?

- Support accelerated development of advanced fossil fuel technologies and export of technologies through the following actions:
 - Authorize a new Fossil Energy RD&D program that reflects the technology development needs of today as recommended in the CURC-EPRI Roadmap
 - Double down on federal RD&D funding to develop technologies that will allow the U.S. to lead the global growth in fossil fuel use through exports of new, cost competitive electric generation technologies and our fossil fuels
 - Modify U.S. development bank policies that prevent U.S. manufacturers and equipment suppliers from selling their equipment in overseas coal projects
 - Provide federal incentives to enable new fossil energy generation projects including carbon capture projects in Congressional energy and infrastructure legislative proposals

Federal RD&D Funding

- Federal RD&D Funding
 - FY18 budget proposing \$280 million for Fossil Energy R&D program – in comparison, FY17 omnibus provided \$632 million
 - Unclear where cuts will be made
 - Successful technology commercialization in the utility industry will require federal support beyond basic R&D
 - Diminished private sector investments
 - Need more federal funding, not less – consensus that public sector funding is necessary

Status of other Federal Policy Efforts

- Congressional Efforts:
 - Renewed efforts on legislation to authorize new coal and fossil energy RD&D programs – likely through energy infrastructure efforts
 - Federal incentive efforts currently targeted at closing cost gap or accessing low cost financing for CCUS :
 - 45Q carbon sequestration credits
 - Private activity bonds
 - Opportunities for additional coal-focused policy efforts under discussion
- Regulatory reform efforts well underway to repeal or replace Clean Power Plan

ANALYSIS OF JOBS AND ECONOMIC BENEFITS OF FOSSIL ENERGY RD&D AND DEPLOYMENT

Study Objective

- Effort supported by ClearPath Action and CURC
- In discussions with NERA and Advanced Resources International for modeling the study
- Objective:
 - Estimate how improved carbon capture technology supported with federal RD&D can have a positive impact on fossil fuel jobs and the American economy in lieu of carbon dioxide regulations under a high economic growth outlook as called for by President Trump.

Study Scope

- Assumes 3 to 4% GDP growth – electrification of industry and increased manufacturing a key assumption to achieve this growth rate
- Assumes reduced costs and improved performance for CO₂ capture technology through ongoing RD&D, and will model the macro-economic impact of this on electric sector
 - Carbon capture on both coal and gas
 - Will look at impact of increased utilization of existing fleet
- Will model impact of increased enhanced oil recovery operations on the U.S. economy
- Will maintain current law and phase out renewable subsidies
 - Maintain state and regional RPS programs
 - Will not model Clean Power Plan

STUDY: DOMESTIC AND MULTINATIONAL OPTIONS TO FUND LARGE-SCALE PILOT PLANTS

Study Overview

- Purpose of Study: To investigate options to overcome barriers to financing large pilot projects for fossil fuel-based power plants with CCS.
- Sponsors: U.S. Department of Energy, Japan's New Energy and Industrial Technology Development Organization, and the Carbon Utilization Research Council
- Methodology: Multinational working groups focused on two tasks:
 - Innovative methods to finance large scale pilot projects
 - Multilateral collaboration as a financing option and effective models
- Release: May 2017

General Study Findings:

- Large pilots (10-50 MWe, \$100-500mm) are a critical step in technology development.
- Barriers include:
 - perception of limited market for mature technology, especially for coal systems in OECD countries;
 - financial challenges related to high cost, relative risk, difficulty demonstrating a “persuasive business case”; and
 - lower government priority compared to other low carbon technologies.
- Multilateral financial collaboration could contribute to large pilot project success. Study released in 2017 identifies key issues that could hinder collaboration and how to mitigate those in collaborative frameworks.

Thank you!

Questions:

Shannon Angielski

Carbon Utilization Research Council (CURC)

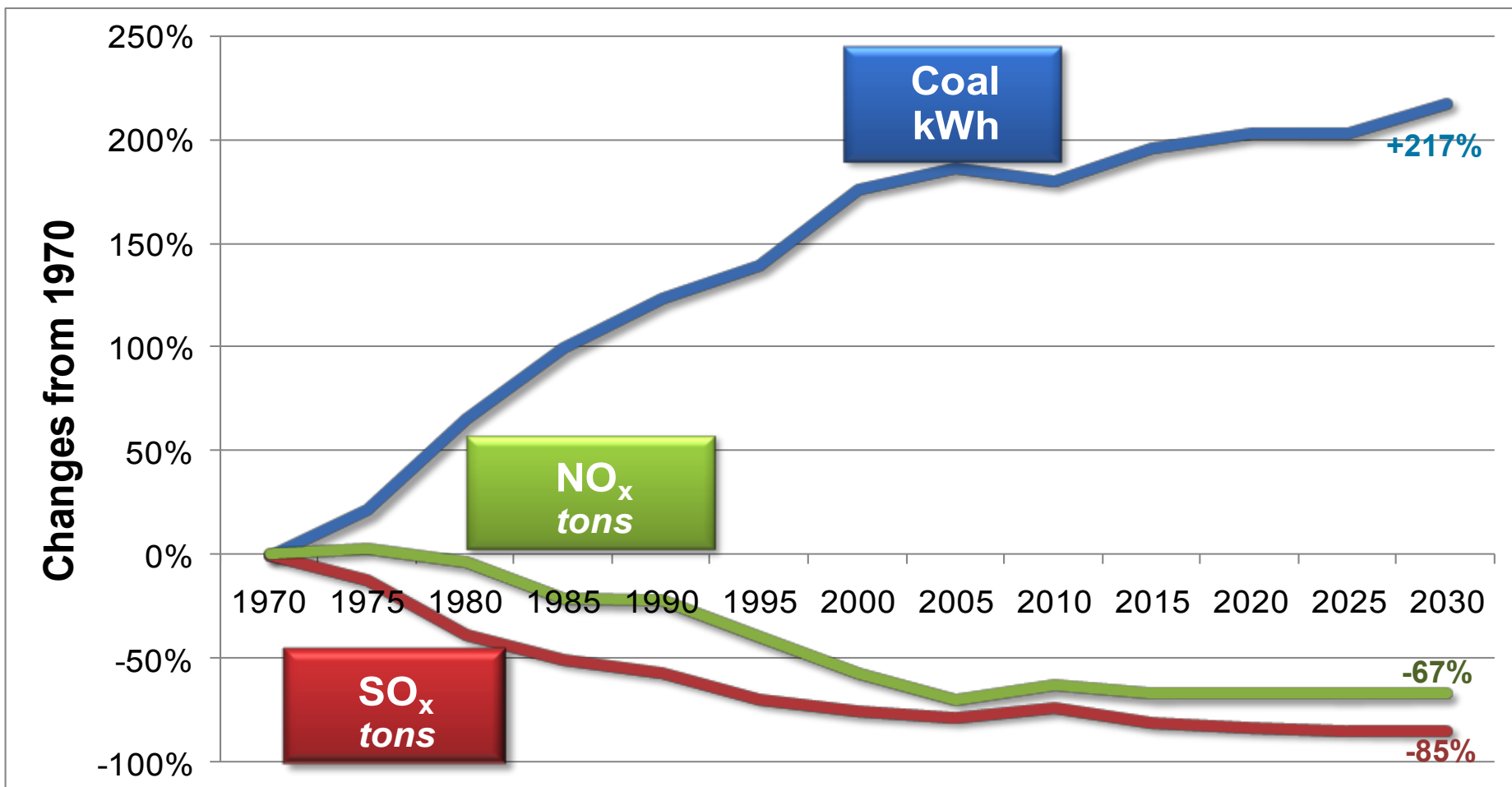
www.curc.org

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#1: Preserve and Enhance the Value of the Existing Fossil Fuel Fleet

- The existing fleet of fossil fuel plants –
 - Provides affordable, reliable, and 24/7 electricity
 - Supports jobs in fuel production and for the operation and maintenance of power generation facilities
 - Serves as the engine for economic growth and domestic energy security
- There is tremendous investment in the existing fossil fuel fleet:
 - provides two-thirds of U.S. generation needs
 - is very clean and highly efficient with new technologies
- Over the last 40 years, technology advances have led to impressive improvements in the environmental footprint while keeping electricity prices low

Emissions Continue to Decline While Generation from Fossil Fuels Increase



Sources: EPA National Air Pollutant Emission Trends; EIA Annual Energy Review and EIA AEO '09 AARA

#2: Technology will Ensure U.S. Energy Security through a Balanced Generation Portfolio

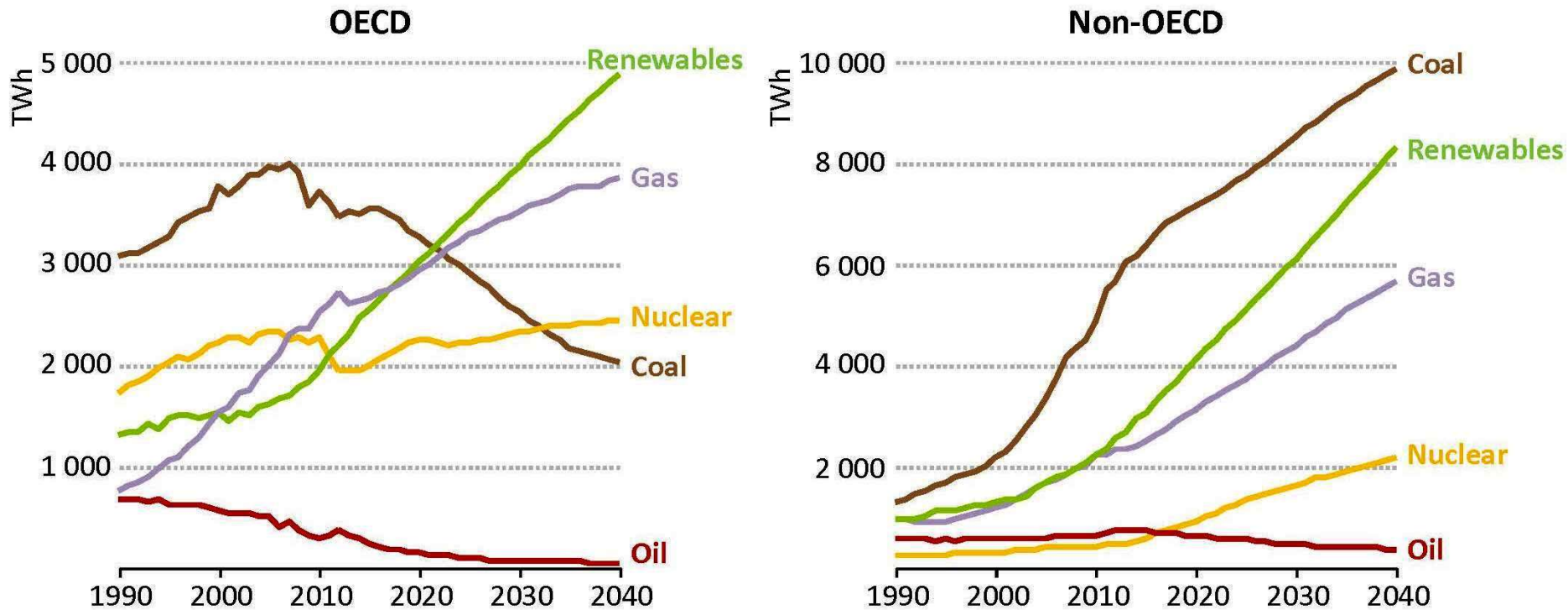
- Fossil Fuels are an essential energy option and necessary to maintain fuel diversity and energy security
- Over reliance on any single source is not good for consumers:
 - Fukushima disaster and limited restarting of nuclear generation in Japan
 - Renewable dependency in Germany costing \$0.33/kwhr vs. \$0.12/kwhr in the US
- All sources are needed; all sources face challenges
 - Nuclear – high costs for construction and challenges with waste disposal
 - Renewables – intermittency, weather disruptions & regional availability limits their reliability
- Technology will enable power generators to retain the benefit of options and assure use of all available domestic energy resources even in a low carbon future

#3: Technology Will Position U.S. as a Leader in the Global Growth of Fossil Fuel Use while Reducing Its Emissions

- Fossil Fuels are the most affordable and fastest growing energy resource worldwide
 - 1.3 BILLION people on the globe have no electricity, and fossil fuels are the primary source of power in these emerging economies due to their low cost, accessibility, and reliability in generation
 - In a world that is using more and more fossil fuels, significantly more carbon dioxide will be emitted on a global scale.
- Key Messages:
 1. There is an opportunity for U.S. industry to lead the global growth in fossil fuel use through exports of commodities – our fossil fuels, and the export of new, cost competitive electric generation technologies.
 2. Without technology in a world that is outpacing the U.S. in the use of fossil fuels, we will not effectively mitigate the emissions of carbon dioxide or the environmental footprint of fossil fuel use.
 3. Fortunately, the U.S. can capitalize on the opportunity to lead in the development of technology to mitigate CO₂ emissions while also reaping the economic and energy security benefits of recovering over 200 billion barrels of domestic crude oil.

Global Market for New Fossil Energy Generation

Electricity generation by fuel

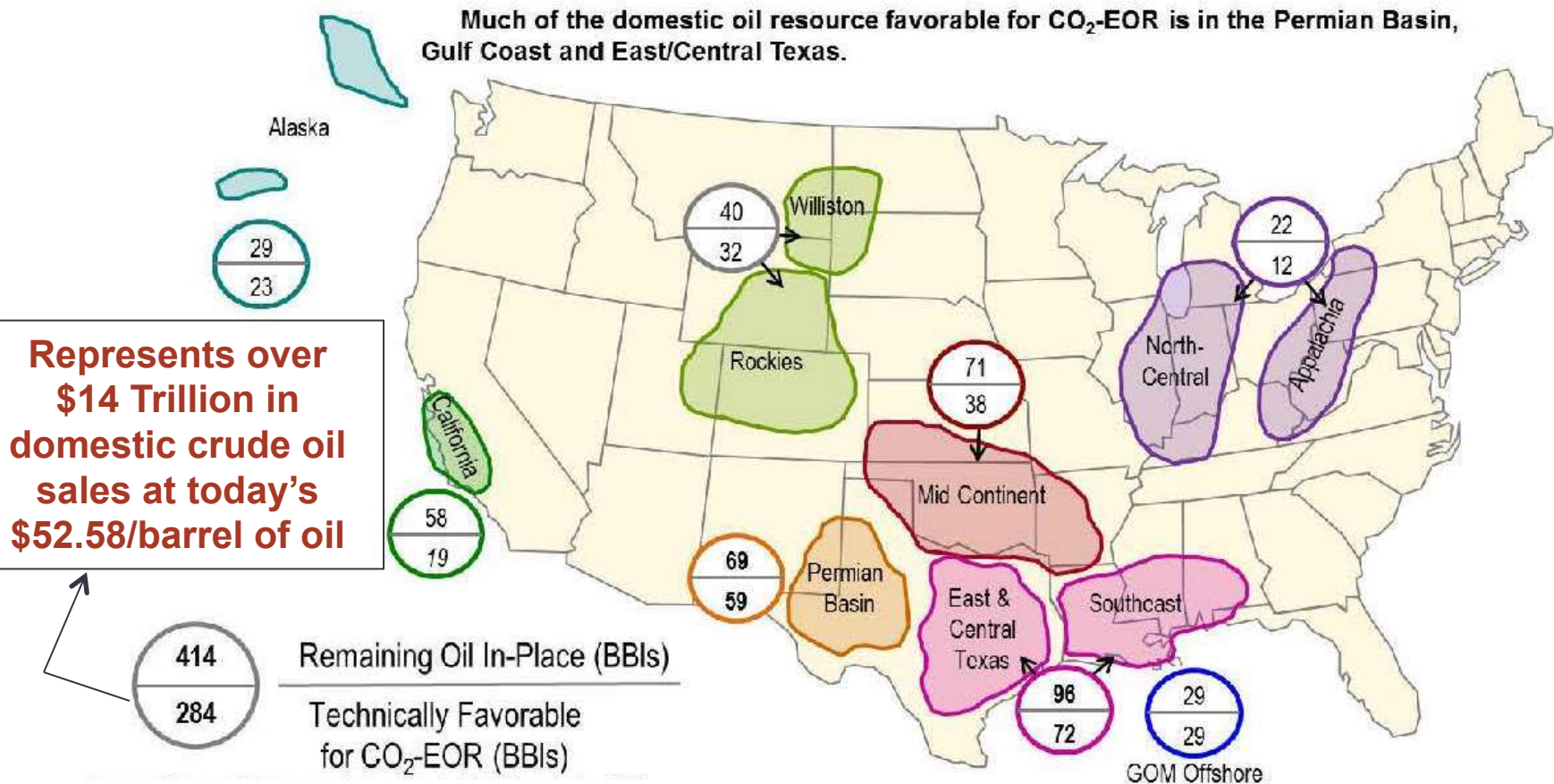


WEO Special Report on Energy & Climate Change
 Changing Dynamics of Power Generation
 (Source: [IEA WEO 2015](#))

Economic Potential of CO₂-EOR in the US

Regional Distribution of CO₂-EOR Potential

Much of the domestic oil resource favorable for CO₂-EOR is in the Permian Basin, Gulf Coast and East/Central Texas.



Importance of Carbon Capture Technology

“Many models could not limit warming to below 2°C if bioenergy, CCS and their combination are limited”

Source: *International Panel on Climate Change, 5th Assessment report, 2014*

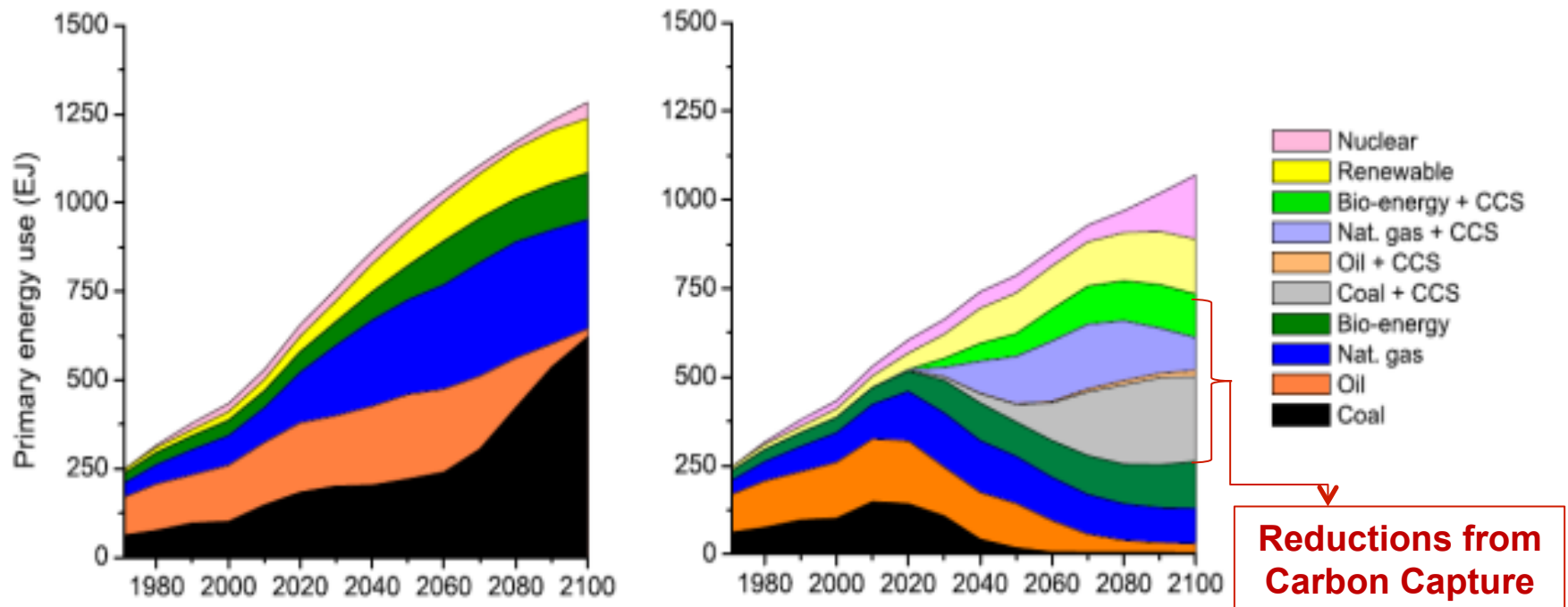


Fig. 2 Trends in global energy use for the baseline (*left*) and the mitigation scenario RCP2.6 (*right*) (CCS=Carbon Capture and Storage)

*Source: IPCC, 2014

“Carbon capture and storage (CCS) is the only technology able to deliver significant emissions reductions from the use of fossil fuels. CCS can reduce emissions not only from power generation, but also from industrial sectors such as iron and steel, refining, petrochemical, and cement manufacturing.”
– International Energy Agency (DATE)

Scenarios

| | Key Assumptions | Alternative Base | | | | | | | | | |
|----------|---|---|-------------|-------------|----------|-----|-----|----------|-----|-----|--|
| Base | <p>Generally track AEO17, no CPP</p> <ul style="list-style-type: none"> NETL C&P for coal and gas electricity technologies No LCOE improvement EOR with “2% rule of thumb” CO2 “adder” based on IRPs 4%/yr growth (less > 2030?) | <p>AEO17 LO&G resource</p> <p>Same, except use an EIA scenario with higher O&G prices</p> | | | | | | | | | |
| Policy | <p>Apply DOE assumptions/goals for LCOE reduction via RD&D</p> <table border="1"> <thead> <tr> <th></th> <th><u>2030</u></th> <th><u>2040</u></th> </tr> </thead> <tbody> <tr> <td>SCPC/ccs</td> <td>20%</td> <td>40%</td> </tr> <tr> <td>NGCC/ccs</td> <td>10%</td> <td>20%</td> </tr> </tbody> </table> | | <u>2030</u> | <u>2040</u> | SCPC/ccs | 20% | 40% | NGCC/ccs | 10% | 20% | <p>Same, except use an EIA scenario with higher O&G prices</p> |
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