

Benefits Analysis of Fossil Energy R&D

2018 NETL CO₂ Capture Technology Project Review Meeting – August 13, 2018

Modeling the Impacts of 45Q



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- Introduction to the Energy Markets Analysis Team at NETL
- Overview of energy market modeling
 - NEMS/CTUS results with 45Q
- Conclusions

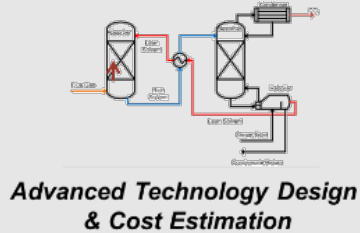
Systems Engineering & Analysis (SEA)

Teams and Scope

Energy Process Analysis

Energy Process Design, Analysis, and Cost Estimation

- Plant-level modeling, performance assessment
- Cost estimation for plant-level systems
- General plant-level technology evaluation and support



Energy Systems Analysis

Resource Availability and Cost Modeling

- CO₂ storage (saline and EOR)
- Fossil fuel extraction
- Rare earth elements
- General subsurface technology evaluation and support

Grid modeling and analysis

Environmental Life Cycle Analysis



Process Systems Engineering Research

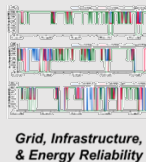
- Process synthesis, design, optimization, intensification
- Steady state and dynamic process model development
- Uncertainty quantification
- Advanced process control

Design, optimization, and modeling framework to be expanded to all SEA “systems”

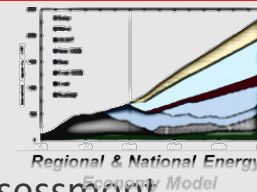
Energy Markets Analysis

Energy Economy Modeling and Impact Assessment

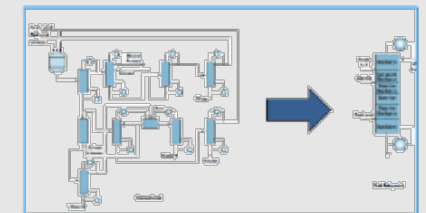
- Enhanced fossil energy representation
- Multi-model scenario/policy analysis
- Infrastructure, energy-water



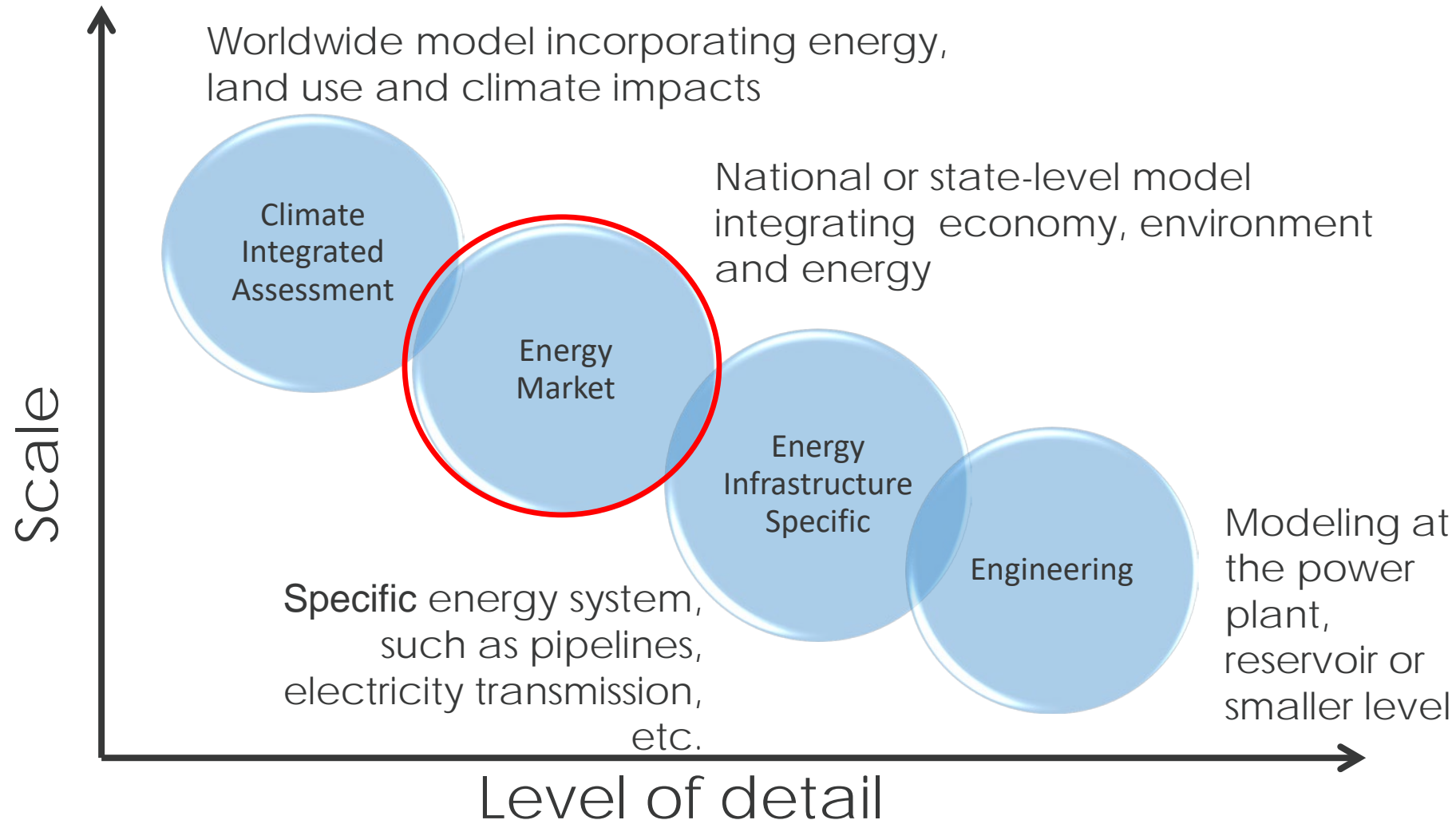
- Economic impact assessment
- General regulatory, market and financial expertise



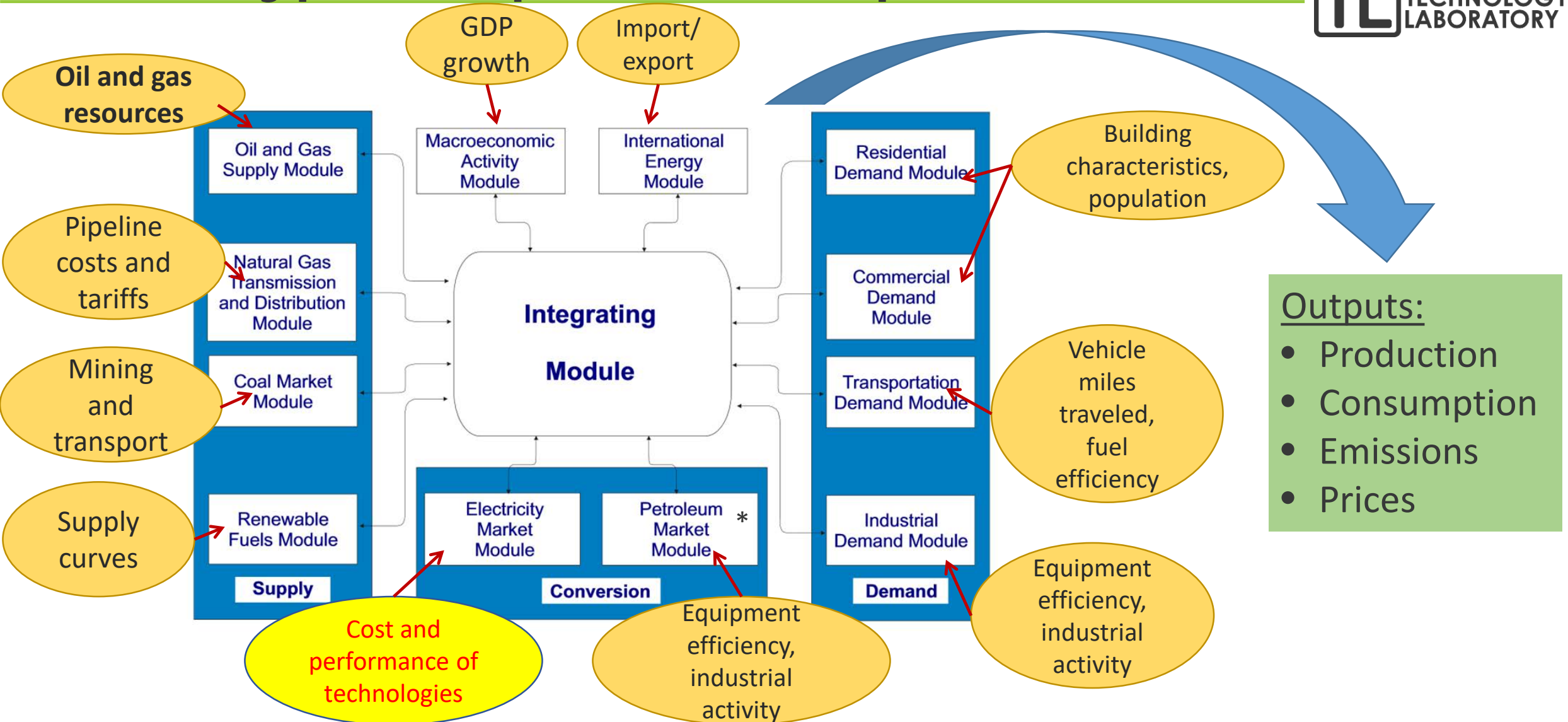
Advanced Energy Systems through Process Systems Engineering



Models are representations of the physical world – energy models span a large scale



NEMS – typical inputs and outputs



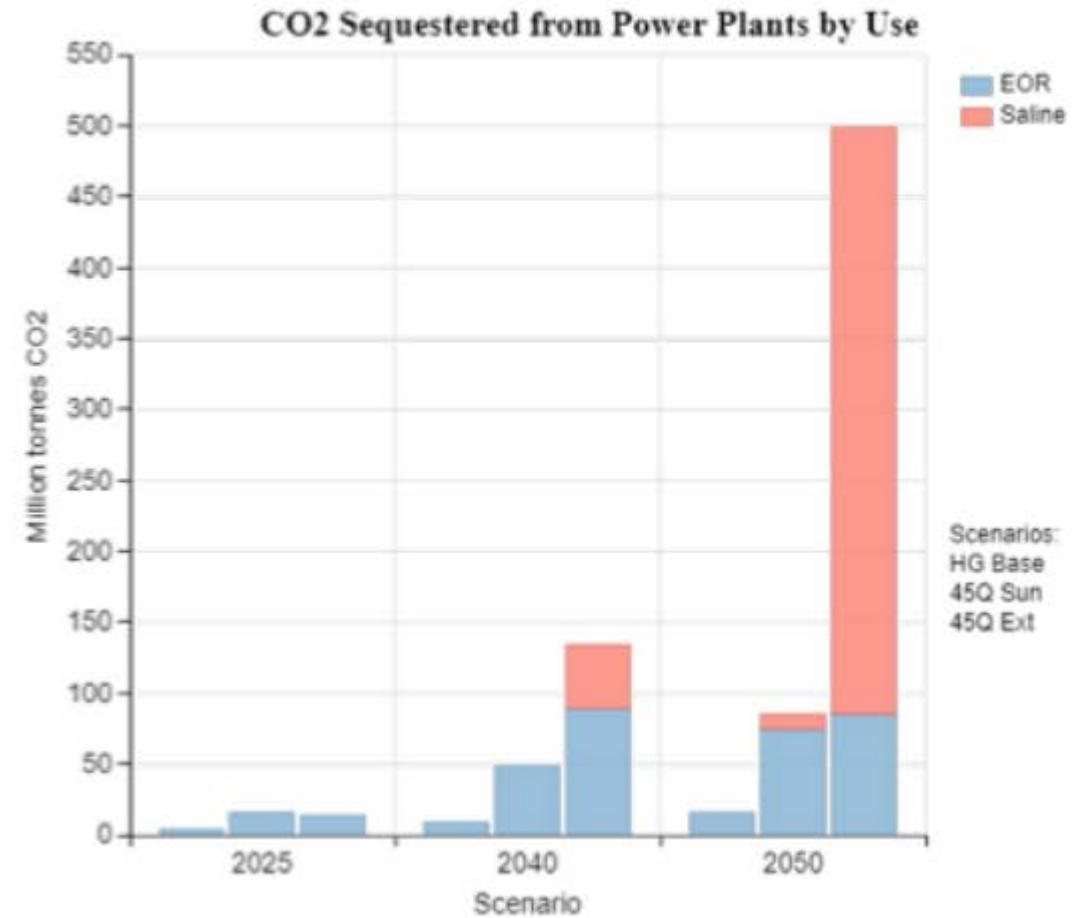
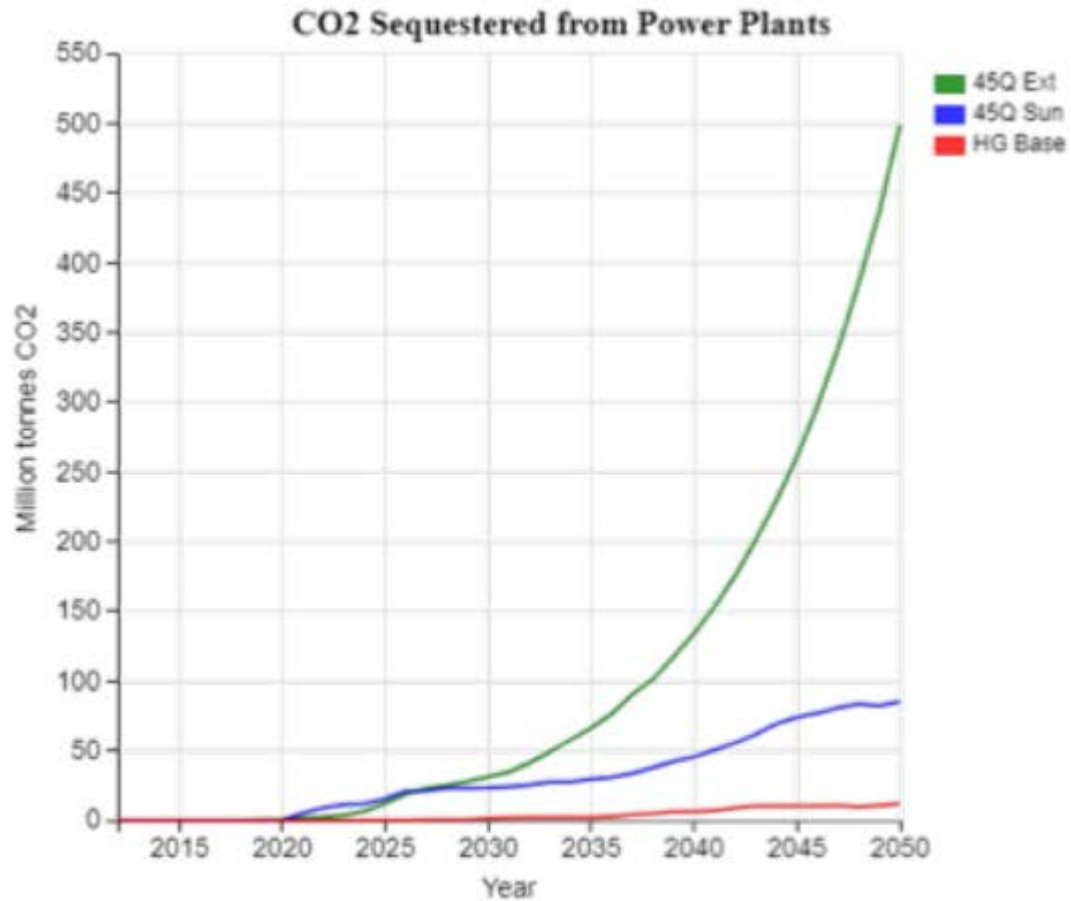
Improving EOR representation in NEMS with CTUS

- NEMS did not include strong ties between captured CO₂, EOR and pipelines
- NETL developed the Capture Transport Utilization and Storage (CTUS) plug-in sub-module
- Multiple sources, sinks, and EOR sites spatially represented
- Estimates an optimal carbon capture, utilization, and storage (CCUS) pipeline network
- Passes transport and storage cost back to potential CCUS technology options in the main CTUS-NEMS model

Modeling the impacts of 45Q using scenario analysis

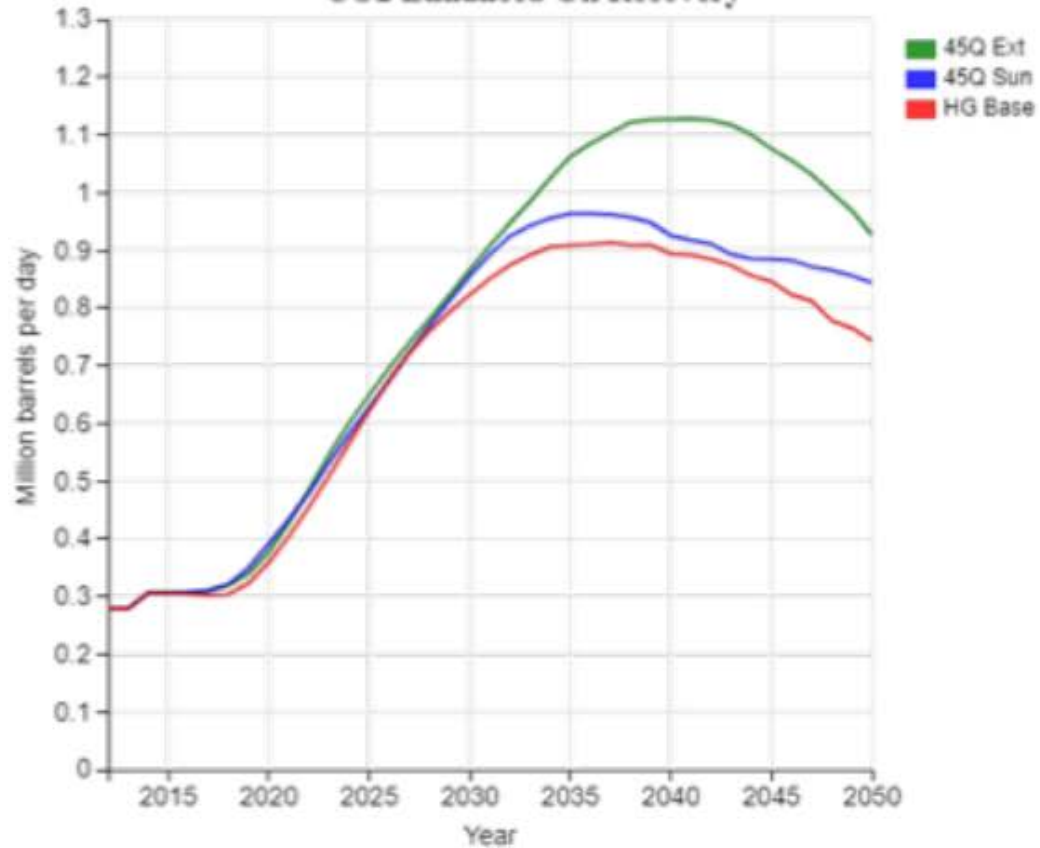
- Using NEMS-CTUS to run a number of scenarios with critical inputs changed, we can compare the results to determine impacts of the regulation and its various facets
 - **High Growth Base Case (“HG Base”)**: High economic growth with 2.6% per year increase in GDP and high electricity demand of 2% per year, lower EOR O&M costs, and CCS technologies reflecting no federal R&D
 - **45Q Tax Credit with Sunset Case (“45Q Sun”)**: High Growth with CCS Program Goals Case combined with a 45Q sequestration tax credit that provides \$35/ton for captured CO₂ used for EOR and \$50/ton for captured CO₂ sent to geologic storage. Credits are available for power and industrial CCS projects that start construction by January 1, 2024
 - **45Q Tax Credit Extended Case (“45Q Ext”)**: High Growth with CCS Program Goals Case combined with a 45Q sequestration tax credit that provides \$35/ton for captured CO₂ used for EOR and \$50/ton for captured CO₂ sent to geologic storage. Credits are available for power and industrial CCS projects indefinitely

CO2 Sequestered from Power Plants – 45Q Sunset vs. Extended

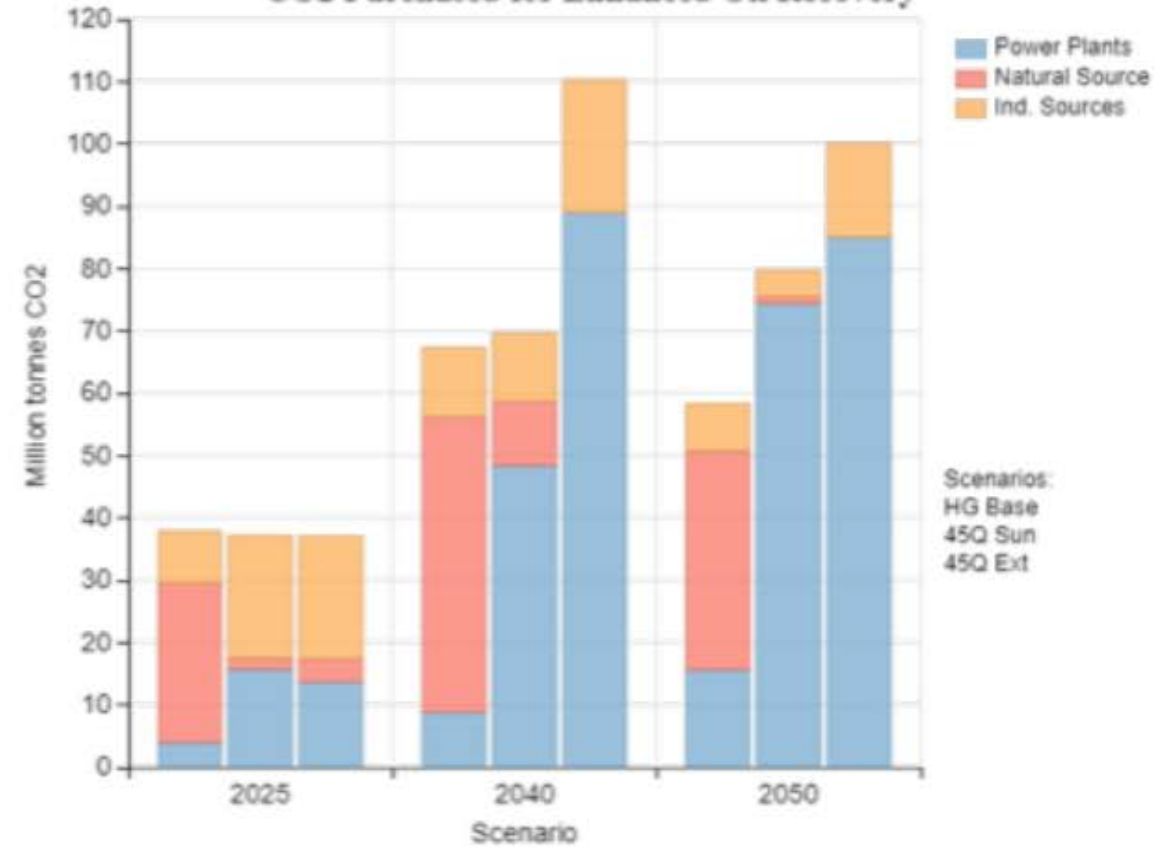


The 45Q Tax Credit Scenarios Result in Significant Displacement of Naturally Sourced CO2 for EOR

CO2 Enhanced Oil Recovery



CO2 Purchased for Enhanced Oil Recovery



Conclusions

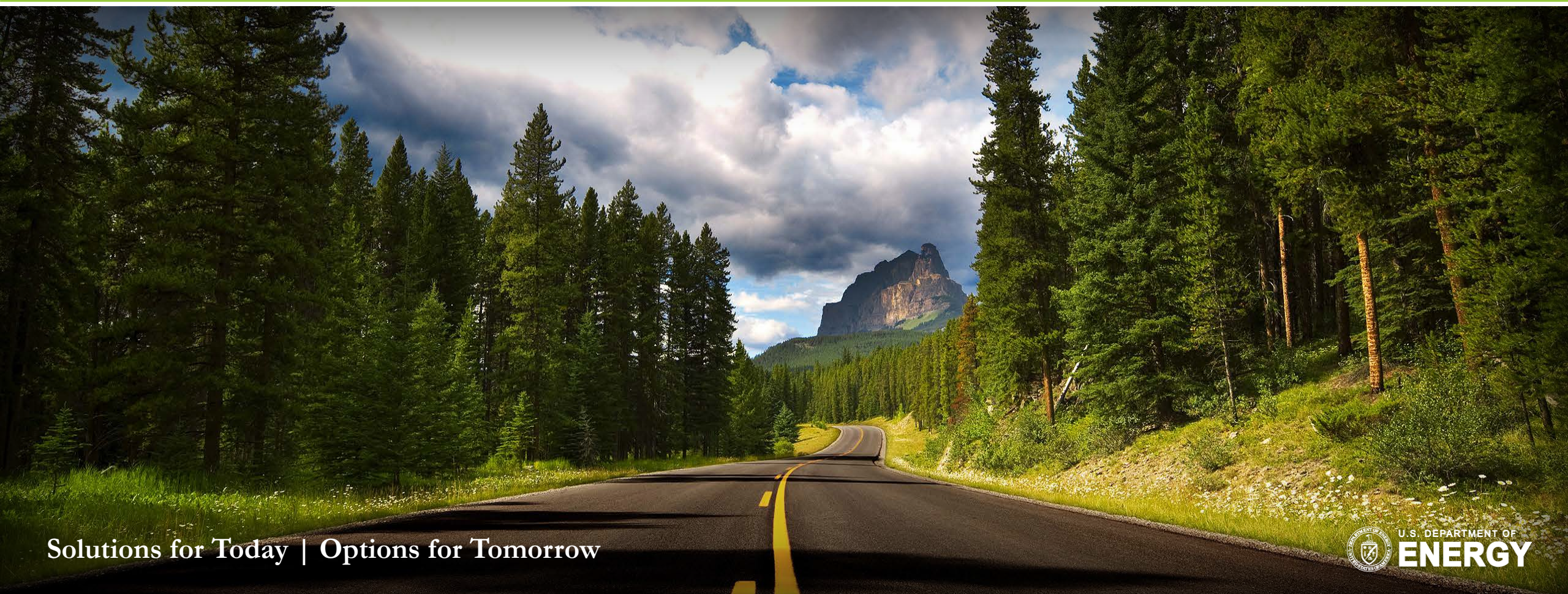
- Implementation of 45Q does significantly drive new and retrofit CCUS technology
- The sunset provision does limit future deployments
- 45Q changes the supply pattern of CO₂ for EOR from natural to power plant sources
 - Industrial sources do not significantly change (fully developed industrial source module is under development)
- Coal with 90% capture is the primary CCUS technology deployed in these scenarios

For more information...

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