Analysis of the Impact of 45Q Sequestration Tax Credits Using the Improved Representation of Industrial Carbon Capture in NETL-NEMS

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Outline

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Purpose and Overview

• Purpose
  • Task was to enhance the CTUS-NETL version of National Energy Modeling System (NEMS) to better represent CO₂ capture opportunities at industrial sources, focusing on Ethanol, Hydrogen and Natural Gas Processing (NGP) facilities
  • Then use the enhanced structure to analyze R&D or policy impacts

• Overview
  • The model enhancements have been completed
    • CCUS investment decisions have been added to the Liquid Fuels Market Module (LFMM) for the three industries and linked to the CTUS submodule
    • Scenarios examining 45Q tax credits indicate industrial CCUS is economic; the enhanced model improves projections regrading these sources
Two scenarios were constructed to examine how 45Q sequestration tax credits might stimulate industrial and power plant CCUS.

Both cases use NETL-NEMS with the enhanced representation of industrial capture:

- Reference case (45Q Ref): 45Q tax credit as legislated (sunsets)
- 45Q Credits extended (45Q Ext): tax credits extended through 2050

Cases include lower EOR O&M costs, high economic and electricity demand growth assumptions, and program goals for power carbon capture, utilization, and storage as in prior AEO2017 45Q analysis.
The “Furthering Carbon Capture, Utilization, Technology, Underground Storage, and Reduced Emissions Act” or “FUTURE Act” was passed as part of the Bipartisan Budget Act of 2018 in February. The FUTURE Act expands and extends the existing Section 45Q CO₂ sequestration tax credit.

- The tax credit provides a 12-year, permanent sequestration tax credit for qualified facilities that capture and permanently store CO₂.
- The tax credit is available to both power and industrial sources of CO₂.
  - The tax credit for CO₂ used for EOR ramps in starting at $12.83 per metric ton in 2017, rising linearly to $35 per metric ton by 2026. After 2026, credits rise with inflation.
  - The tax credit for CO₂ that is permanently stored in saline aquifers ramps in starting at $22.66 per metric ton in 2017, rising linearly to $50 per ton by 2026. After 2026, credits rise with inflation.
- Facilities must start construction by January 1, 2024, to be eligible for the tax credit.
NEMS - typical inputs and outputs

Inputs:
- Oil and gas resources
- Pipeline costs and tariffs
- Mining and transport
- Supply curves
- Oil and Gas Supply Module
- Natural Gas Transmission and Distribution Module
- Coal Market Module
- Renewable Fuels Module
- Macroeconomic Activity Module
- International Energy Module
- Electricity Market Module
- Petroleum Market Module
- Commercial Demand Module
- Transportation Demand Module
- Industrial Demand Module
- Residential Demand Module

Outputs:
- Production
- Consumption
- Emissions
- Prices

* Now known as Liquid Fuel Market Module
Schematic of Model Structure

OGSM: Oil and Gas Supply Module
LFMM: Liquid Fuels Market Module
EMM: Electricity Market Module
CTUS: Carbon, Transport, Utilization and Storage Module

OGSM: Oil and Gas Supply Module
- Industrial CO₂ Capture: by individual site, aggregated into quantity and price bins for each OGSM region
- Competitive Market for CO₂
  - Competing Prices for CO₂ By Source
  - Available CO₂ By Source
  - Demand for CO₂ By EOR

LFMM: Liquid Fuels Market Module
- Potential Revenue Stream from EOR
- CO₂ Supplied by CTL to each OGSM Region
- Price of CO₂ From CTL to each OGSM Region
- Pipeline Infrastructure to Support CO₂ Flows
- Cost of transport from source to sinks (EOR and/or Saline Storage)
- Cost of Saline Storage
- CO₂ captured for EOR and/or Storage
- Cost of transport
- Cost of Storage

EMM: Electricity Market Module
- Potential Revenue Stream from EOR
- CO₂ Supplied by Gen Units to each OGSM Region
- Price of CO₂ From Gen Units to each OGSM Region

CTUS: Carbon, Transport, Utilization and Storage Module
- Competitive Market for CO₂
- P and O CO₂, for EOR
- Cost of transport
- Cost of Storage
Industrial Sources Responsive to 45Q

- CO₂ captured at power plants expands dramatically when the 45Q tax credit is extended
  - R&D goals bring down the cost of coal CCUS after the tax credit expires in the 45Q Ref case
- Much of the increase in captured CO₂ is sent to saline storage, rather than EOR
- Industrial CO₂ capture does not expand significantly with the extension
  - Most of the CCUS is retrofit rather than new capacity because ethanol and hydrogen production is not expanding
  - Natural gas processing CCUS in new facilities is not modeled, but the CO₂ capture potential is likely small based on existing plant potential
CO₂ Purchased for EOR

- The various industrial CO₂ sources compete with CCUS at power plants and natural sources to provide CO₂ to EOR
  - Ethanol provides the largest share of industrial CO₂, followed by hydrogen
  - Hydrogen capture is higher and NGP is lower as a result of the updated data in this enhanced version of NETL-NEMS
- When the tax credit is extended, CO₂ captured at power plants expands and natural sources are displaced.

Note CO₂ is incremental above 2015 levels
• Total oil production is relatively unchanged by the extension of the 45Q credits.
  • Some production is accelerated, but in both cases production tapers down as existing fields are depleted
With the 45Q tax credits extended, power CCUS capacity increases to over 52 GW by 2050 of which 43 GW is new coal CCUS.

Overall CCUS remains a relatively small share (< 3%) of total electric capacity.
• With the extended tax credits, generation from new coal CCS expands and displaces primarily generation from gas without CCS and renewable sources.
Conclusions

• Industrial sources are responsive to 45Q in the model but hits a limit quickly
• Over longer time frames, and if the 45Q sunset is removed, CCUS on power generation experiences further deployment growth
• CO2 sent to EOR also reaches a saturation point, but sending CO2 to saline formations is also economically attractive in the model
• CCUS has modest, but important, deployment levels since this provides cost reduction impetus of “learning-by-doing”
"An economist is an expert who will know tomorrow why the things he predicted yesterday didn't happen today."

--Evan Esar