>> FOSSIL FORWARD

Revitalizing CCS: Bringing Scale & Speed to CCS Deployment

Principal Recommendations

Fossil fuels will remain the world's dominant energy source for decades to come.
If the world is to address climate change by reducing CO_2 emissions, the key approach will not be replacing fossil fuels, but addressing CO_2 emissions from them.

- **In order to achieve CCS deployment at commercial scale, policy parity for CCS with other low carbon technologies and options is required.**
  - > Policy parity for CCS in funding, extending tax credits and other subsidies provided to renewable energy sources will facilitate creation of a robust CCS industry in the U.S., benefitting the American people and leading to the development of lower cost, near zero emission energy technology.
- **Technology and funding incentives must be significantly better coordinated to be effective.**
  - > A plan is needed to ensure a total of 5-10 GW of CCS/CCUS demonstration projects are in operation in the U.S. by 2025. Federal incentives, including feed in tariffs, tax credits, production credits, loan guarantees and "contracts for difference," must be reviewed for their combined adequacy and effectiveness in supporting CCS deployment.
- **DOE program goals need far greater clarity and alignment with commercial technology and financing approaches used by industry.**
  - > A DOE-industry task force should be convened to clearly define the role and objectives of individual projects in achieving broad program goals, to achieve a better understanding of industry technology and investment goals, and to prioritize projects in light of limited budgets and the need to advance CCS technologies to Technology Readiness Level 9.
- **Funding for CCS RD&D is limited and must be enhanced and focused.**
  - > While "priming the pump" with early stage funding for promising technology concepts is important, budgetary constraints and the need to move more quickly to advance large-scale CCS projects dictates a need for DOE to cull its support for technologies that show a clear promise of meeting or exceeding the Department's CCS performance goals.
- **Public acceptance continues to be a major hurdle.**
  - > There is a need to accelerate DOE's efforts in CCS/CCUS public engagement, education and training activities, especially those targeting counties and states with demonstration projects and regions with potential infrastructure sites.
- **Control of GHG emissions is an international issue in need of international initiatives.**
  - > In addition to maintaining existing CCS/CCUS international collaborative efforts, such as the Carbon Sequestration Leadership Forum (CSLF) and the U.S.-China Clean Energy Research Center (CERC), international partnerships in commerce should also be pursued. Fostering CCS/CCUS demonstrations projects in developing nations could provide a low-cost means to increase global knowledge and acceptance of commercial scale CO_2 storage.

NATIONAL COAL COUNCIL

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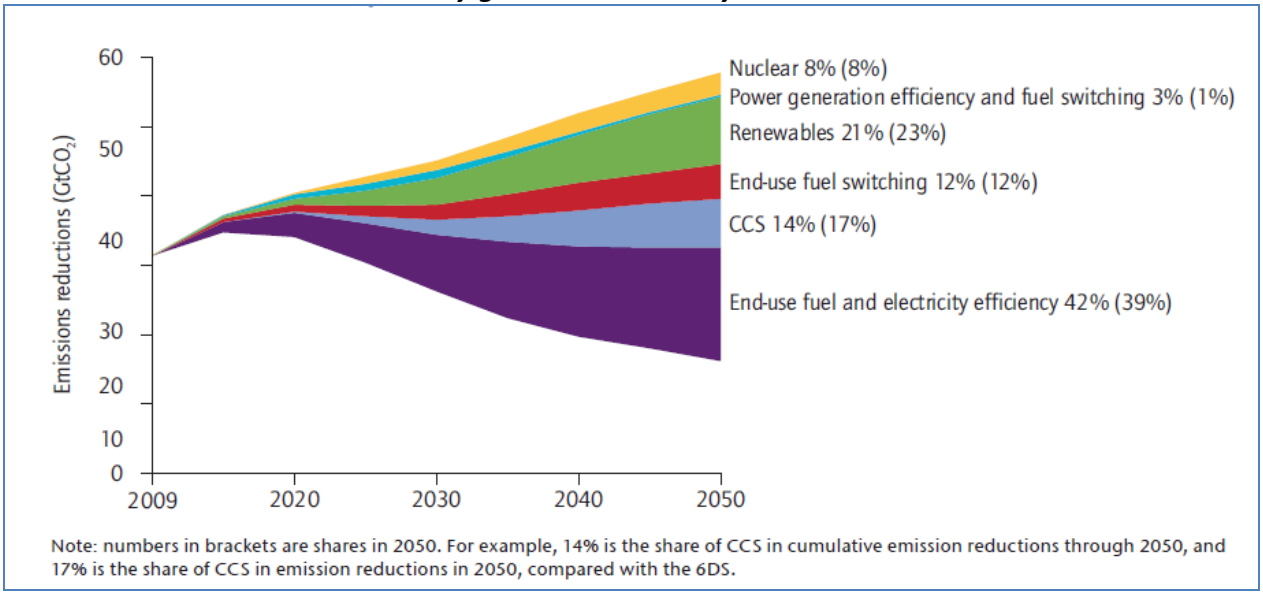
"I am writing to request the National Coal Council (NCC) conduct a study that assesses the value of the Department of Energy's (DOE) Carbon Sequestration Program … What is industry's assessment of the progress made by the DOE and others regarding cost, safety and technical operation of CCS/CCUS? In other 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?"

U.S. Energy Secretary Ernest J. Moniz – May 2014

The National Coal Council's study's basic theme is that while the DOE is indisputably a world leader in the development of CCS technology, the DOE CCS/CCUS program has not yet achieved critical mass. The NCC's "Fossil Forward" assessment supports the findings that:

- CCS is the only large-scale technology that can mitigate CO_2 emissions from fossil fuel use for electricity generation and key industrial sectors, including cement production, iron and steel making, oil refining and chemicals manufacturing.
- Not including CCS as a mitigation technology is projected to increase the overall costs of meeting CO_2 emissions goals by 70%-138%.
- U.S. CO_2 emissions represent less than 16% of world emissions, thus global and wide-scale implementation of CCS is necessary to meet CO_2 reduction goals.
- Capital and operating costs for projects with CCS are more expensive than conventional technologies and carry greater technology and commercial risk. Project risks include financing, permitting, public acceptance, cost overruns, schedule delays, performance, environmental compliance, operational flexibility and long-term liability.
- Funding remains a major challenge. All existing large-scale projects have a combination of public and private funding to help minimize risk exposure. Projects generally include a basket of federal and state/provincial incentives such as grants, tax credits or loan guarantees.
- Significantly more CCS/CCUS pilot and demonstration projects are needed in order to commercially deploy the technology. Without adequate demonstration, there can be no commercialization of CCS/CCUS.
- DOE has a world leading CCS RD&D portfolio. DOE programs consist of numerous relatively small projects in the early stages of development; program goals, however, are presented in terms of performance and cost of NOAK (nth-of-a-kind) commercial systems. This makes it impossible to objectively assess progress against DOE program goals.
- 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. The current basket of incentives has not been effective in advancing demonstration projects.
- There is a policy mismatch between CCS/CCUS technology funding and other DOE energy programs. Policy disparity is inhibiting the advancement of CCS/CCUS technology deployment.
- Control of greenhouse gas (GHG) emissions is a global problem in need of global solutions. DOE has undertaken important steps to form international collaborations but more will be needed.

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



IEA Technology Road Map

The International Energy Agency (IEA) found that a diverse set of technologies would be required to meet global GHG emissions reduction goals. IEA estimated that CCS would provide about 14% of the cumulative needed emissions reductions by 2050 or 17% of the yearly reductions in 2050. Therefore, not only is CCS critical, but its relative importance is projected to grow over time. It is also important to recognize that IEA's goal assumes very significant efficiency improvements and renewables growth. If either of these does not occur at the rates shown, it is most certain that fossil fuels will fill the remaining gap, thus further increasing the need for wide spread global deployment of CCS. CCS is the scalable hedge against failure to achieve renewable or efficiency goals.

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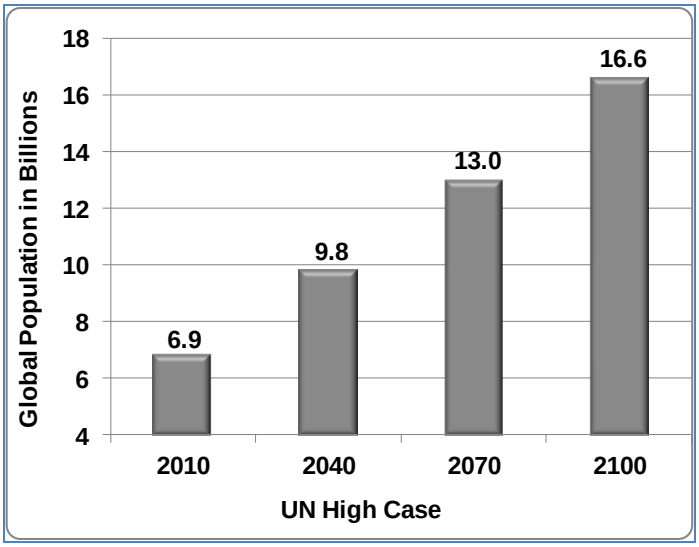
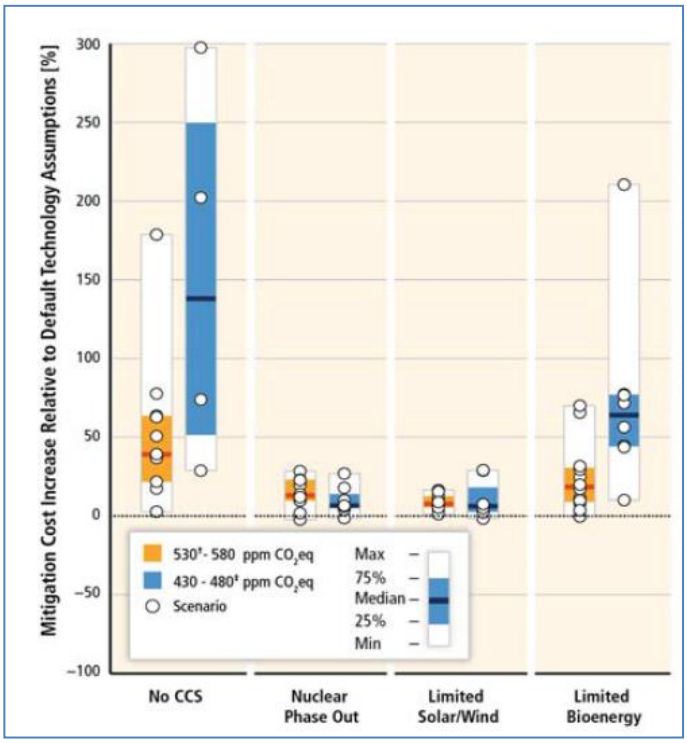


United Nations Global Population Projection: High Case

The United Nations' (UN) projections on population growth continue to show increases beyond 2050 up to 2100. The UN's high case projections indicate that world population could conceivably double in the next two generations. These additional people will need more power, more food, more drinking water, and other basic requirements that will only make CO_2 reductions that much more difficult without CCS.



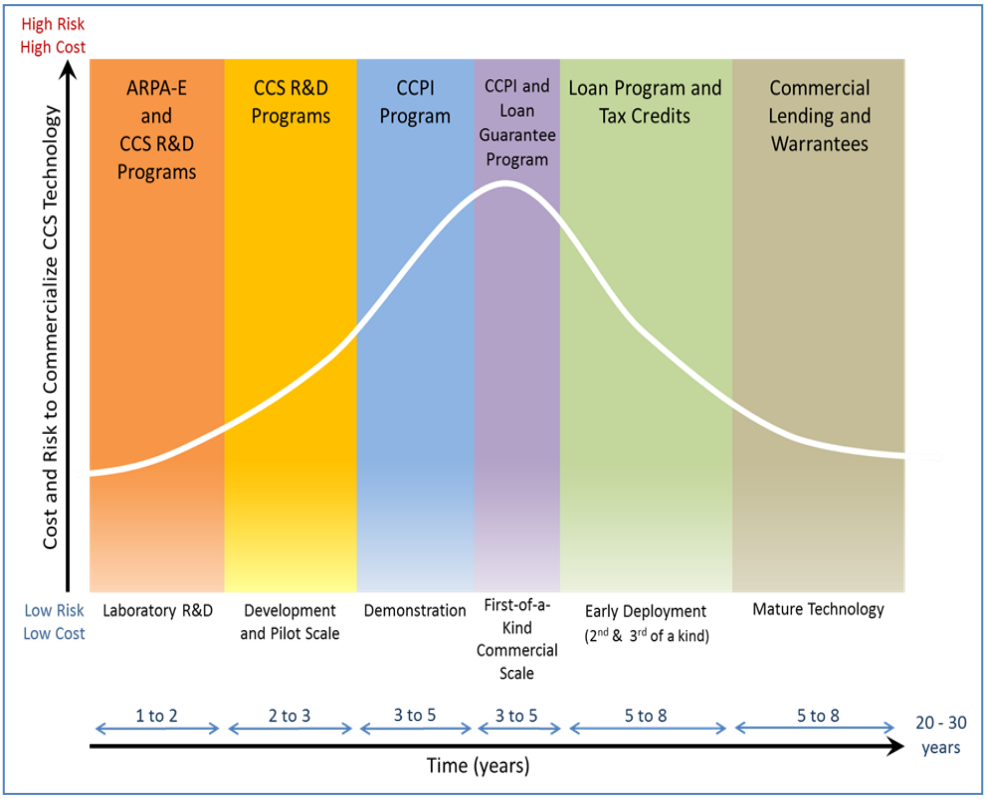
Not including CCS as a mitigation technology is projected to increase the overall costs of meeting CO_2 emissions goals by 70%-138%.

The mitigation cost without CCS would increase relative to a global energy scenario with default technology assumptions. The increase in cost estimated by the IPCC was about 138% (median estimate), significantly greater than the IEA's assessment of a 70% increase. By comparison, a nuclear phase out would increase the median cost by only ~7%. Similarly, if wind and solar expansion was limited, the increase in global mitigation costs would also increase by only ~6%. While these figures are only estimates, the relative magnitudes are significant.

Climate Change Mitigation Costs Without CCS and Other Technologies

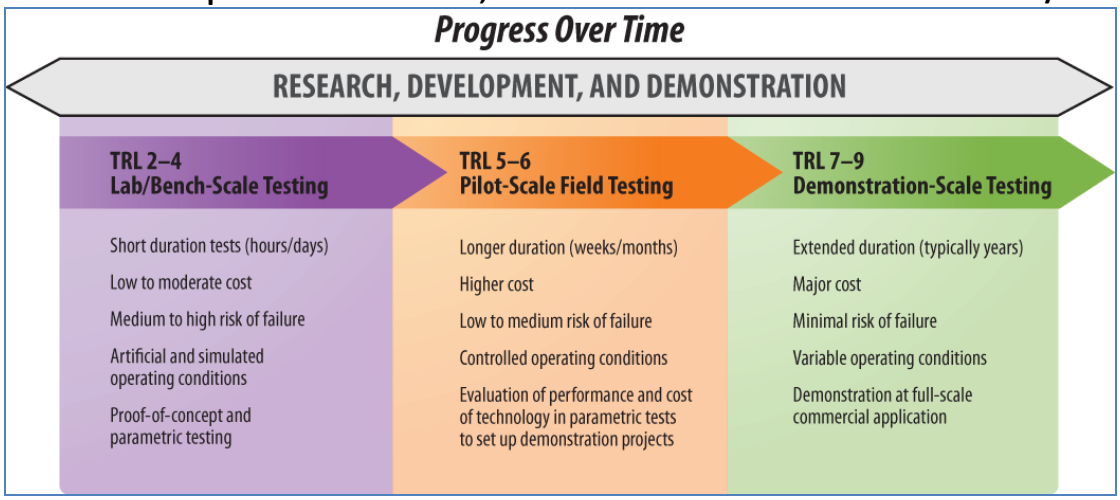
Capital and operating costs for projects with CCS are more expensive than conventional technologies and carry greater technology and commercial risk.

While DOE's Loan Guarantee program provides significant assurance financially and will certainly lower borrowing cost, the program does not cover technology risk or performance risk. These risks need to be satisfied to bring in conventional bank financing and normally require the contractor/developer to provide a wrap guarantee, possibly a parent guarantee, or guaranteed off take agreements, which are troublesome to provide until the technical risk has been overcome. Providing guarantees has proven troublesome on projects to date and has been a leading cause of the inability to finance certain projects, resulting in significant and costly delays.



Energy Technology Development Spectrum to Commercialize Technology for CCS

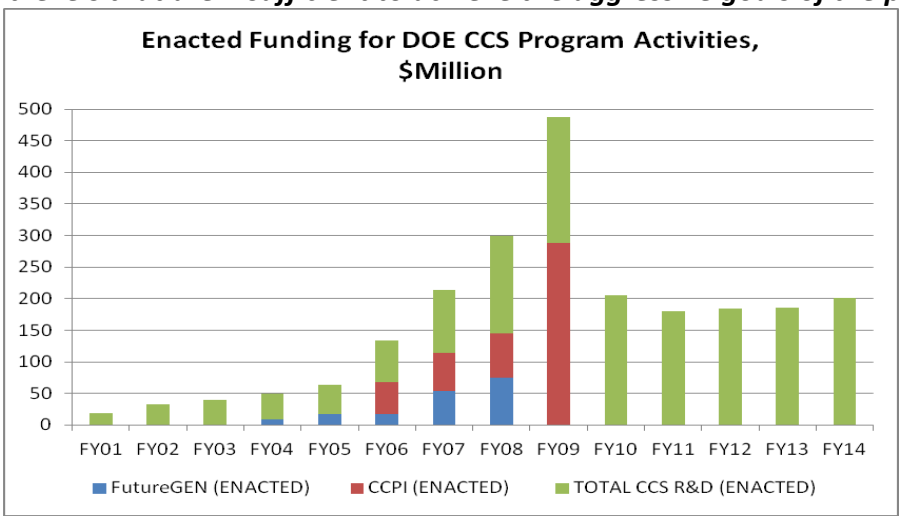
Significantly more CCS/CCUS pilot and demonstration projects are needed. Without adequate demonstration, there can be no commercialization of CCS/CCUS.



Stages of CO_2 Capture Technology R&D – Technology Readiness Level (TRL)

At the present time, none of the DOE CCS programs have evolved above TRL level 6, the pilot scale field testing in the 10 – 50 MW range. The Kemper County IGCC plant will be the first IGCC plant with CCS and, if successful, would be at TRL 8. The PetraNova plant would be at TRL 7. The Boundary Dam demonstration project would be at TRL 7, after some longer period of successful operation. It should be pointed out that commercialization occurs after the successful completion of TRL 9. None of the technologies, thus far, have completed TRL 9, which includes extended operation (typically years) at full scale.

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.



Federal Funding for DOE CCS Program Activities

Annual federal funding has historically supported budgets for R&D activities, but has not supported the significantly larger federal budgets necessary for demonstrations and large scale projects such as FutureGen, which are necessary to advance CCS towards commercial deployment. Federal funding for the CCS R&D program since 2001 has totaled over $1.6 billion, but has been widely distributed to small R&D scale projects supported by the DOE CCS R&D program. More than half of the $1.6 billion funded through the R&D program has been allocated to the CO_2 sequestration program and the Regional Carbon Sequestration Partnerships, yet the budgets for that R&D program are still not sufficient to support the large scale demonstrations contemplated at one million tons/year that are needed to advance to the next phase of geologic storage on the path towards commercial operation.