USEA – June 23, 2015 – Washington, DC

National Coal Council

Celebrating 30 years ~ 1984|2014

The National Coal Council provides advice and recommendations to the Secretary of Energy on general policy matters relating to coal and the coal industry.

NCC is a Federal Advisory Committee organized under FACA legislation

Members are appointed to serve by Secretary of Energy

120-125 members

More than 30 studies conducted for the Secretary of Energy

Prepared by NCC members at no cost to DOE

- **Industry –**
  coal suppliers, utility & industrial consumers & coal transportation
- **Support Services –**
  engineering firms, vendors, consultants & attorneys
- **Academics**
- **NGOs –**
  environmental & trade association reps
- **Government –**
  PUC & state energy officials

Extensive Range of Topics

Carbon Management
Clean Coal Technologies
Coal & Coal Technology Exports
Coal Conversion
Coal's Image
Utility Deregulation
Climate & Clean Air Regulations
Building New Coal Power Plants
Industrial Coal Use
CCUS for EOR
Value of Existing Coal Fleet

>> STUDY REQUEST

Secretary Moniz's Charge to NCC – May 2014

… request the NCC conduct a study that assesses the value of DOE's Carbon Sequestration Program … The assessment should address the question: "What is industry's assessment of the progress made by the DOE and others regarding cost, safety, and technical operation of CCS/CCUS?

… In other words, how does industry see and accept major technical findings from the CCS/CCUS community, and how do those relate to DOE programs and investments?

… an assessment based on technical soundness and results to date would provide a welcome perspective from leading companies with experience in CCS/CCUS technology."

>> Study Leadership & Lead Authors

- NCC Chair – **Jeff Wallace**, VP Fuel Services, Southern Company Svcs
- Coal Policy Committee Chair – **Fred Palmer**, Senior VP, Peabody Energy
- NCC CPC Vice Chair– **Bill Brownell**, Chairman, Hunton & Williams

- Study Chair – **Amy Ericson**, President, Alstom Inc.
- Technical Chair – **Carl Bozzuto**, Alstom

- Lead Authors –
  - **Holly Krutka**, Shenhua Group
  - **Pam Tomski**, Global CCS Institute
  - **Shannon Angielski,** CURC
  - **Carl Bozzuto,** Alstom
  - **Jeff Phillips,** EPRI

>> Study at a Glance

"Fossil Forward – Revitalizing CCS:

Bringing Scale & Speed to CCC Deployment"

- Executive Summary
- Chapter A: The CCS/CCUS Imperative
- Chapter B: Global Status of CCS/CCUS
- Chapter C: Overview of Current DOE CCS/CCUS Programs – Status & Achievements
- Chapter D: CCS/CCUS Deployment Challenges
- Chapter E: Gap Analysis
- Chapter F: Recommendations

>> Fossil Forward Principal Theme

"While DOE is indisputably a world leader in the development of CCS technology, the DOE CCS/CCUS program has not yet achieved critical mass."

- "Without adequate demonstration there can be no commercialization."
- "There is no point in capturing CO2 if there is no place to use it or store it."

>> Magnitude of the Problem

- Current # of demonstration projects in operation or under construction globally = 22

  Projected need by 2050 = 3,400

- The current global CO2 storage rate = 40 million tons/year

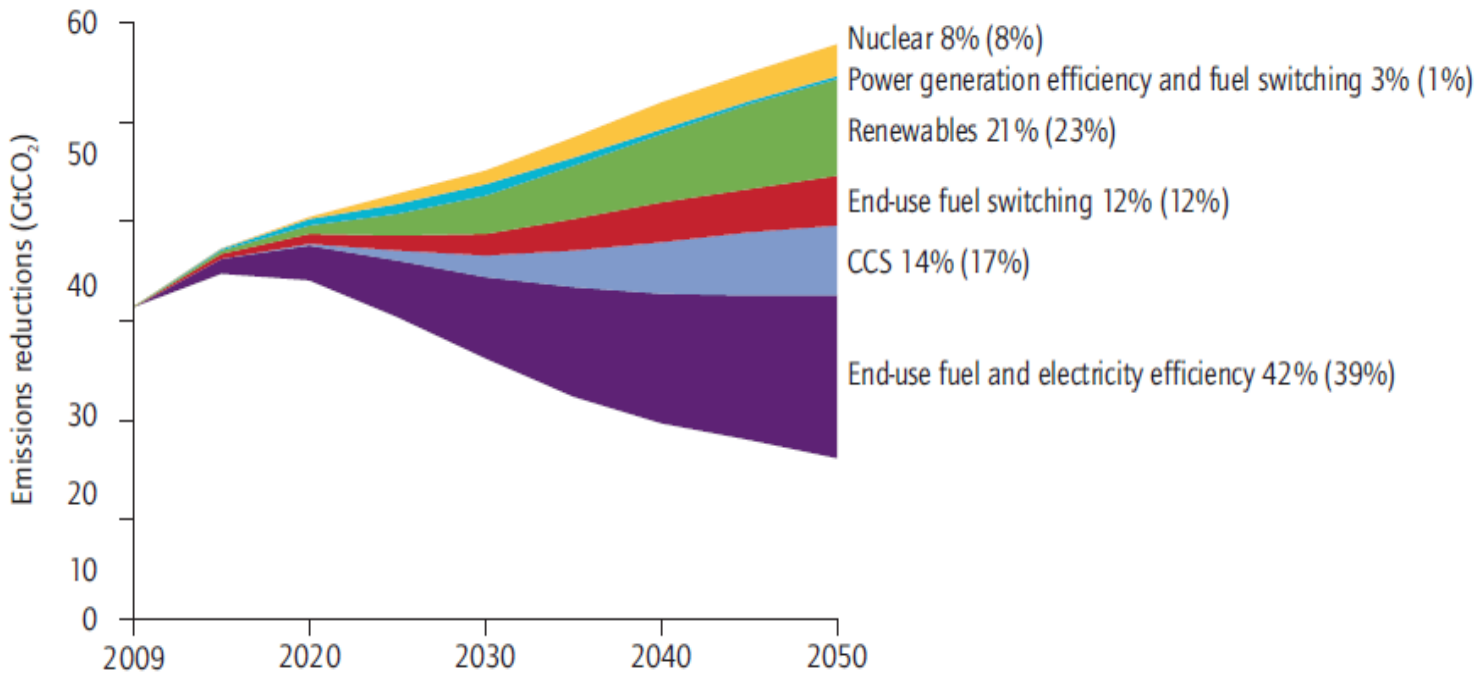
  Projected need = 10 billion tons/year

- Cumulative total CO2 emissions 2050 ~ 2,000 billion tons

  Projected "safe" level of emissions = 884 billion tons

>> The CCS/CCUS Imperative

CCS is the only large-scale technology that can mitigate CO_2 emissions from fossil fuel use for electricity generation and key industrial sectors.

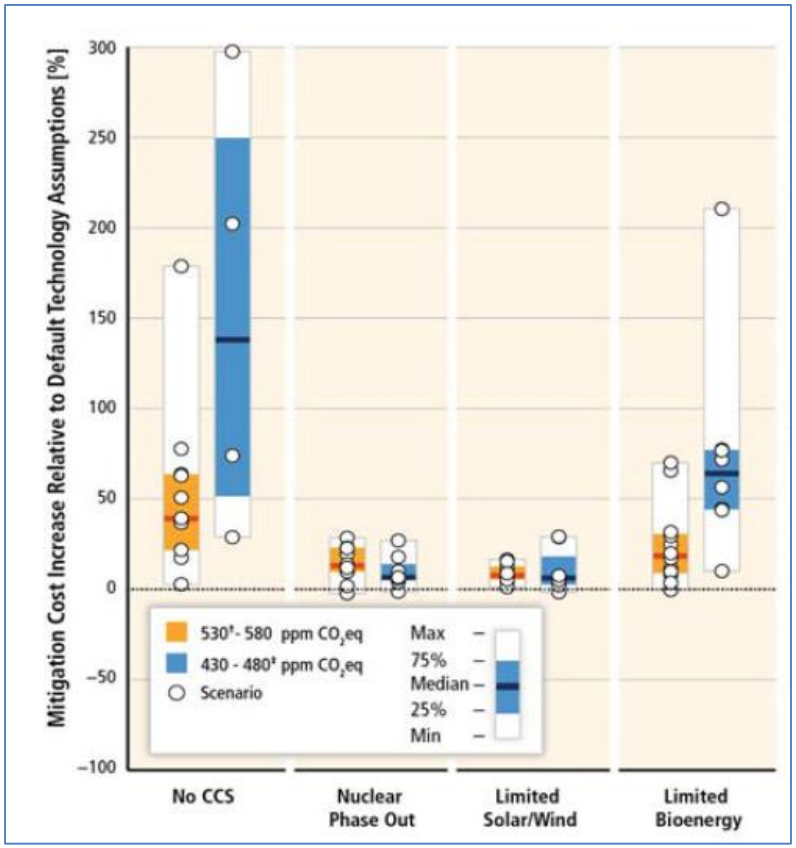


Note: numbers in brackets are shares in 2050. For example, 14% is the share of CCS in cumulative emission reductions through 2050, and 17% is the share of CCS in emission reductions in 2050, compared with the 6DS.

IEA Technology Road Map

>> The CCS/CCUS Imperative

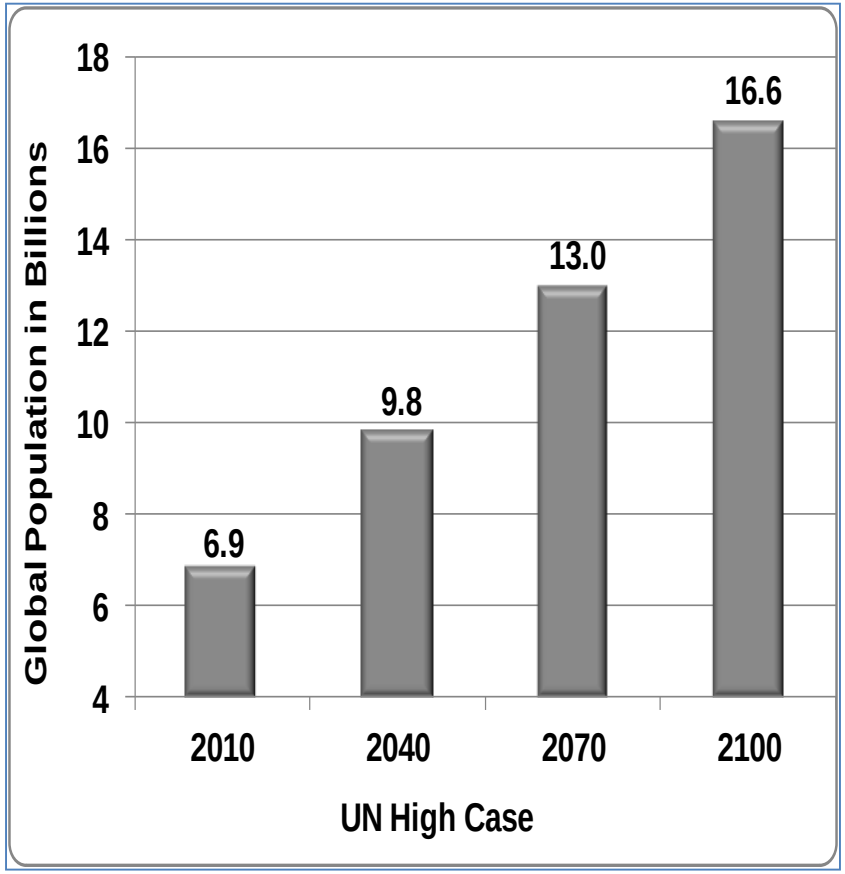
Not including CCS as a mitigation technology is projected to increase the overall costs of meeting CO_2 emission goals by 70-138%.



Climate Change Mitigation Costs Without CCS and Other Technologies

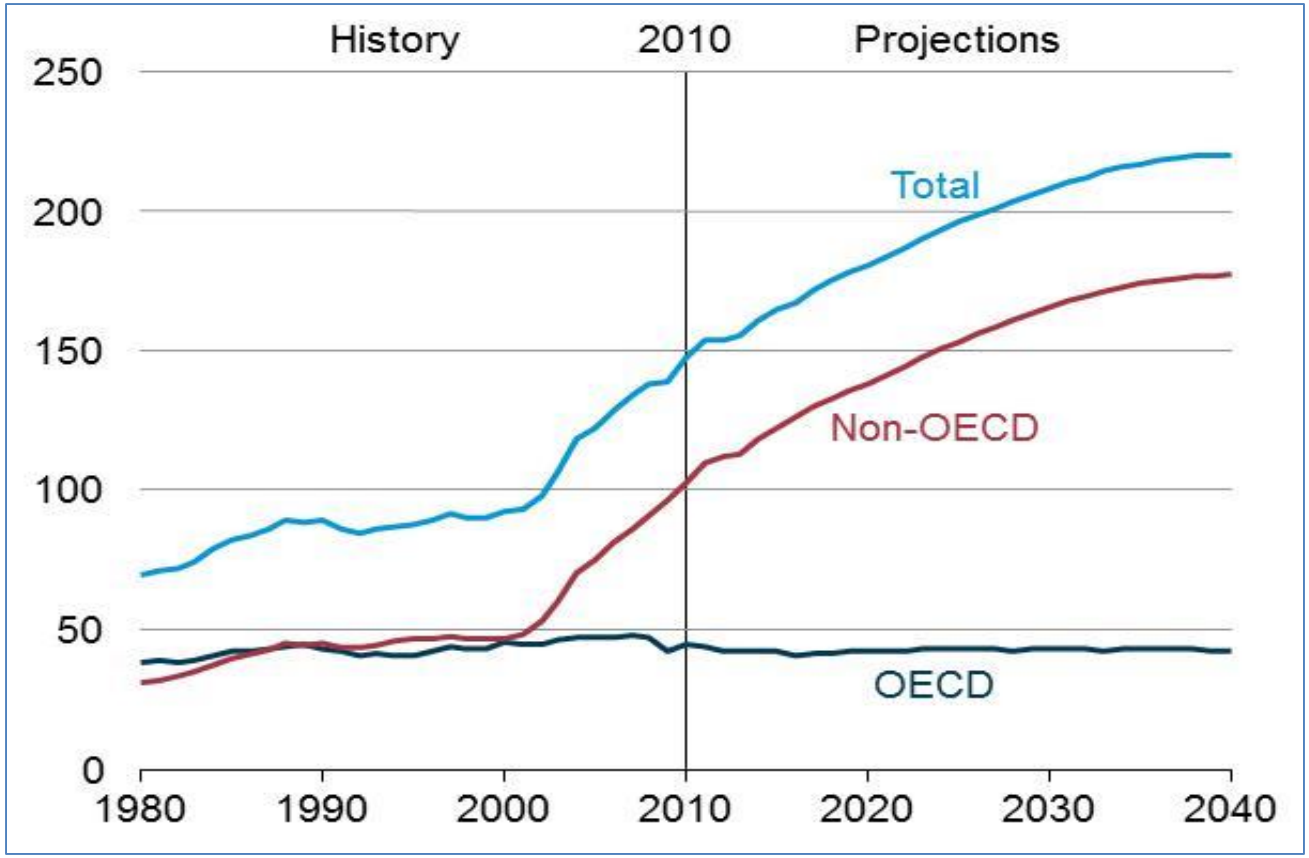
>> The CCS/CCUS Imperative

U.S. CO_2 emission represent less than 16% of world emissions; global and wide-scale implementation of CCS is necessary to meet GHG goals.



United Nations Global Population Projection: High Case

>> The CCS/CCUS Imperative



Projected Global Coal Consumption Through 2040

Quadrillion BTU/Year ~ EIA Reference Case

>> Key Recommendations Overview

- ***In order to achieve CCS at commercial scale, policy parity with other low/no carbon technologies is required.***
- ***Technology and funding Incentives must be significantly better coordinated to be effective.***
- ***DOE program goals need far greater clarity and alignment with commercial technology and funding approaches used by industry.***
- ***Funding for CCS RD&D is limited and must be enhanced and focused.***
- ***Public acceptance continues to be a major hurdle.***
- ***GHG control is an international issue in need of international initiatives.***

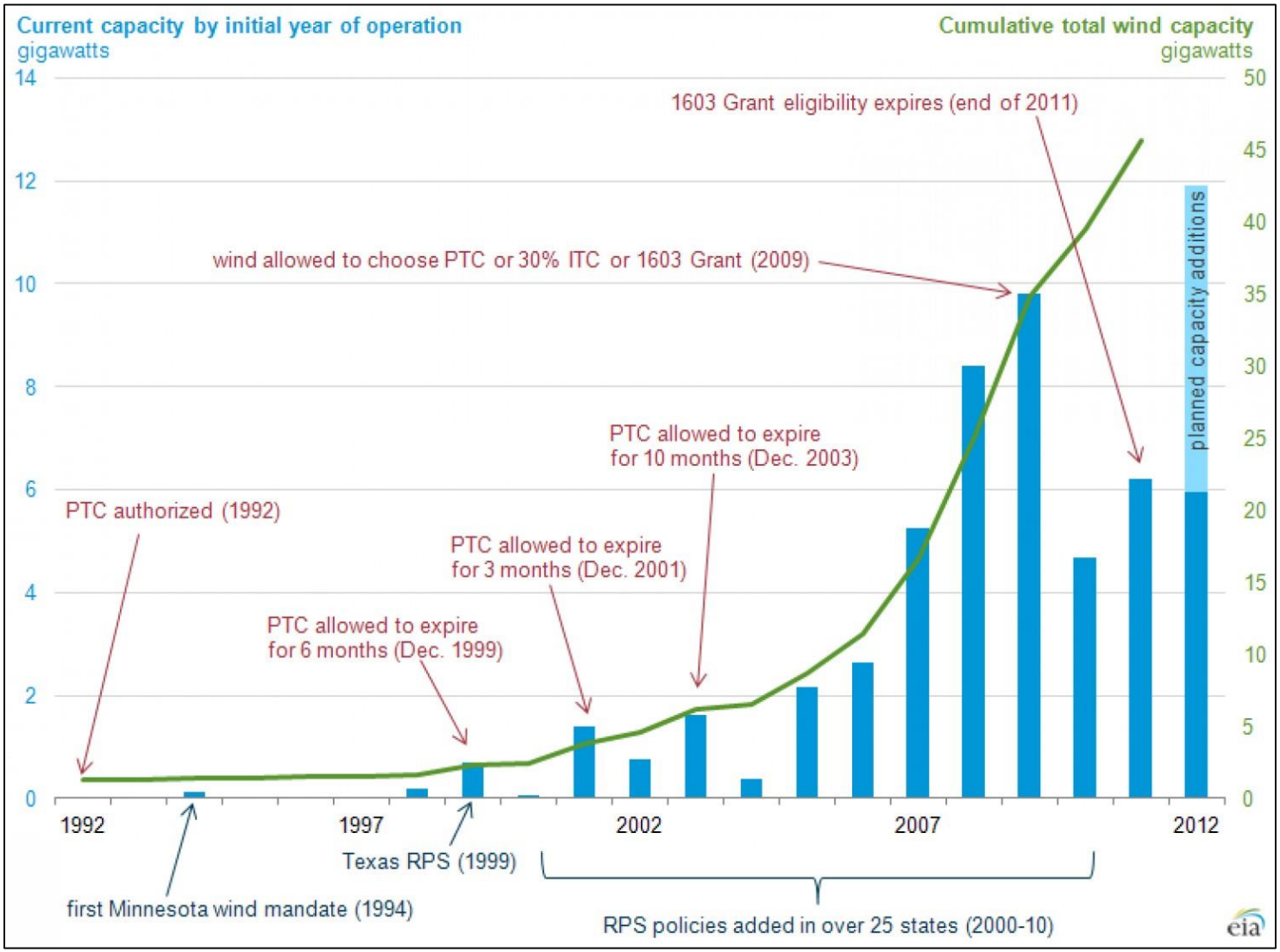
>> Key Recommendation

In order to achieve CCS at commercial scale, policy parity with other low/no carbon technologies is required…

<u>The National Coal Council recommends that:</u>

- **DOE take a stronger position on the need for policy parity with respect to funding allocations**
- **DOE take a stronger position on the need for policy parity with respect to incentive mechanisms and subsidies applied to near zero emission energy technology**

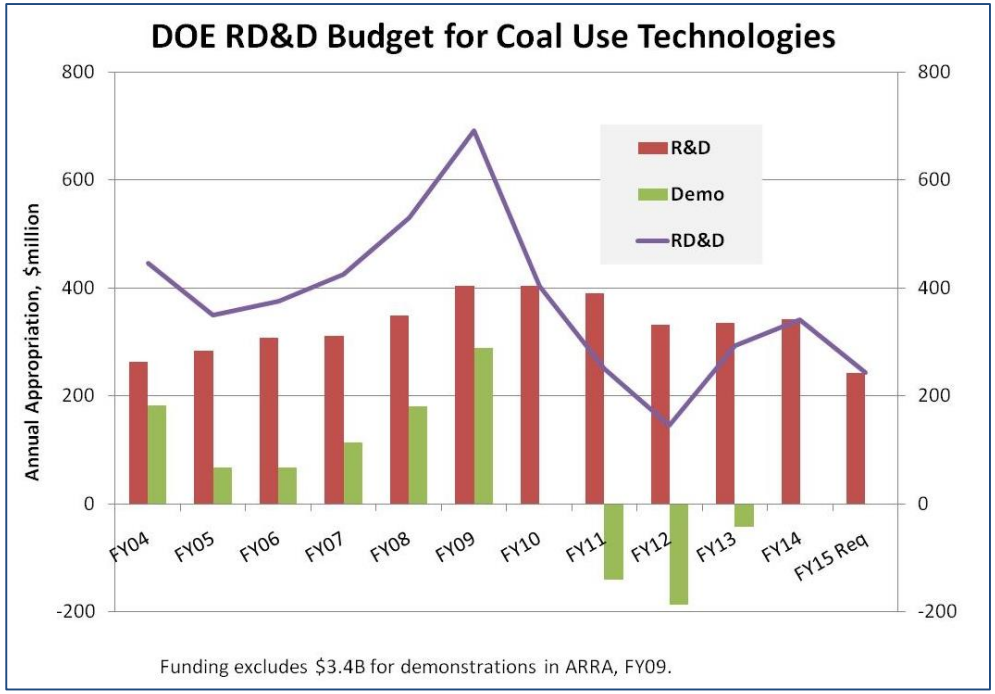
>> Potential Benefit from Policy Parity



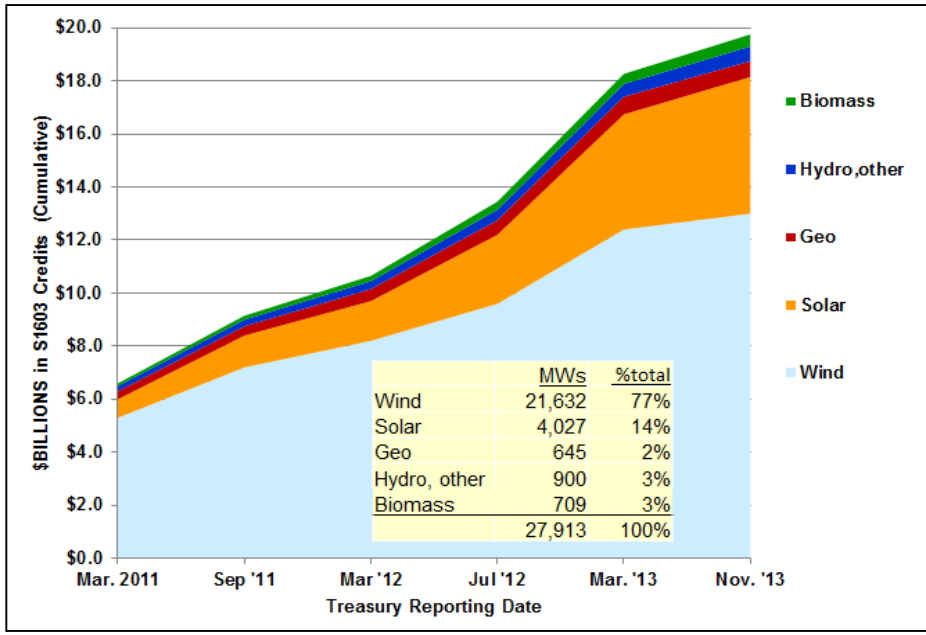
>> Policy Dis-Parity

- DOE CCS R&D Program = $200+ million annually
- Coal provides about 37-40% of U.S. electricity generation
- DOE Office of Energy Efficiency & Renewable Energy = $1.9 billion ($775 million in direct support of renewables)
- Residential rooftop solar provides 0.43% of U.S. electricity generation.

>> Policy Dis-Parity

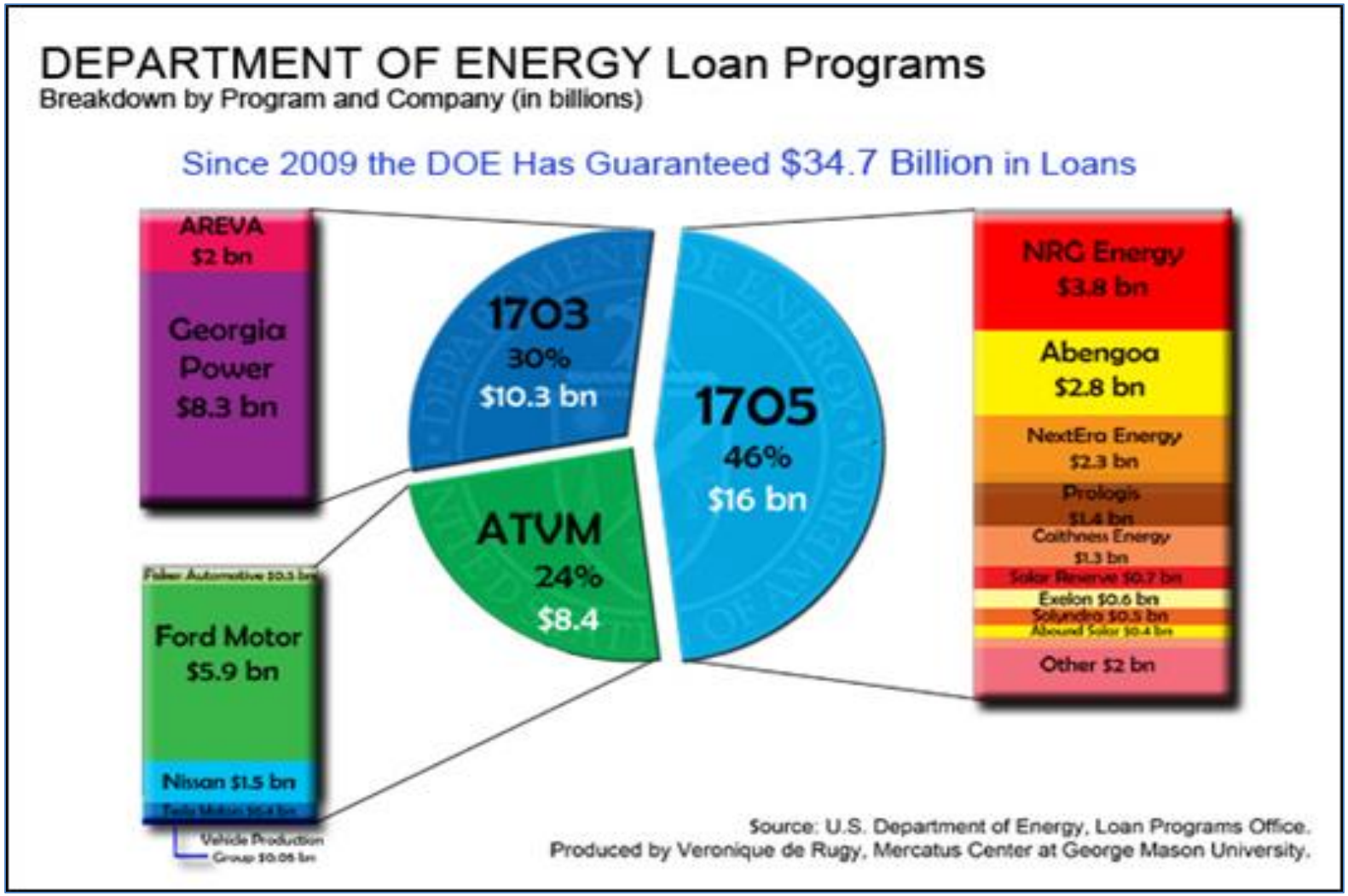


DOE RD&D Budget for Coal:
Excluding $3.4 billion Recovery Act Funding



Treasury Grants:
Subsidies for Renewable Project Deployment in 2009 Recovery Act = $20 billion

>> Policy Dis-Parity



>> Key Recommendation

Funding for CCS RD&D is limited and must be enhanced and focused…

- **DOE continue fostering a portfolio of technologies for implementing CCS and "prime the pump" with early stage funding for promising concepts. NCC recommends that after technologies reach TRL 4, DOE cull its support to only those technologies which show a clear promise of meeting or exceeding DOE's CCS performance goals**

- **DOE continue to develop a plan for demonstrating second generation and transformational CCS technologies showing cost and performance advantage at a scale of 25-50 MW by 2020 and make subsequent budget request to carry out the plan**

>> Key Recommendation

Technology and Funding Incentives must be significantly better coordinated to be effective…

<u>The National Coal Council recommends that:</u>

- **DOE develop a plan to have a total of 5-10 GW of CCS/CCUS demonstration projects in operation in the U.S. by 2025**

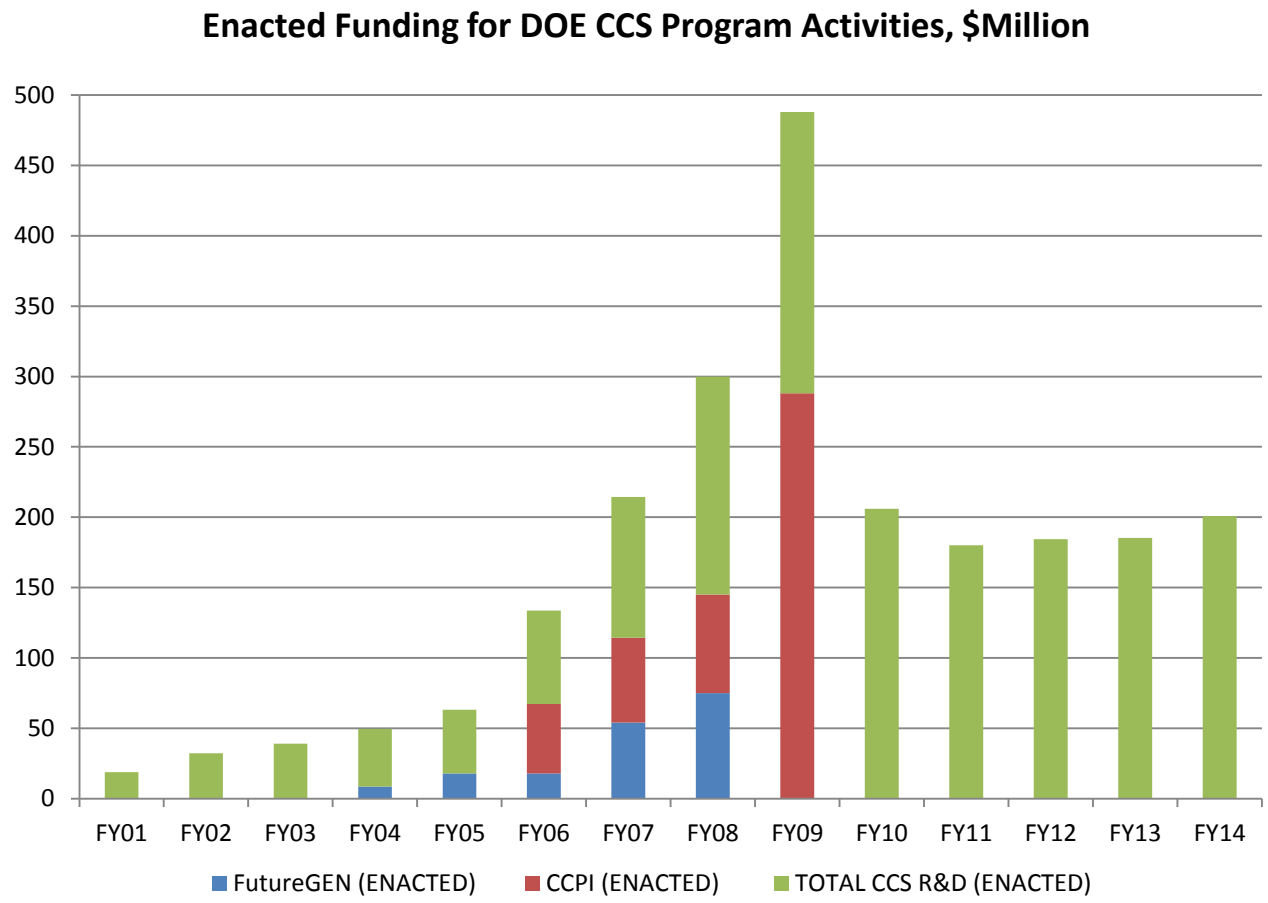
- **DOE expand the RCSP program to identify and certify at least one reservoir in each region that is capable of storing a minimum of 100 million tons of CO2 at a cost of less than $10/ton by 2025**

- **All federal incentives for CCS demonstration projects undergo a coordinated review for their combined adequacy and effectiveness in supporting CCS deployment in time to achieve the installation of storing a minimum of 100 million tons of CO2 at a cost of less than $10/ton by 2025**

- **Concerted effort be undertaken by DOE to identify and pursue creative mechanisms to finance CCS/CCUS projects**

>> Current DOE CCS Program

Funding for DOE programs is inconsistent with DOE goals. DOE programs have been inadequately funded at levels that are insufficient to achieve the aggressive goals of the program.



>> DOE CCPI Program

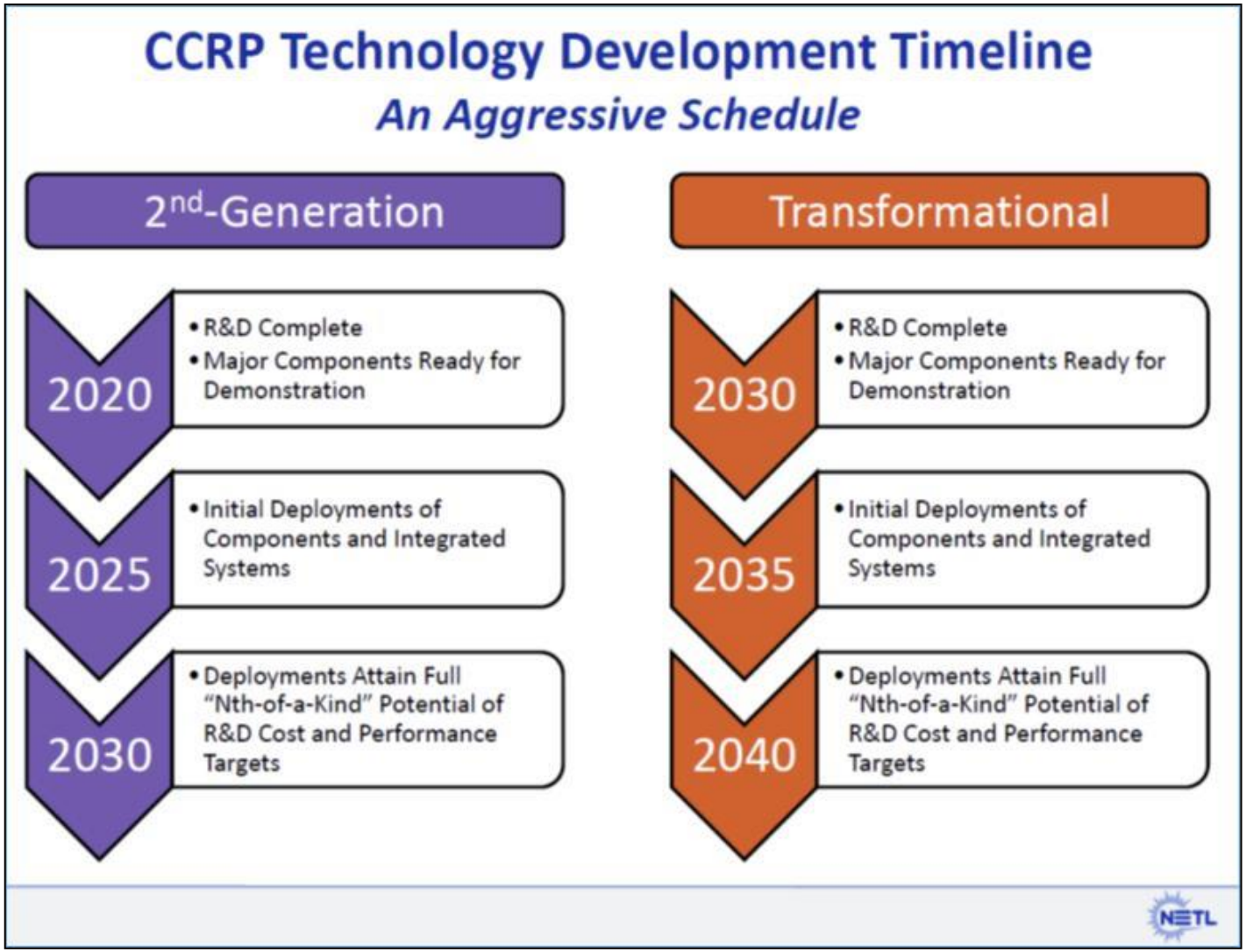
CCPI does not appear to have a high success rate.
Only a small number of projects have been selected for funding.
Ratio of Federal Grant to Total Project Cost = 5-18%

Status	Number of Projects
Complete	4
Active	4
Withdrawn	7
Discontinued	2
Negotiations Ceased	1
Total	18

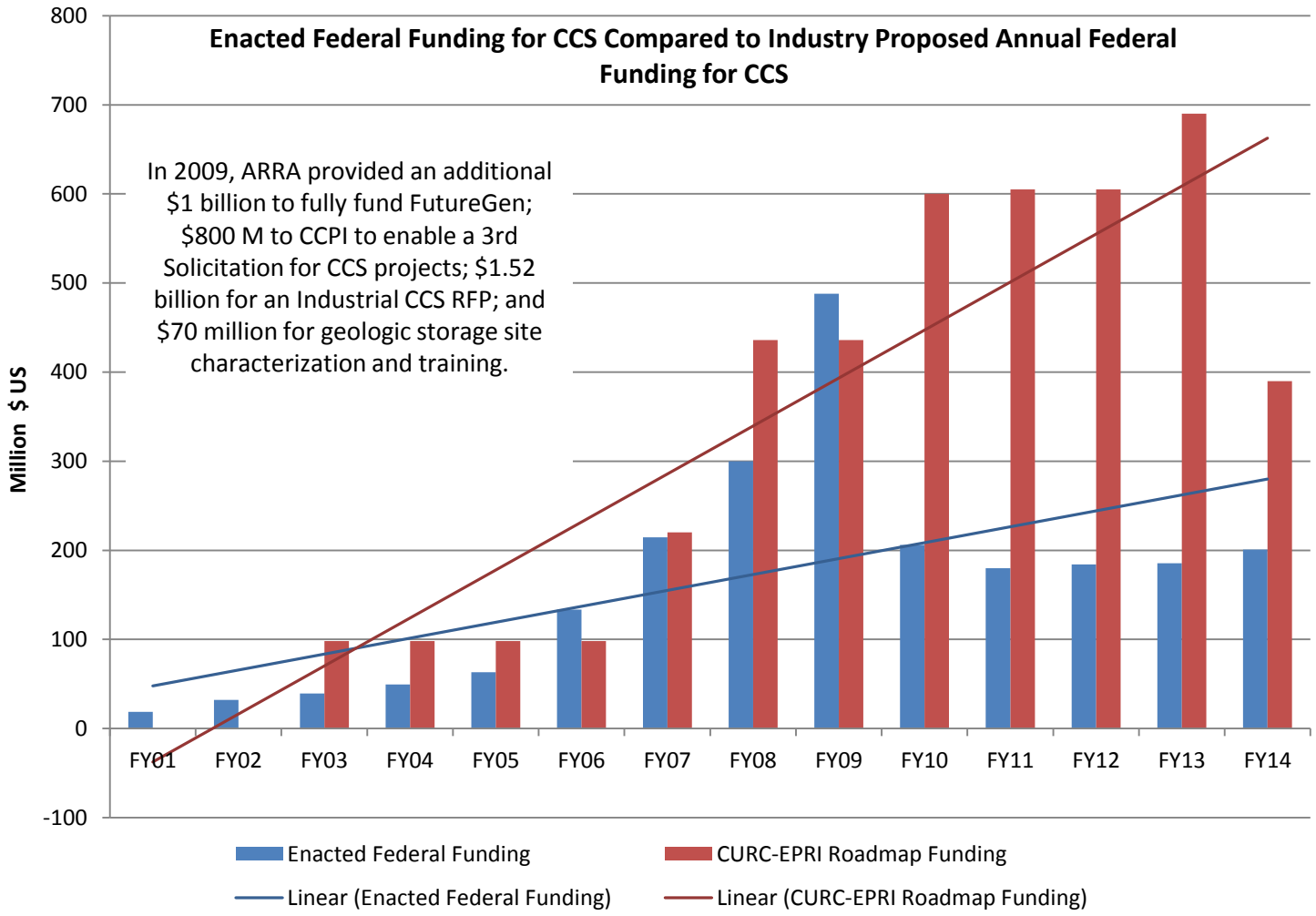
	Applications Submitted	Applications Selected
Round 1	36	8
Round 2	13	4
Round 3	36	6

Project	Total Federal Grant	Total Project Cost	Federal Cost Share
Hydrogen Energy California	$408 M	$4 B	10%
Summit Texas Clean Energy	$450 M	$2.5 B	18%
NRG Energy	$167 M	$1 B	17%
Southern Kemper Energy	$293 M	$6.1 B	5%
Totals	$1.752 B	$13.6 B	13%

>> CCS Gap Analysis Assessment



>> Current DOE CCS Program



Federal Funding vs. Industry Recommended Funding

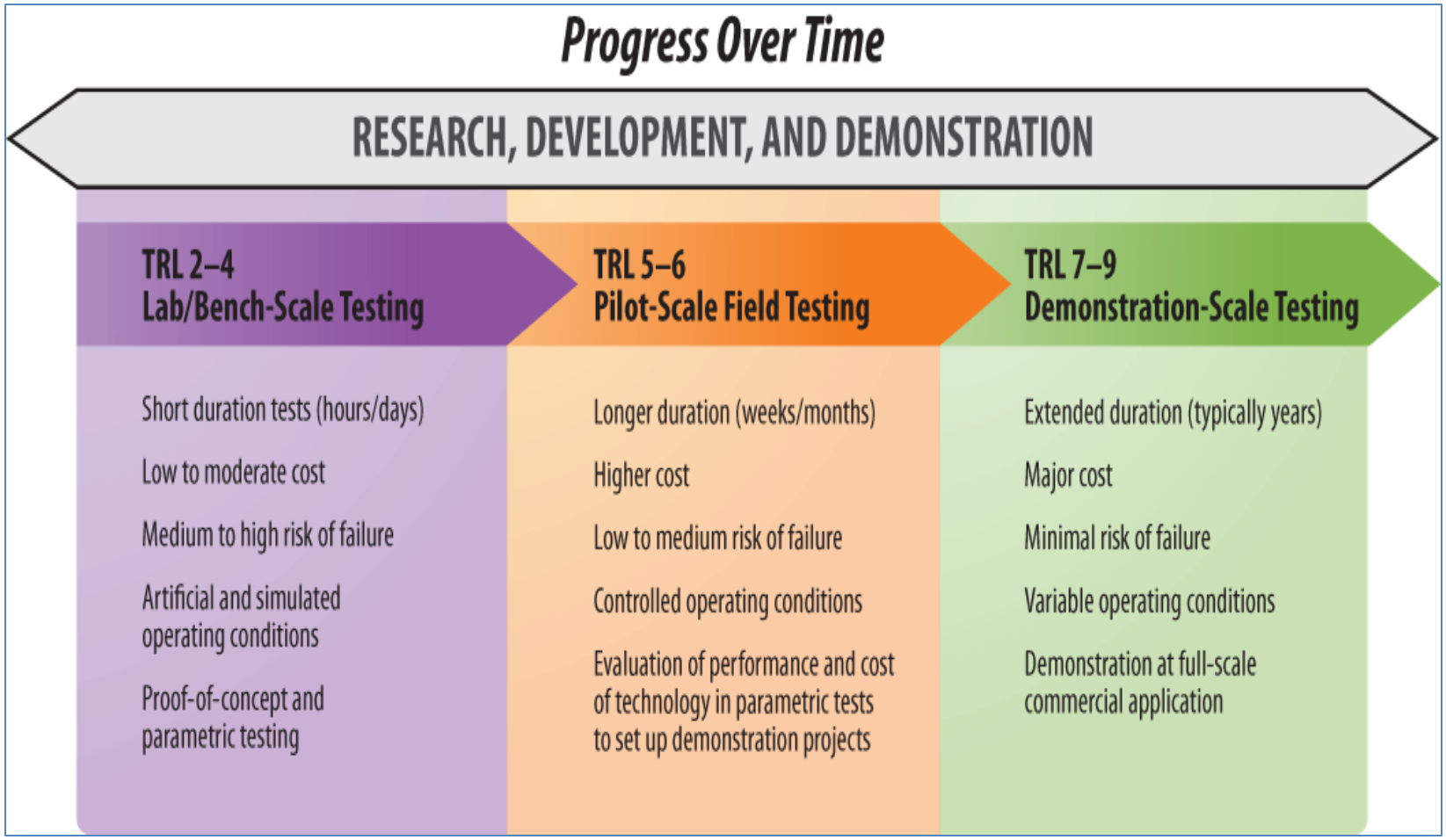
>> Key Recommendation

DOE Program Goals need far greater clarity and alignment with Commercial Technology and Funding Approaches Used by Industry…

- **DOE and Industry prioritize projects critical to achieving goals consistent with the need to bring CCS technologies up to Technology Readiness Level 9**
- **DOE establish interim goals that are more amenable to testing for scale up of CCS technologies that show promise towards meeting the cost and performance goals**
- **A targeted number of projects or GW's be established with dates of operation that are consistent with overall emission reduction targets**
- **Future QER reports examine CCS infrastructure needs for a comprehensive nationwide CCS/CCUS system**
- **DOE undertake a general equilibrium model study to determine if the goal of CCS cost parity by 2035 is adequate and consistent with the overall CO2 reduction goals**

>> Current DOE CCS Program

Stages of CO2 Capture Technology R&D



>> Current DOE CCS Program

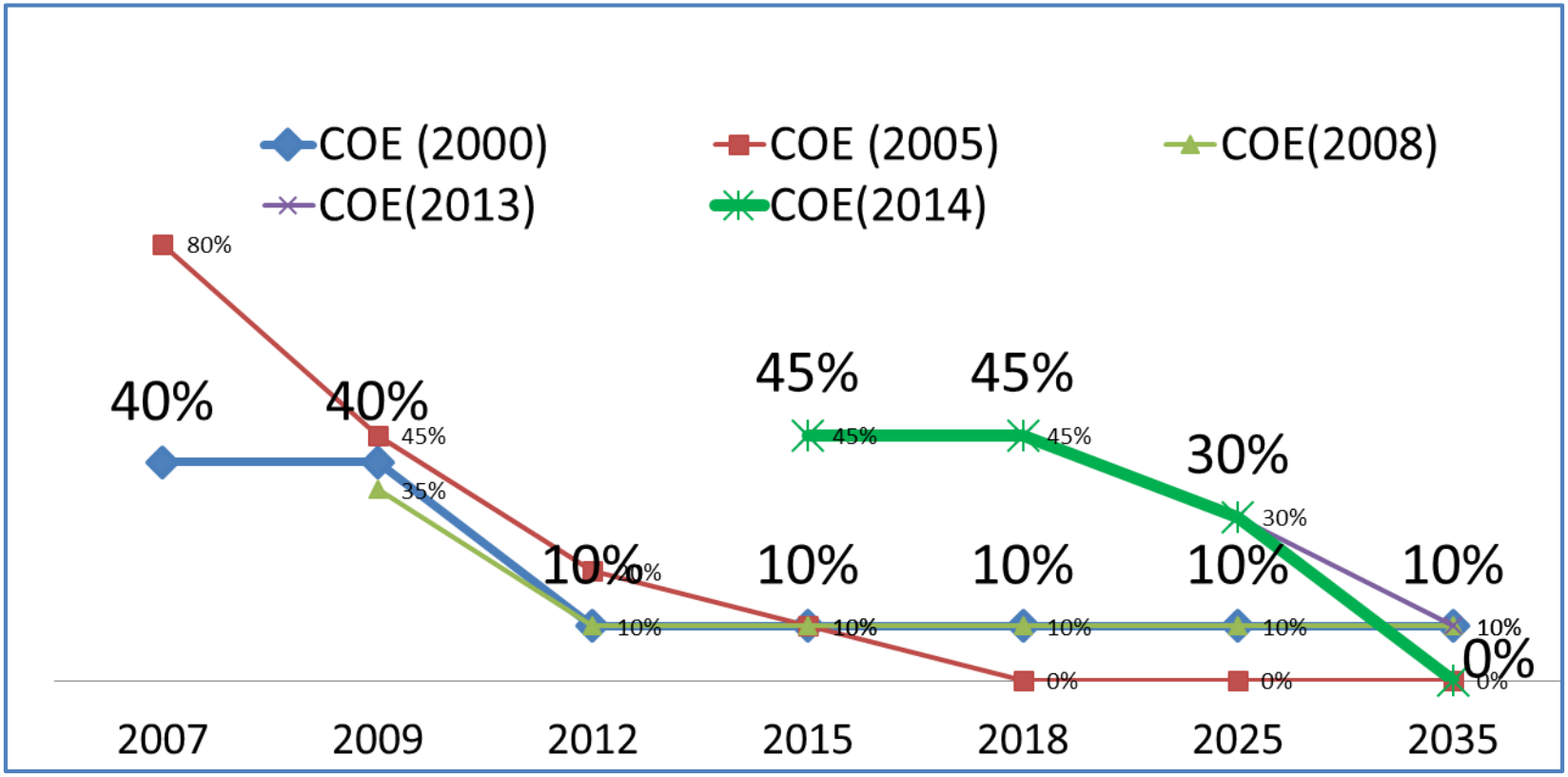
While DOE has enabled advancement of CCS technology, existing portfolio of 70 projects are predominantly small and in early stages of development.

Program Area	Key Technology	Number of R&D Projects					Total
		TRL 1	TRL 2	TRL 3-4	TRL 5-6	TRL 7	
Post-Combustion Capture	*Solvents*		3	9	5	-	**17**
	Sorbents		3	9	2	-	**14**
	Membranes		4	5	1	-	**10**
	Hybrid/Novel		5	3	1	1	**10**
Pre-Combustion Capture	*Solvents*		2	1	→	-	**3**
	Sorbents		2	1	1	-	**4**
	Membranes		2	5	-	-	**7**
	Hybrid/Novel		3	-	-	-	**3**
Compression	*Compression*		-	-	2	-	**2**
TRL Totals			**24**	**33**	**12**	**1**	**70**

Need for fresh, transformational ideas
"Wave" of bench scale projects approaching graduation (1/2 of portfolio)
Up to 12 candidate ≤1MW pilots progressing toward large pilot scale

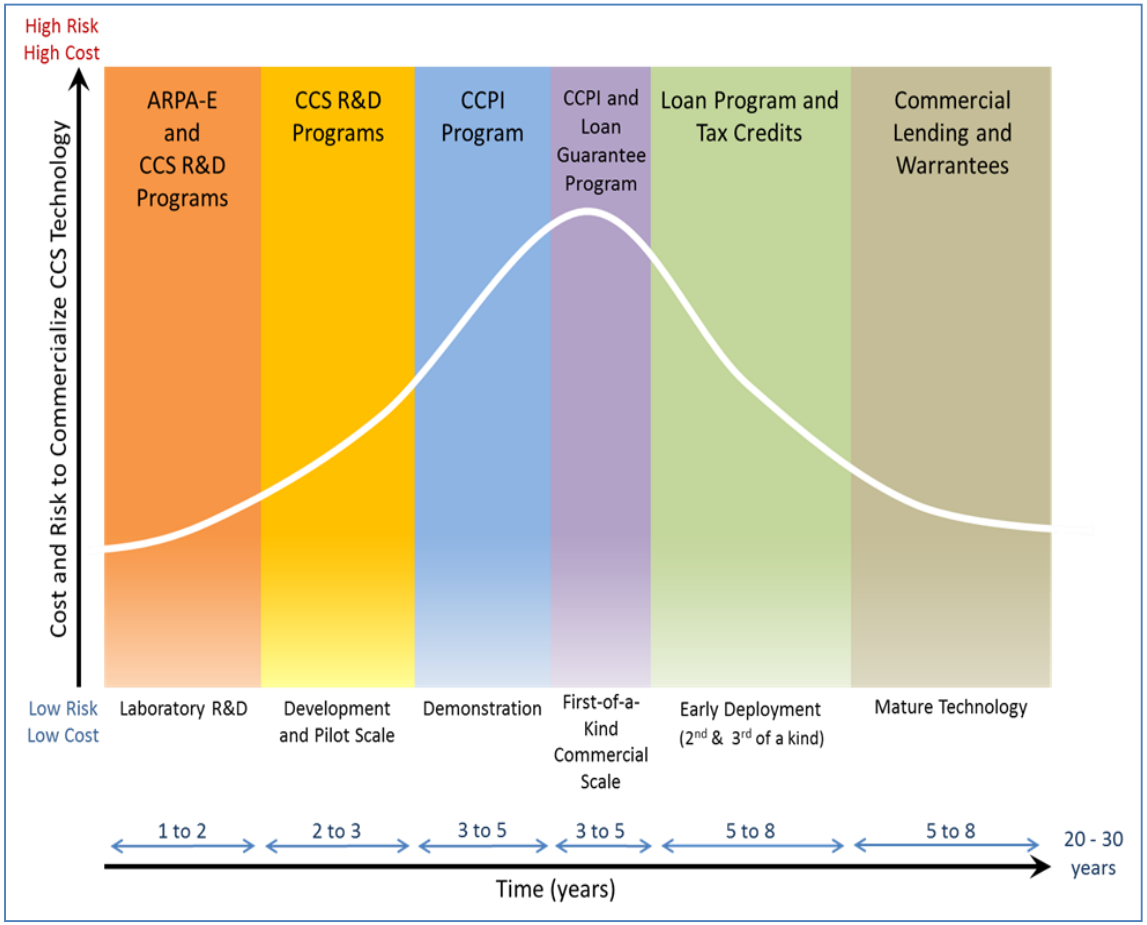
>> Current DOE CCS Program

Timeline of DOE Cost Goals



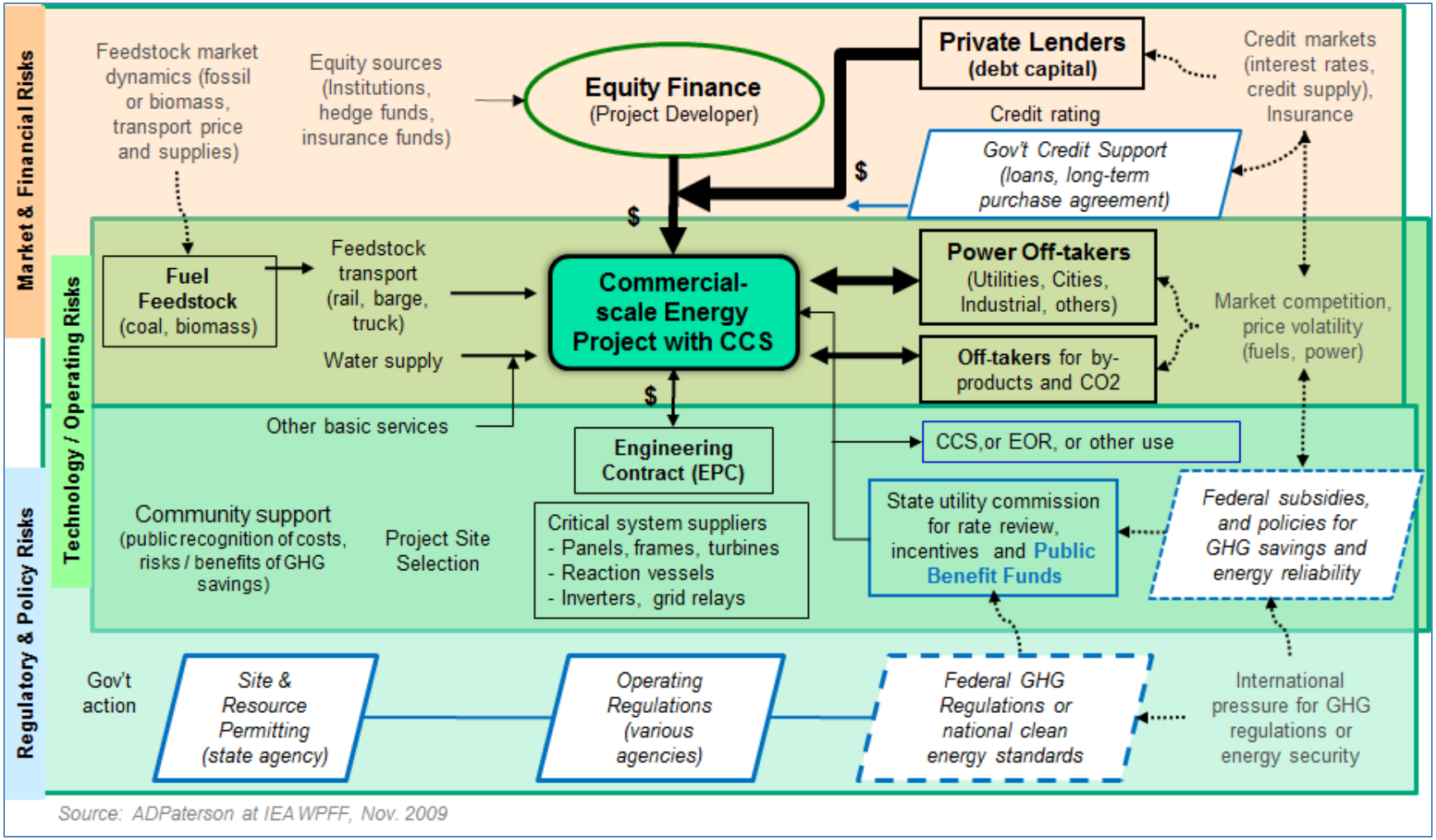
>> Current DOE CCS Program

Capital and operating costs for projects with CCS are more expensive than conventional technologies, carrying greater commercial risk.



Energy Technology Development Spectrum to Commercialize Technology for CCS

>> Current DOE CCS Program



Risk-based Project Analysis Employed in Commercial Scale Underwritings

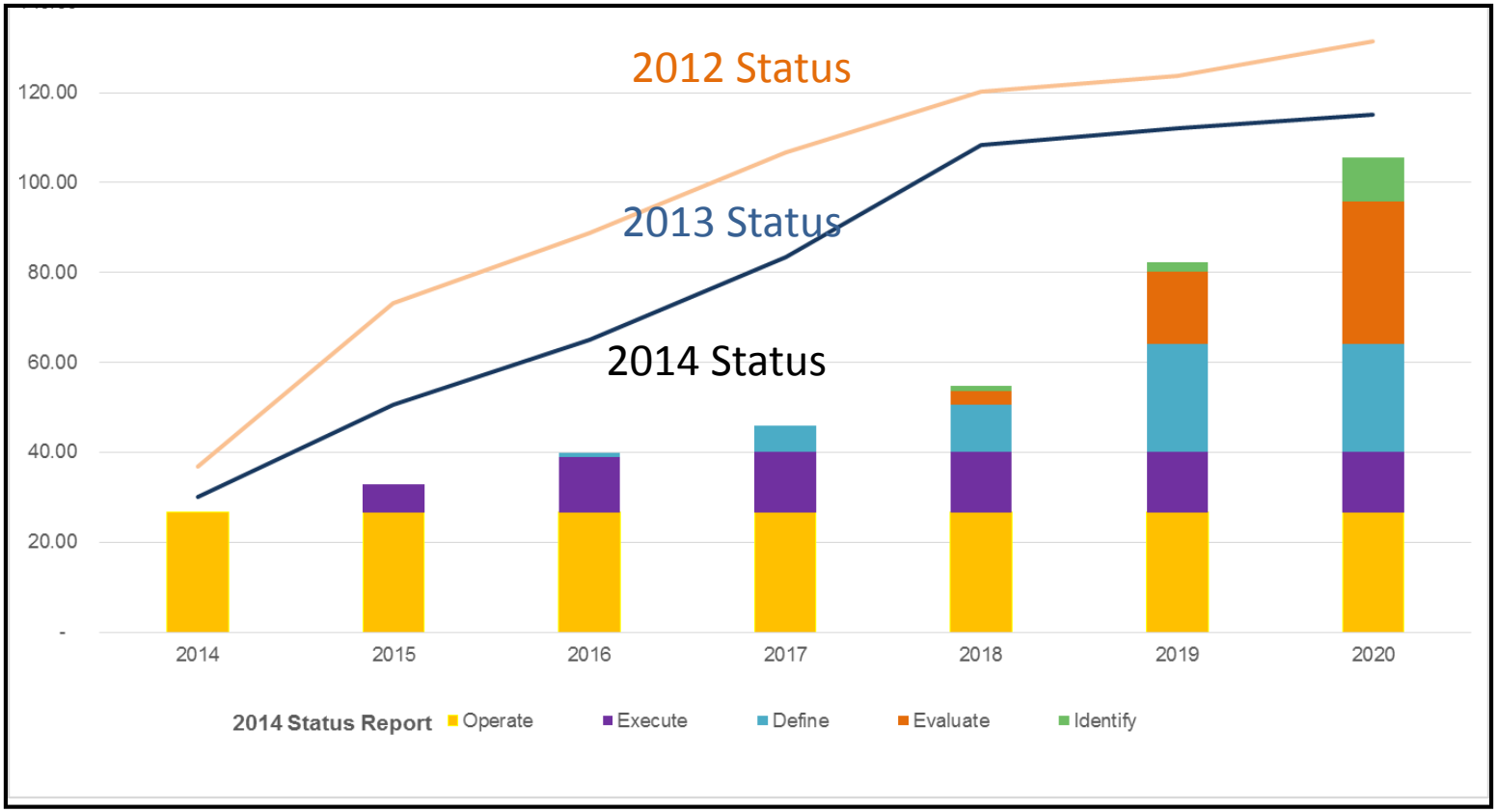
>> Key Recommendation

GHG Control – International Issue in need of International Initiatives

- **DOE maintain its current CCS/CCUS international collaboration efforts including Carbon Sequestration Leadership Forum and US-China Clean Energy Research Center**
- **DOE pursue international partnerships in commerce for CCS/CCUS demonstrations in CO2 intensive developing nations. Focus to be given to CO2 utilization and storage projects to increase global knowledge and acceptance of commercial scale CO2 storage**
- **DOE actively advance the recently announced collaboration with China on a water producing, commercial scale CCUS project**
- **DOE propose an international pool of funds specifically set up for the implementation of CCS demonstration projects at scale**
- **DOE consider programs and policies to promote the purchase of US manufactured CCS equipment for international CCS demonstration projects**

>> Global Status of CCS/CCUS

The planned amount of CO_2 captured and stored is declining and nowhere near the tons required.



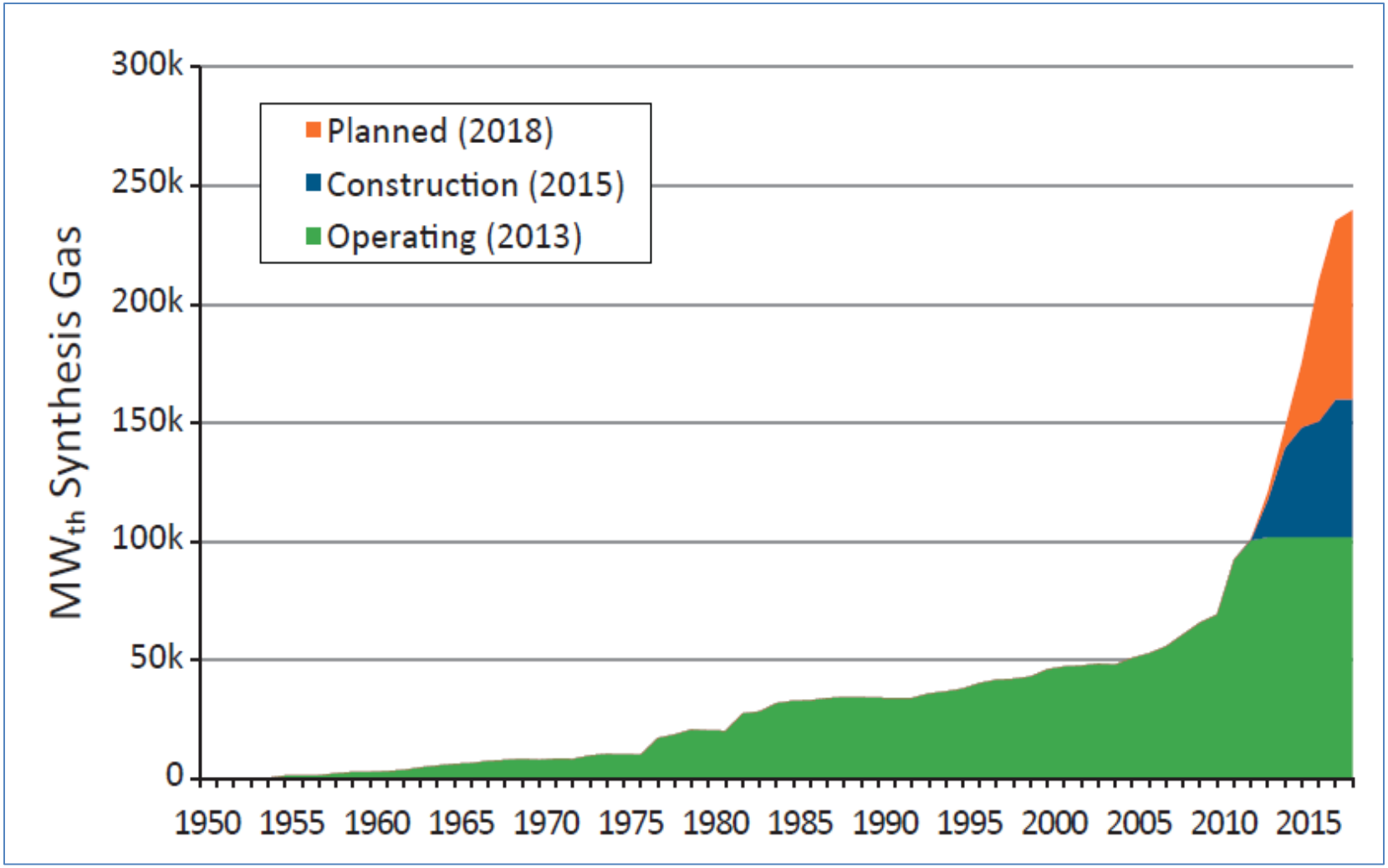
CO2 Potentially Stored by Projects in Pipeline

>> International Partnerships

U.S.–China Clean Energy Research Center
中美清洁能源研究中心

carbon sequestration leadership forum

>> Global Status of CCS/CCUS



Global Gasification Projects

>> Key Recommendation

Public Acceptance continues to be a major hurdle…

- **DOE increase its existing CCS/CCUS public engagement, education and training activities targeting counties and states with demonstration projects and regions that have potential infrastructure developments**
- **DOE incorporate into its outreach/education program experience from existing projects, including direct discussions with people that operate such projects and those that live near them**
- **DOE create a University Carbon Systems Research Program so as to place engineering students in summer internships focused on CCS/CCUS technologies**

FOSSIL FORWARD

Revitalizing CCS
Bringing Scale and Speed to CCS Deployment

Janet Gellici – jgellici@NCC1.org – www.NationalCoalCouncil.org

NCC History of Support for Advanced Coal Technologies

NCC 9 Major Studies on Carbon Management 2000-2015

- R&D Needs for Sequestration of CO2 – May 2000
- Coal-Related GHG Management – May 2003
- Coal: America's Energy Future – March 2006
- Technologies to Reduce or Capture & Store CO2 – June 2007
- The Urgency of Sustainable Coal – May 2008
- Low Carbon Coal: Meeting U.S. Energy, Employment & CO2 Emissions Goals with 21st Century Technologies – Dec. 2009
- Expediting CCS Development: Challenges & Opportunities – March 2011
- Harnessing Coal's Carbon Content to Advance the Economy, Environment & Energy Security (CCS-EOR) – June 2012
- **Fossil Forward – Revitalizing CCS:**

  Bringing Scale & Speed to CCS Deployment – January 2015

NCC History of Consistent Findings & Recommendations

- **Enhancing efficiency** of existing coal fleet is a **first step** toward reducing CO2 emissions; **New Source Review (NSR) disincentivizes** power plant operators from pursuing efficiency improvements
- R&D must be pursued simultaneously on numerous GHG technologies and storage options with the **aim of developing a portfolio of options** suitable for various applications
- Employ DOE-industry partnerships to **demonstrate technologies on a large-scale** basis to reduce technology costs and expedite commercial availability
- **International partnerships** are necessary to advance GHG technology solutions and global adoption
- **Financial incentives** and federal funding support are vital, especially for early mover and FOAK projects
- Deployment of CCS/CCUS technologies offers the most impactful opportunity to achieve CO2 emission reductions