NATIONAL COALCOUNCIL

>> FOSSIL FORWARD

Revitalizing CCS: Bringing Scale & Speed to CCS Deployment

Chapter D – CCS/CCUS Deployment Challenges

Scale of CO_2 Capture and Utilization

The capture, storage and/or utilization of CO_2 on a global basis will entail enormous challenges at the scale at which technologies would need to be deployed to mitigate these emissions.

- Global CO_2 emissions in 2013 were 36 billion tons and are projected to grow to 2,062 billion tons in 2050. IEA estimates that only 884 billion could be safely emitted in 2050 to meet CO_2 reduction goals.
- By comparison, the highly successful Title IV SO_2 cap and trade program in the U.S. was targeted to reduce SO_2 emissions from 10 million tons/year down to 5 mt/year.
- The global amount of CO_2 to be captured for CCS/CCUS exceeds the largest production industries of the world, e.g. coal (world production 7.8 billion tons in 2013) and oil (world production 4.2 bt in 2013).

Commercialization Requires Adequate Time & Effort

The typical development and commercialization of a new technology in the power industry generally progresses through:

1. Invention and laboratory conceptual stage
2. Small sub-pilot and pilot testing phase
3. Small, slip stream field testing stage
4. Field demonstration stage
5. Early commercial deployment

The term “commercially viable” is different from "commercially available.” Commercially “viable” means a technology has achieved at least TRL 7 or 8, and been evaluated to have the potential to be commercially "available." *A technology can be deemed "available" if it meets the following criteria:*

- 1 year of operation with 70% availability at scale within 5 years after start up
- Reasonable cost and performance: performance objectives are met, and project finance can be obtained without the need for a consortium

Survey Results

NCC conduct a survey of individuals in the coal and power industries, academia and other stakeholders to assess their perspective of whether DOE’s assistance was helpful in achieving their technology goals. The survey was sent to 250 people; 48 responded for a response rate of 19%. About half the respondents received some form of DOE support on CCS/CCUS projects and of these 59% achieved their project goals.

	By 2020	By 2025	By 2030	By 2035	By 2040	Longer
CCS	5%	39%	32%	0%	7%	17%
CCUS	29%	44%	0%	18%	0%	9%

Survey Results – Respondents' Projections on When CCS/CCUS Could Become Commercially Available

Main element		Key Factor	Not a factor
CCS/CCUS		**40%**	**11%**
	Combustion Tech.	49%	4%
	Gasification Tech	49%	9%
	Transportation	11%	17%
	Storage	51%	7%
	Capture	71%	2%
	Efficiency	26%	20%
	Public Acceptance	18%	9%
	Safety	20%	2%
	Cost reduction	14%	7%
	Operations progress	18%	7%
CCS		**47%**	**6%**
CCUS		**40%**	**11%**

Survey Results – Value of DOE Assistance in Achieving CCS/CCUS Objectives

First Generation Technologies: Deployment Challenges

First generation technologies include mono-ethanol-amine (MEA) scrubbing, chilled ammonia scrubbing, oxy-combustion and IGCC with CO_2 capture. The primary challenge to commercial deployment of these technologies is the increased capital cost of the plant compared to a conventional plant which results in an increased cost of electricity (COE). High costs have been a barrier to further commercialization; in order to overcome these cost disadvantages, second generation technologies are being developed.

Second Generation Technologies: Deployment Challenges

CO_2 Conversion Technologies include:

- Biomass based transportation fuels, according to the IEA will reach ∝ 27% by 2050.
- Cement, minerals, plastics, enhanced fixation of biomass, and CO_2 as chemicals feedstock.

Greater investment in these technologies will help fulfill the potential of CO_2 utilization.

Use of CO_2 as Feedstock for Chemical Industries:

- CO_2 is used in various chemical processes, and for the synthesis of organic compounds.
- Global CO_2 demand for urea amounts to over 115 million tons/year of CO_2; could reach 84 mt/year.

CO_2 Use in Other CCS/CCSU Technologies:

These technologies are currently in the R&D stages. Development would require major investments.

- CO_2 consuming inorganic binders for cement and concrete and mineral carbonation.
- Chemical looping
- Algae production; micro organisms; renewable methanol; CO_2 enhanced water recovery

Key Findings

Among the challenges to development, deployment, and commercialization of CCS/CCUS at power plants:

- Lack of infrastructure for transport and storage of captured CO_2 in massive quantities
- Financing power plants with CCS/CCUS is a major issue
- Legal and regulatory issues still remain unresolved
- Public acceptance is still an issue
- First generation technologies are costly; second generation technologies are in early development stages.
- Economics of CO_2 utilization, which must be considered as a storage option
- General equilibrium models should be used with caution
- Policy mismatch of DOE energy programs for CCS/CCUS funding. Policy parity would provide more energy options for the US.

http://www.nationalcoalcouncil.org/studies/2015/Fossil-Forward-Revitalizing-CCS-NCC-Approved-Study.pdf