Carbon Capture, Utilization, and Storage

Presentation to the USEA

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October 27, 2016

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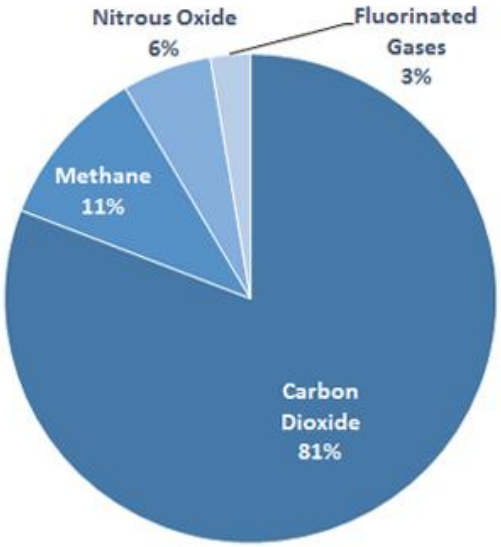
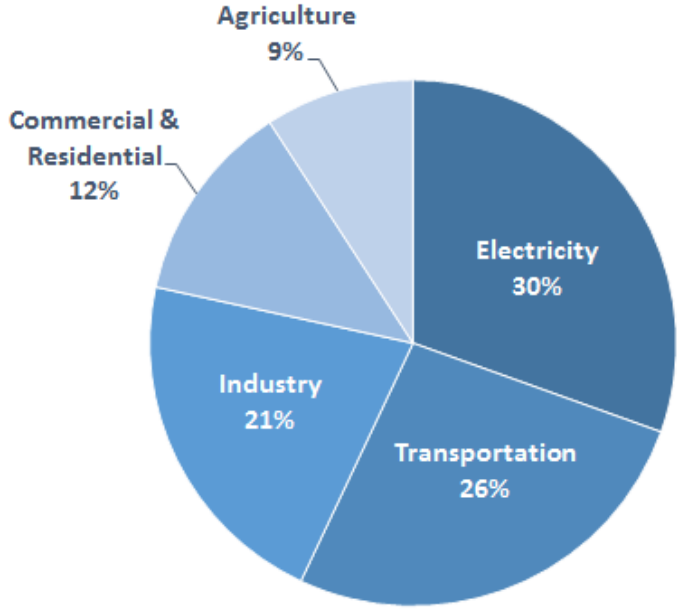
U.S. Greenhouse Gas Emissions in 2014

U.S. Greenhouse Gas (GHG) Emissions



U.S. GHG Emissions by Sector



Total: 6,870 Million Metric Tons (MMT) CO_2-e

Electricity: 2,081 MMT CO_2-e
Industry: 1,462 MMT CO_2-e

- **CCUS is applicable to > 50% of U.S. CO_2 emissions**
- **CCUS is a key option to deeply decarbonize industry**
  (e.g. process emissions from cement, iron and steel, refining, some chemicals)
- **CCUS enables deep decarbonization pathways (e.g. BECCS)**

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Source: United States Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014

Role of CCUS in Global Climate Mitigation

CCUS provides 13% of emissions reductions by mid-century in the International Energy Agency's scenario to limit global temperature increase to 2° C.

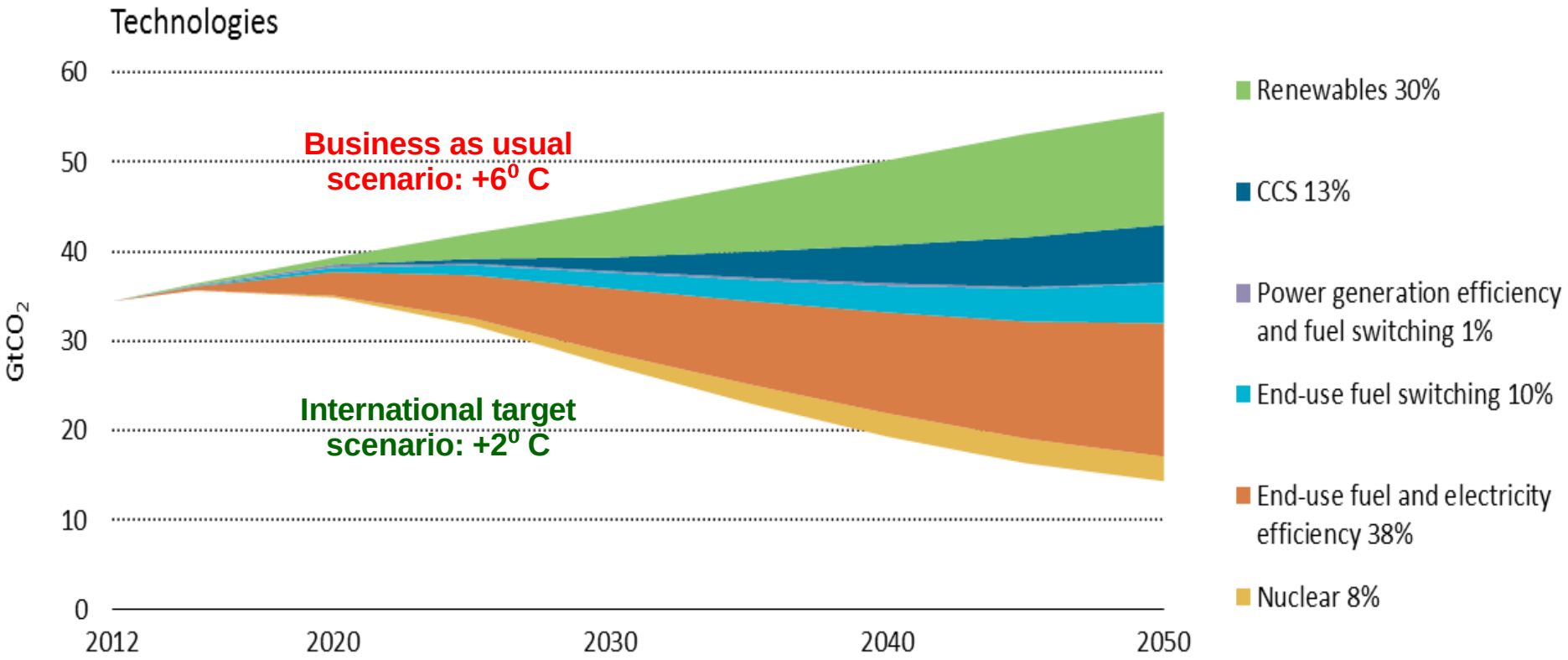

Figure source: International Energy Agency, Energy Technology Perspectives, 2015

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Without CCUS, a 450ppm Scenario is Highly Unlikely, and More Costly

60% of primary energy must be low carbon by 2050; >90% by 2100

- The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Synthesis Report (AR5) concluded that **without CCUS:**
  - Realizing a scenario with less than 2°C of global temperature rise **may not be possible** and the **costs of mitigation could increase by 138 percent**

Mitigation costs increase with limited availability of technologies

(Percent change relative to default technology assumptions)

2100 concentrations (ppm CO_2-eq)	no CCS	nuclear phase out	limited solar/wind	limited bioenergy
450 (430 to 480)	138% (29 to 297%) 4	7% (4 to 18%) 8	6% (2 to 29%) 8	64% (44 to 78%) 8

Legend—fraction of models successful in producing scenarios
(numbers indicate the number of successful models)

- : all models successful
- : between 80 and 100% of models successful
- : between 50 and 80% of models successful
- : less than 50% of models successful

Source: Intergovernmental Panel on Climate Change, "Climate Change 2014 Synthesis Report, Summary for Policymakers," http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf, P. 25.

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Incentives for CCUS Projects

CCUS deployment is driven by project economics, but economics are challenging in the current low oil price environment. The Administration supports incentives for CCUS deployment

Tax and financial incentives to support CCUS deployment are currently under consideration:

- Incentives for CO_2 storage and EOR including expansions of the existing 45Q provisions
- CO_2 price stabilization
- Master limited partnerships (MLPs)
- Private activity bonds (PABs)
- Investment tax credits (ITCs)

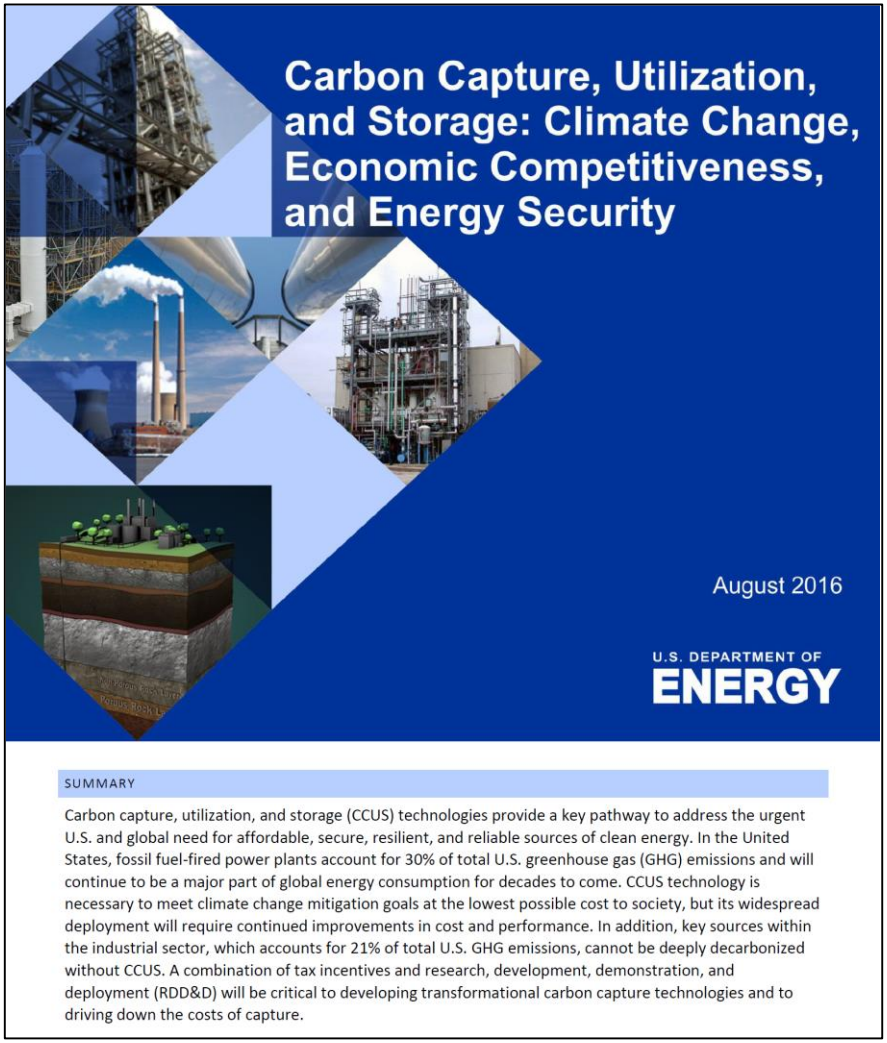
CCUS Incentives in the President's FY2017 Budget Request:

- A refundable investment tax credit (ITC) for CCUS projects and supporting infrastructure
- A 20 year, refundable sequestration tax credit (STC) for captured CO_2; $10 per metric ton EOR and $50 per metric ton saline

DOE White Paper

- In August 2016 DOE released a White Paper on the implications of Carbon Capture, Utilization and Storage.
- Describes how CCUS is essential to achieve U.S. climate, economic development, and energy security objectives.
- Contains an analysis of proposed CCUS incentives and R&D.

Available at: http://energy.gov/fe/downloads/doe-white-paper-carbon-capture-utilization-and-storage



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Analysis of CCUS Technology RDD&D and Proposed Tax Credits

DOE explored the impact of the tax incentives and federal RDD&D on the deployment of CCUS technologies

Policies analyzed include:

- **"Base Case"**: Variation of the AEO 2015 High Oil and Gas Resources Case
- **"45Q"**: Hypothetical revision of the Section 45Q sequestration tax credits to provide $50/metric ton for CO_2 in saline storage and $35/metric ton for CO_2 used for EOR
- **"R&D"**: DOE technology cost and performance goals for CCUS are achieved
- **"Admin"**: CCUS Incentives in the Administration's FY2017 Budget Request include $10/metric ton CO_2 for EOR, $50/metric ton CO_2 for saline storage; investment tax credit for CCS capped at $2 billion
- **"Admin+R&D"**: Combines "Admin" with "R&D"
- **"45Q+R&D"**: Combines "45Q" with "R&D"

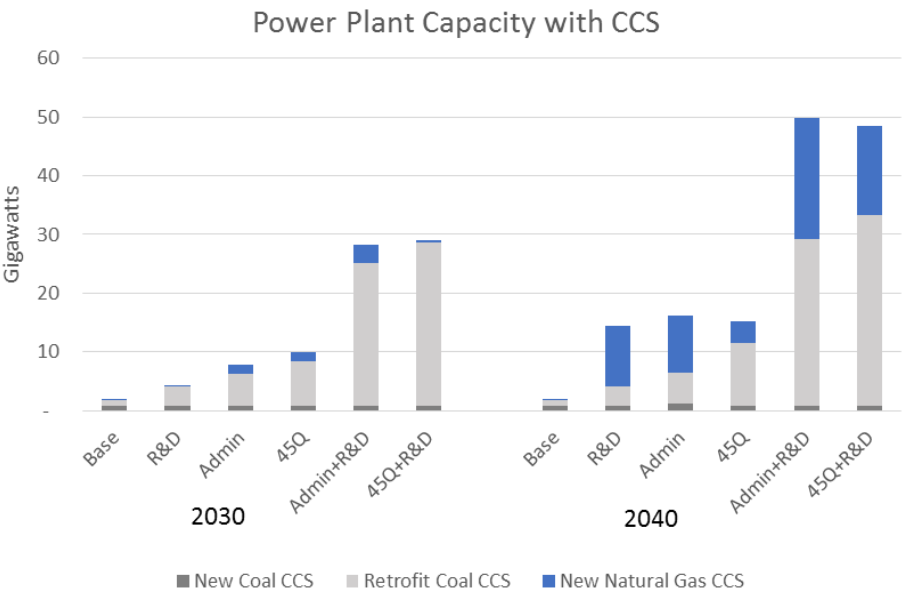
Analysis of CCUS Technology RDD&D and Proposed Tax Credits

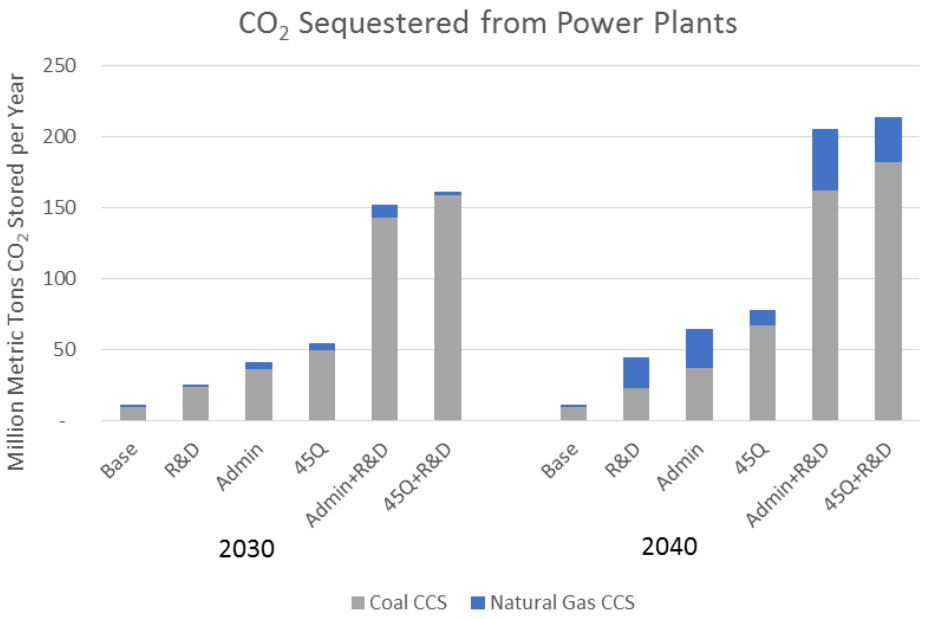
Key findings of the analysis include:

- CCUS can play an important role in reducing carbon emissions and meeting a carbon policy
- Federal RDD&D combined with tax credits make CCUS a viable option
- The market price of CO_2 for EOR combined with a sequestration tax credit ($35 per metric ton) makes EOR a more attractive option for captured CO_2 than saline storage, despite the larger tax credit for saline storage ($50 per metric ton)
  - However, storing CO_2 in saline formations is preferred to EOR in cases where the EOR sequestration tax credit has a lower value ($10 per metric ton)
- To the extent that EOR production cannot absorb more CO_2, the package of policies and tax credits provide an incentive for saline storage of CO_2 as well

Analysis: Results

The combination R&D and tax credits significantly increase CCUS capacity, generation, and the associated CO_2 sequestered from power plants, in comparison to business as usual.





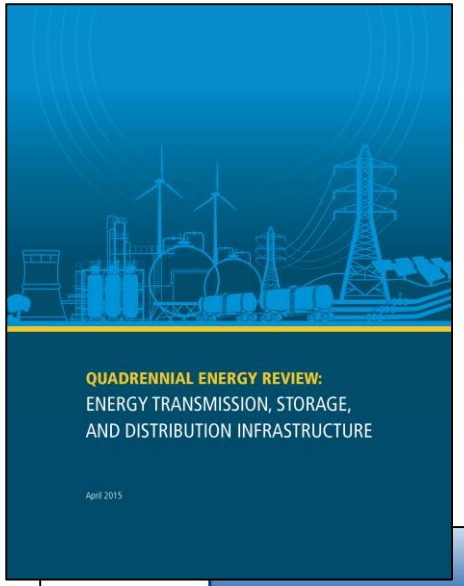
Quadrennial Energy Review: CO_2 Pipelines

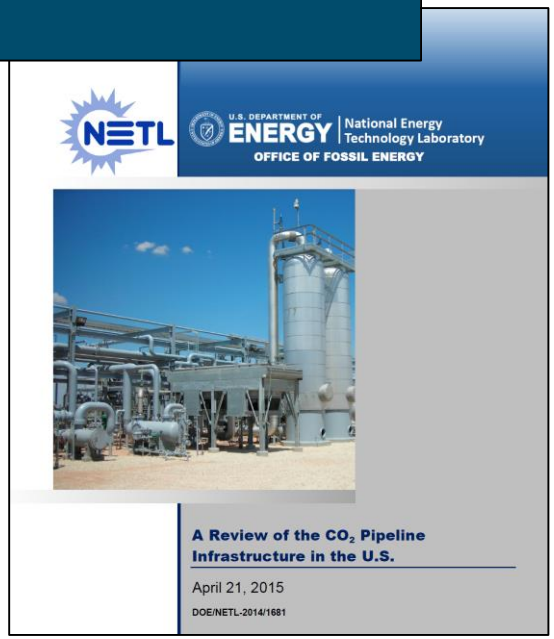
- In 2015, DOE released the first installment of the QER 1.1: *Energy Transmission, Storage, and Distribution Infrastructure*

- QER 1.1 highlighted CO_2 pipelines as an important enabling infrastructure for reducing GHG emissions.

- Key findings of QER CO_2 pipeline analysis:
  - A national carbon policy would create investment certainty and spur significant new investment in CO_2 pipeline infrastructure.

  - Construction through 2030 to meet a low carbon scenario would more than triple the size of current U.S. CO_2 pipeline infrastructure through an average annual build rate of nearly 1,000 miles per year.





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