Incentivizing Carbon Capture Retrofits of the Existing PC and NGCC Fleet

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NETL Carbon Capture Retrofit Analyses

- New SOA Post-Combustion Capture System Quotes
- 2nd Generation Post-Combustion Capture System Cost/Perf
- Energy Velocity: Unit-Specific Data
- QGESS: Retrofit Cost Estimating Methodology
- FE/NELT CO₂ CTUS NEMS
- Analysis of Cost Metrics for Existing Fleet

Systems Analysis of Capture Retrofits for Reference Plants: PC, NGCC, Industrial

NETL CCRD
Carbon Capture Retrofit Database PC, NGCC, Industrial
Cost of Capture for CCS Retrofits

• Retrofitting with CCS economically incentivized via sale of CO$_2$ if:
  
  Annualized Capital and Incremental O&M Costs for Retrofit  +  Annual Revenues Foregone Due to Lost Generation (Derate)  ≤  Annual Revenues from Sale of Captured CO$_2$

• When normalized by CO$_2$ captured, the above becomes:
  – Cost of capture
  – Minimum CO$_2$ plant gate price for which CCS retrofits are incentivized

Above assumes same capacity factor pre- and post-retrofit
Reference Capture Plants: Cost of Capture

NG Price = $6.13/MMBtu
Market Power Price = $60/MWh

Cost of Capture, 2011$/tonne CO2

- Greenfield NGCC: 80
- Retrofit NGCC: 89
- Greenfield PC: 61
- Retrofit PC: 72

- Energy Penalty
- Lost Profit
- O&M
- Capital

DRAFT Results
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Systems Analysis of Reference Capture Plants:
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Analysis of Cost Metrics for Existing Fleet

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Incentivizing CCS Retrofits with EOR Revenues

- Retrofitting with CCS economically incentivized via sale of CO₂ if:

  Annualized Capital and Incremental O&M Costs for Retrofit + Annual Revenues Foregone Due to Lost Generation (Derate) ≤ Annual Revenues from Sale of Captured CO₂

  - When normalized by CO₂ captured, the above becomes the cost of capture or the minimum CO₂ plant gate price for which CCS retrofits are incentivized

• NETL Carbon Capture Retrofits Database (CCRD) provides retrofit assessments for entire fleet

  NETL Retrofit Studies: Incremental cost and derate of retrofits for example plants

  AEO/NEMS: Projected electricity price (to estimate lost revenues)

  Ventyx Energy Velocity: Unit-specific data

  CO₂ Supply Curves: Minimum CO₂ plant gate price for which CCS retrofits are incentivized for each unit in the fleet

  NETL CCRD

  PC, NGCC, Industrial Sources

  Scales retrofit costs and calculates derates and lost revenues for units in entire fleet
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Minimum Plant Gate CO₂ EOR Revenue to Incentivize CCS – Year 2030

Coal Plants

- Same CF pre- and post-retrofit @ historical value
- 30-yr economic life
- $75/MWh* power price
- $138/bbl oil*

2nd Generation technology provides ~24% decrease in CO₂ price

[NEMS Projections. Capital costs reflect ~15% premium due to increase in oil prices.]
Minimum Plant Gate CO₂ EOR Revenue to Incentivize CCS – Year 2017

- SOA Capture Technology
- Same CF pre- and post-retrofit @85%
- 30-yr economic life
- $60/MWh power price
- ~$100/bbl oil

Costs of capture for PC and NGCC using today’s CCS technology are above anticipated CO₂ revenues

Highlights need for capture R&D, CO₂ tax and/or higher CO₂ Revenue
Minimum Plant Gate CO₂ EOR Revenue to Incentivize CCS – Year 2017

**Economic Life Sensitivity**

- **SOA Capture Technology**
- **Same CF pre-and post-retrofit @85%**
- **$60/MWh power price**
- **~$100/bbl oil**

An economic life below 20 years significantly increases cost of capture

New NGCC plants may have greater likelihood over coal plants to operate 30 years post-CCS retrofit
Minimum Plant Gate CO₂ EOR Revenue to Incentivize CCS – Year 2017

Capacity Factor Sensitivity

- SOA Capture Technology
- Same CF pre- and post-retrofit
- 30-yr economic life
- $60/MWh power price
- ~$100/bbl oil

Maximizing/maintaining capacity factors is key for both NGCC and PC plants
Incremental Marginal Cost Trends

Retrofitting SOA CO₂ Capture

Reasonable CO₂ revenue supports higher dispatch

But to what level?

Retrofit: Increased O&M, lost power revenue

$10/tonne CO₂

$30/tonne CO₂
Minimum Plant Gate CO₂ EOR Revenue to Incentivize CCS – Year 2017

Impact of Dispatch

- SOA Capture Technology
- 30-yr economic life
- $60/MWh power price
- ~$100/bbl oil

Shift in dispatch due to CO₂ EOR revenues can provide economic driver for CO₂ capture for PC and NGCC
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NETL Carbon Capture Retrofit Analyses
Evaluating Retrofits in NEMS

CO₂ CTUS NEMS Model Structure

NETL’s CO₂ Capture, Transport, Utilization and Storage (CTUS) model adds capability to NEMS to model NGCC retrofits using data from the NETL Carbon Capture Retrofits Database (CCRD).

Decision to retrofit based on region-specific power generation needs, EOR and CO₂ storage opportunities, and CO₂ pipeline build-out requirements.
Conclusions

Compared cost of CO₂ retrofits to minimum CO₂ price in EOR market

- Even with EOR revenues, state-of-the-art technology unlikely to promote significant retrofits for NGCC or PC
- 2nd gen improvements reduce cost of capture by ~25% and significantly increase potential of deployment
- NGCC and PC retrofit trade-offs
  - Capture technology applied to PC plants provides significantly lower cost of capture
  - Economic life of retrofit for aging coal fleet compared to economic life of new NGCC deployments may partially close cost of capture gap
  - Shift in dispatch due to CO₂ EOR revenues can provide economic driver for CO₂ capture for PC and NGCC
  - CO₂ capture R&D success needed for both PC and NGCC plants!
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QUESTIONS?