NARUC Winter Committee Meetings

Subcommittee on Clean Coal

Opportunities for CCS from the Coal Utilization Research Council (CURC) Perspective

Renaissance Washington Hotel

Washington, DC

Ben Yamagata

Executive Director

Coal Utilization Research Council

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University of Wyoming
West Virginia Coal Association
West Virginia University
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Companies in red indicate 2014 Steering Committee Members

What is CURC?

More information: www.coal.org

Coal Utilization Research Council

Based in Washington D.C. & organized in 1997

50 members – coal producers, utilities, equipment suppliers, states & universities

Focused upon coal related technology development and use as well as CCUS

It’s more complicated than just “Plugging into an electrical outlet”

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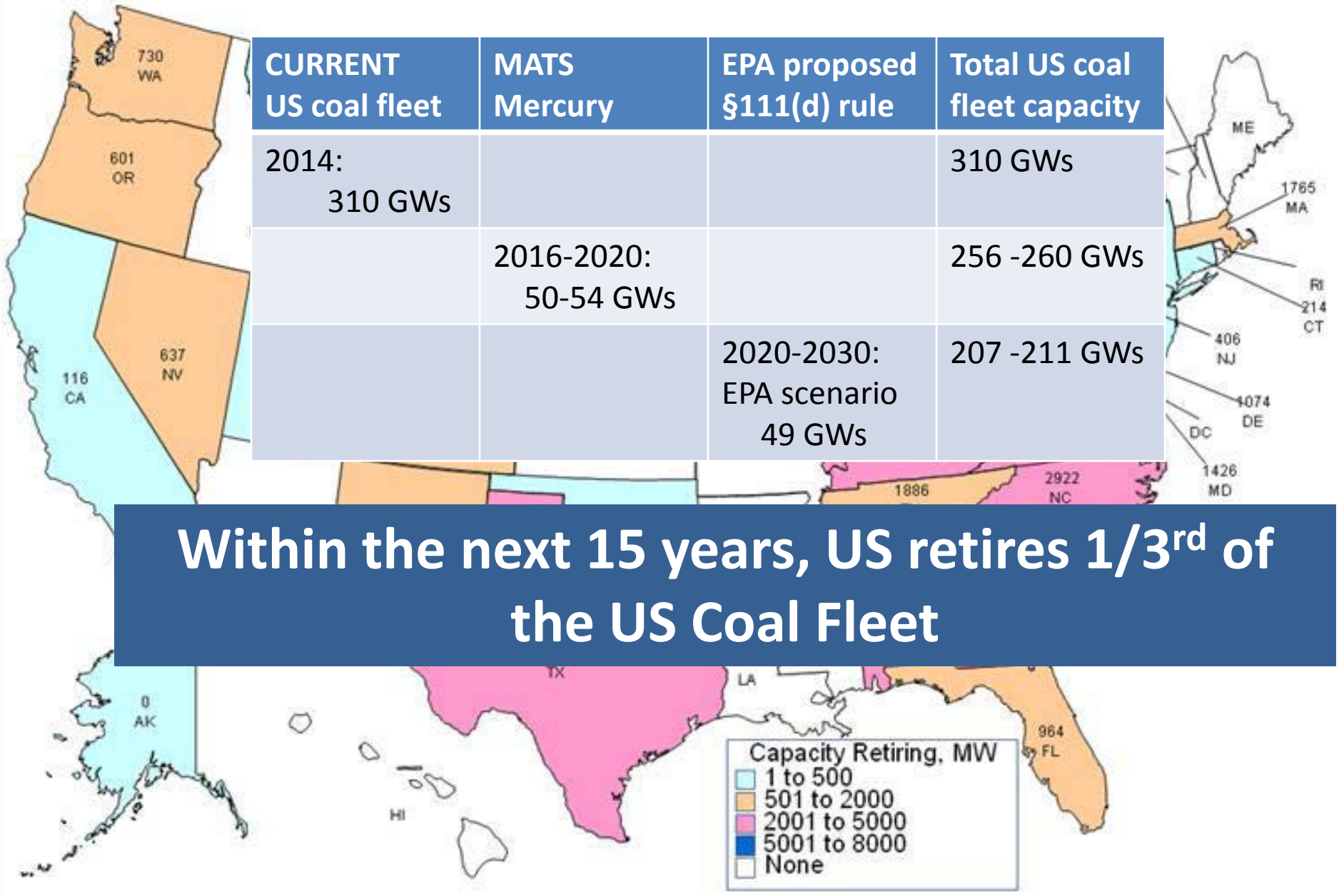
Announced & Planned Coal Retirements: 2010-2020

CURRENT US coal fleet	MATS Mercury	EPA proposed §111(d) rule	Total US coal fleet capacity
2014: 310 GWs			310 GWs
	2016-2020: 50-54 GWs		256 -260 GWs
		2020-2030: EPA scenario 49 GWs	207 -211 GWs



Within the next 15 years, US retires 1/3rd of the US Coal Fleet

Technology Developed to Address other Environmental Concerns

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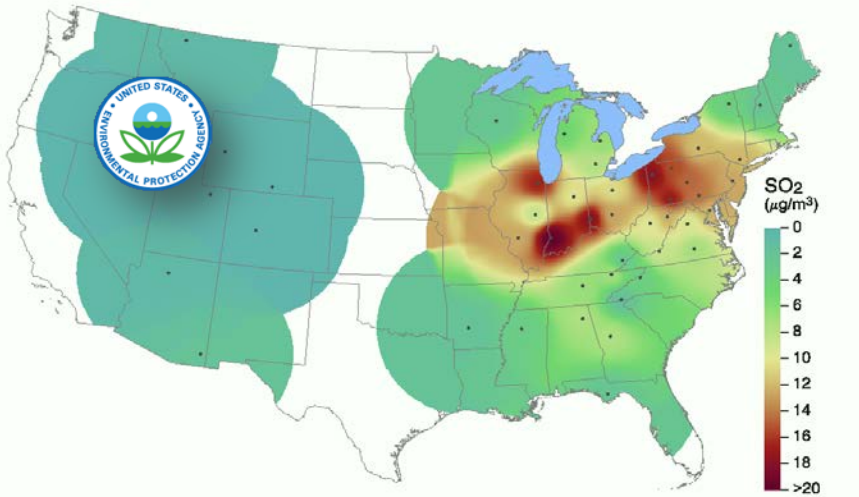
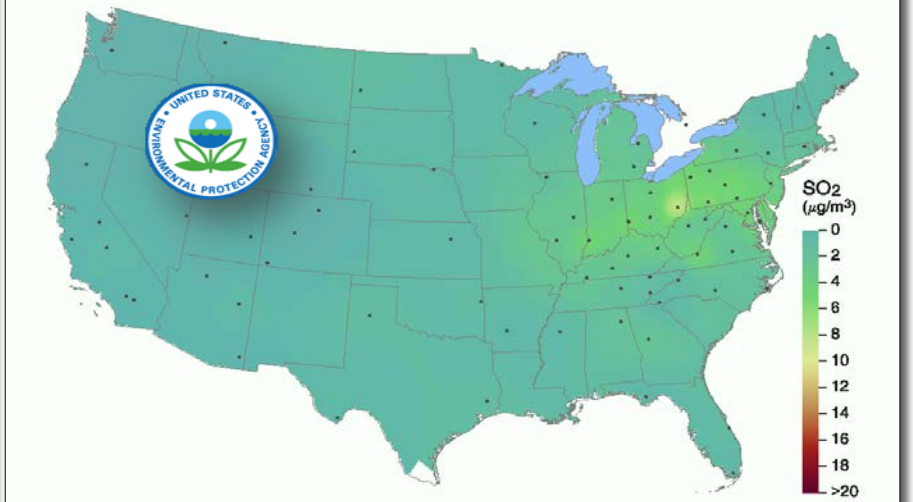
With the application of new technologies developed in partnership between DOE and the private sector, the U.S. is significantly reducing criteria emissions

(particulate matter, sulfur dioxide, carbon monoxide, lead, ozone, and nitrogen oxides)

1990 SO_2 Concentrations

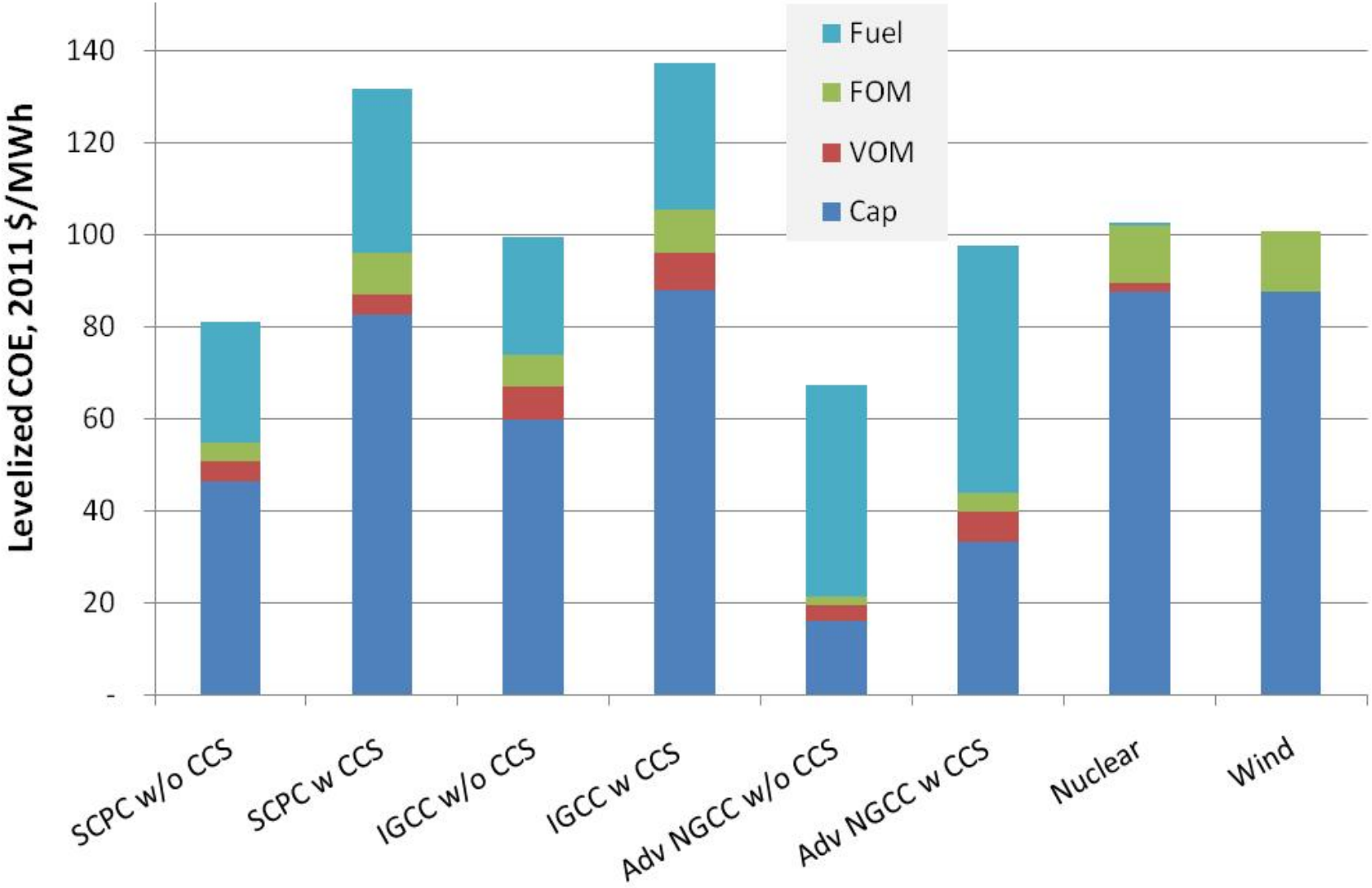


2009 SO_2 concentrations



Current Technology Levelized Cost of Electricity for a New Electric Generating Unit Commencing Operation in 2018

(Based on EIA/AEO 2013er)



Source: CURC analysis of EIA AEO 2013er

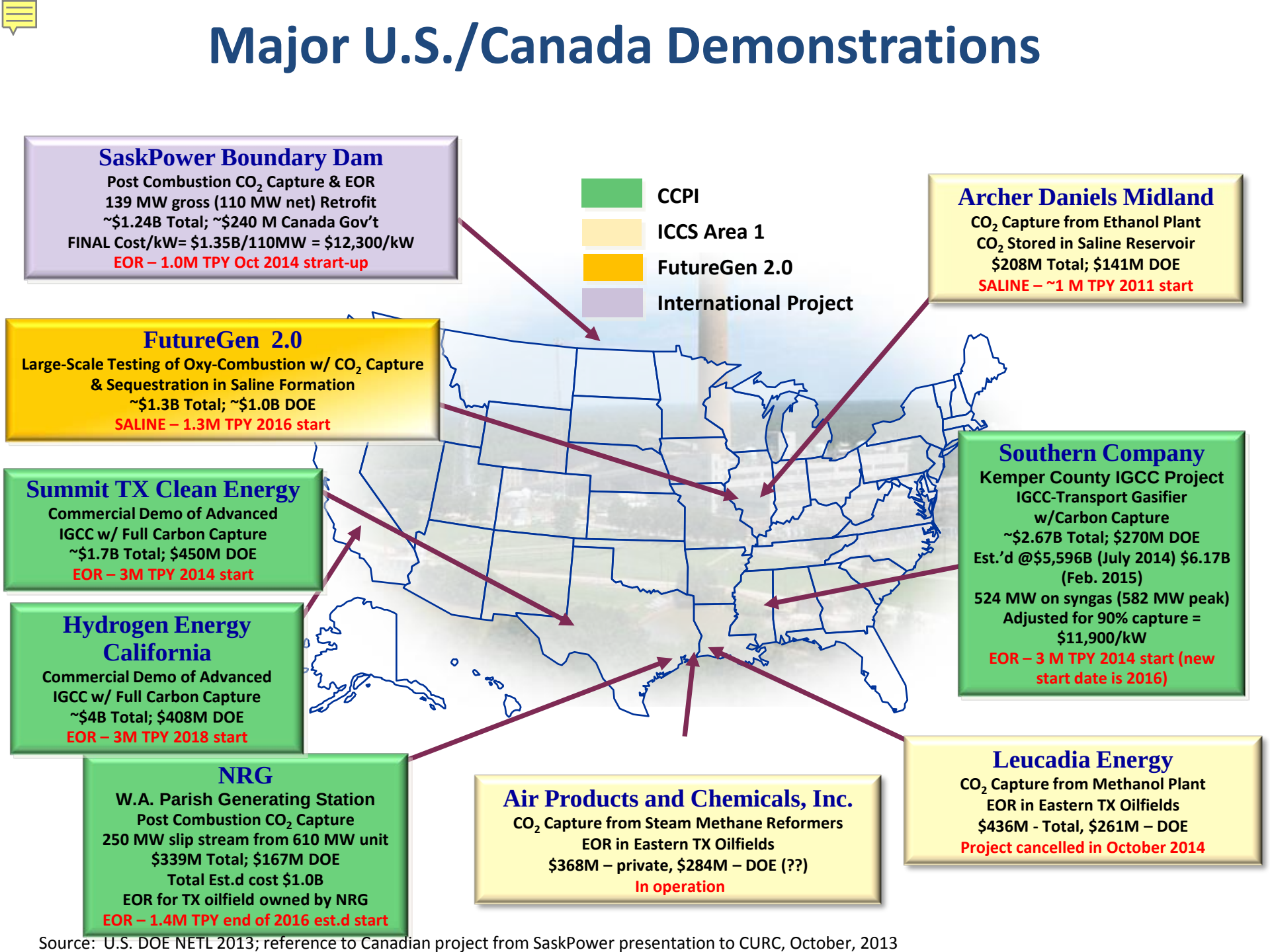
CCS Projects in US and Europe

Map Key

	Power Plant CCS Projects
	Pilot CCS Projects
	Commercial EOR Projects
	Non-Power CCS Projects

Source: Carbon Capture & Sequestration Technologies@MIT

Major U.S./Canada Demonstrations



SaskPower Boundary Dam

Post Combustion CO_2 Capture & EOR
139 MW gross (110 MW net) Retrofit
~$1.24B Total; ~$240 M Canada Gov't
FINAL Cost/kW= $1.35B/110MW = $12,300/kW
EOR – 1.0M TPY Oct 2014 strart-up

FutureGen 2.0

Large-Scale Testing of Oxy-Combustion w/ CO_2 Capture & Sequestration in Saline Formation
~$1.3B Total; ~$1.0B DOE
SALINE – 1.3M TPY 2016 start

Summit TX Clean Energy

Commercial Demo of Advanced IGCC w/ Full Carbon Capture
~$1.7B Total; $450M DOE
EOR – 3M TPY 2014 start

Hydrogen Energy California

Commercial Demo of Advanced IGCC w/ Full Carbon Capture
~$4B Total; $408M DOE
EOR – 3M TPY 2018 start

NRG

W.A. Parish Generating Station
Post Combustion CO_2 Capture
250 MW slip stream from 610 MW unit
$339M Total; $167M DOE
Total Est.d cost $1.0B
EOR for TX oilfield owned by NRG
EOR – 1.4M TPY end of 2016 est.d start

Air Products and Chemicals, Inc.

CO_2 Capture from Steam Methane Reformers
EOR in Eastern TX Oilfields
$368M – private, $284M – DOE (??)
In operation

Archer Daniels Midland

CO_2 Capture from Ethanol Plant
CO_2 Stored in Saline Reservoir
$208M Total; $141M DOE
SALINE – ~1 M TPY 2011 start

Southern Company

Kemper County IGCC Project
IGCC-Transport Gasifier w/Carbon Capture
~$2.67B Total; $270M DOE
Est.'d @$5,596B (July 2014) $6.17B (Feb. 2015)
524 MW on syngas (582 MW peak)
Adjusted for 90% capture = $11,900/kW
EOR – 3 M TPY 2014 start (new start date is 2016)

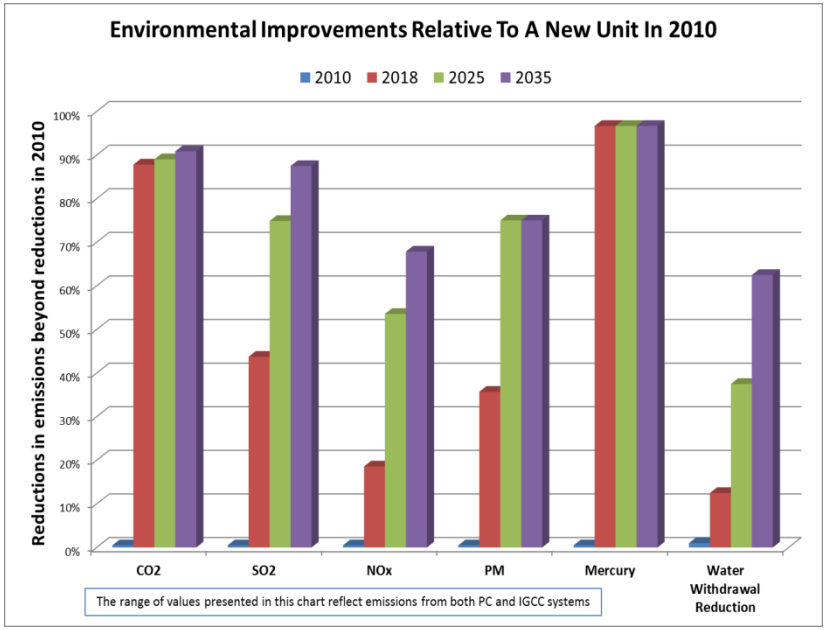
Leucadia Energy

CO_2 Capture from Methanol Plant
EOR in Eastern TX Oilfields
$436M - Total, $261M – DOE
Project cancelled in October 2014

Source: U.S. DOE NETL 2013; reference to Canadian project from SaskPower presentation to CURC, October, 2013

Adequate Time & Funding Produces New and Better Technologies

Reduced emissions of traditional air pollutants, reduced water use and consumption, and reduced CO_2 emissions

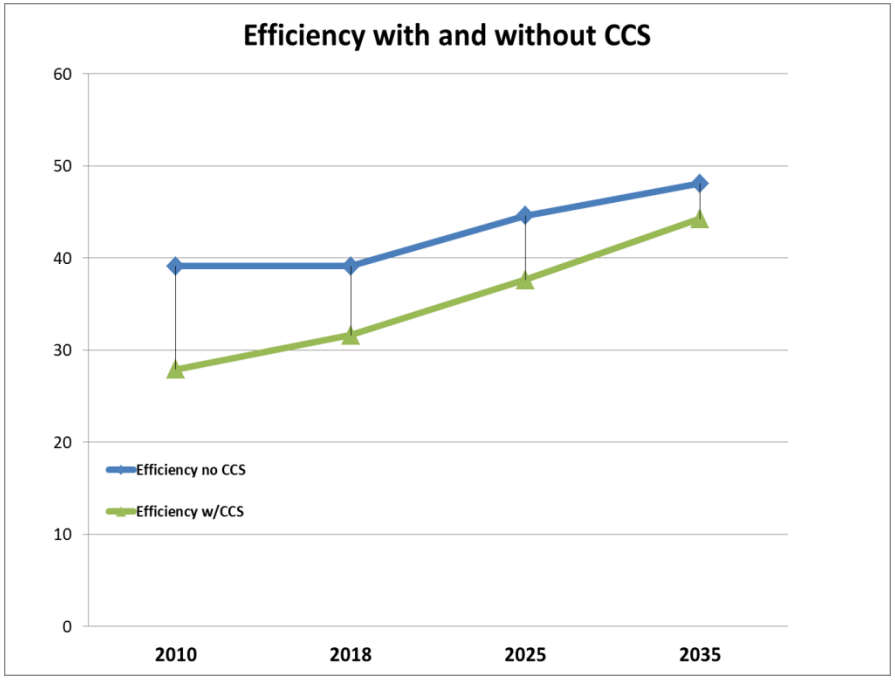


2010 "State of the Art" Baseline Data

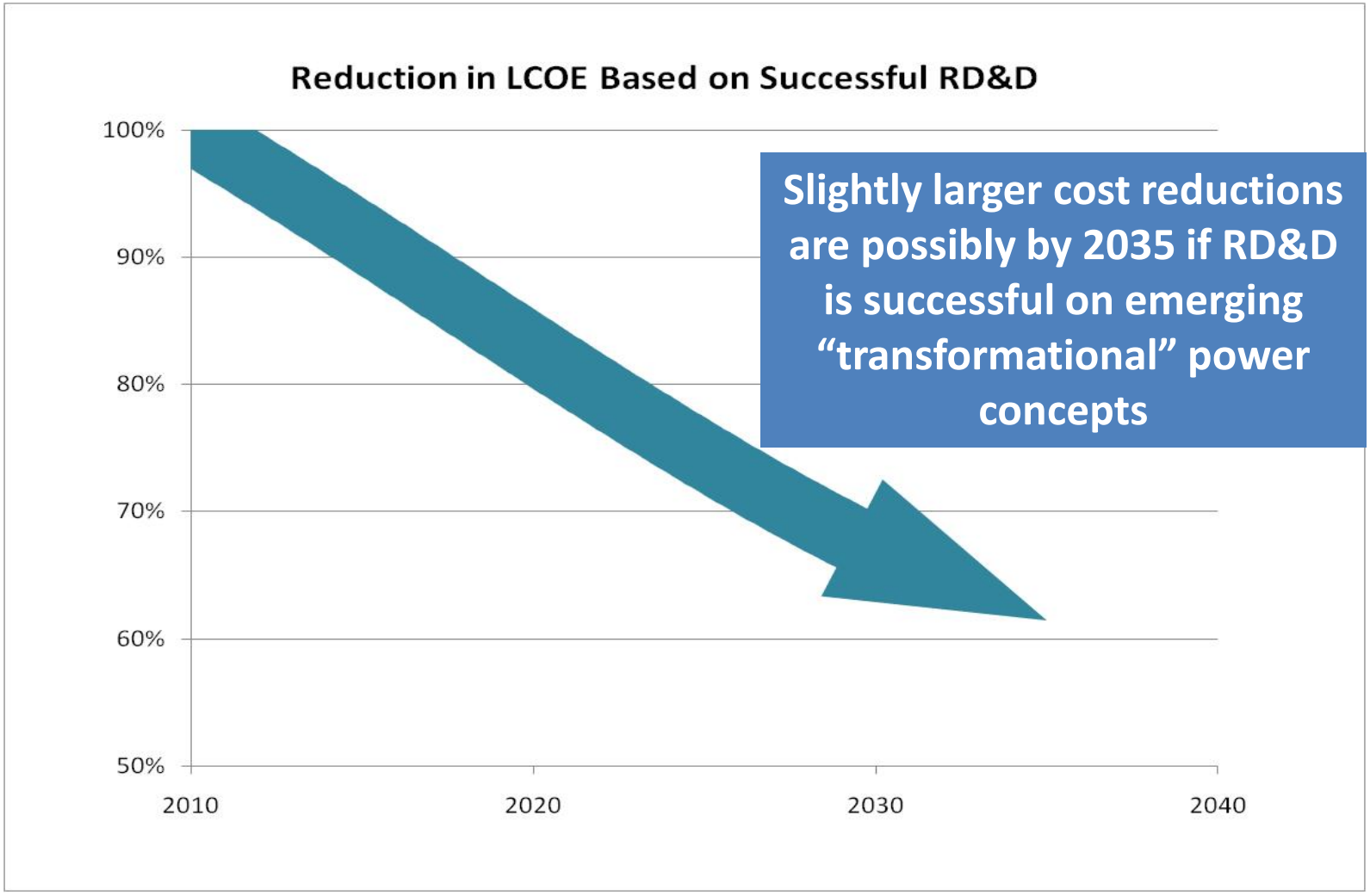
Reductions reflect a range of values for both PC and IGCC technology changes after 2010, but the reductions in 2010 are very significant:

- **CO_2**: 0% (no carbon controls in use)
- **NOx and SO_2:** 90 - 99% reduction
- **PM:** 99.6% reduction
- **Mercury:** 90% reduction
- **Water Withdrawal Reduction** (as a result of cooling towers)**:** 98%

Independent of a climate driver, less CO_2 is emitted as a result of increased power generation efficiency, and less coal is used for the same unit of power output



Successful Technology Development Results in Coal-fueled Electricity Cost-Competitive with Low Carbon Alternatives



The Success of CCS depends upon --

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- **Adequate Time –**
  - **Next 10 years are crucial**
- **Financial support**
  - **Majority of funding must be public monies**
- **Regulatory support**
  - **Accommodate time needed for RD&D**
- **Support from legislators, regulators, the public**

3-Part Technology Program Coal from 2015 to 2050 & Beyond

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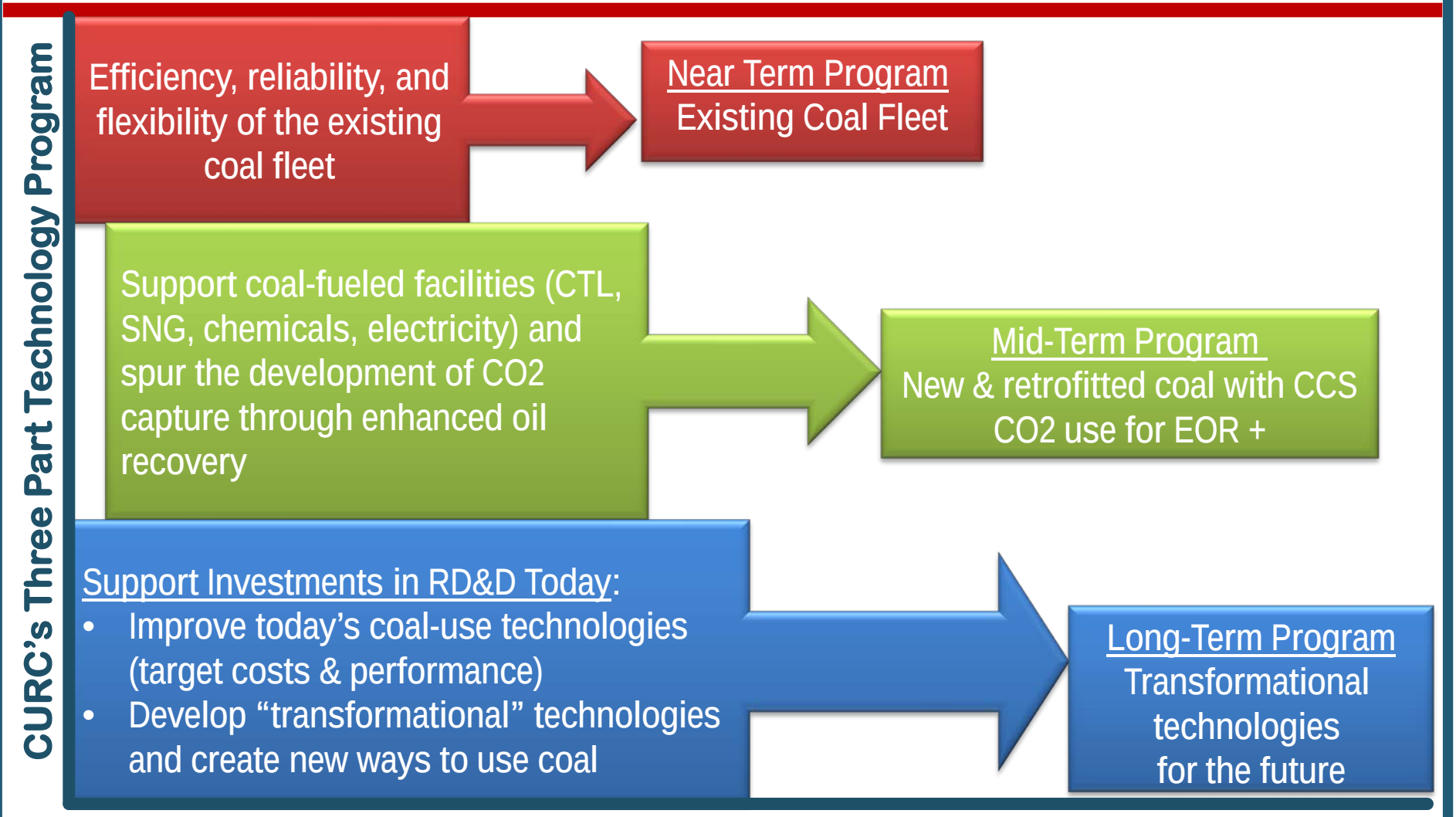

Thank You