SSAE Newsletter

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// ABOUT

The Strategic Systems Analysis and Engineering (SSAE) directorate provides the decision science and analysis capabilities necessary to evaluate complex energy systems. The directorate's capabilities address technical, economic, resource, policy, environmental and market aspects of the energy industry. These capabilities are critical to strategic planning, direction and goals for technology R&D programs and the generation of market, regulatory and technical intelligence for NETL senior management and DOE. SSAE offers a range of multi-criteria and multi-scale decision tools and approaches for this support:

- Process systems engineering research: advanced modeling, simulation and optimization tools for complex dynamic systems
- Process and cost engineering: plant-level synthesis, process modeling and simulation of energy systems with performance estimates
- Resource and subsurface analysis: evaluation of technologies, approaches and regulations for subsurface energy systems and storage
- Market and infrastructure analysis: economic impacts and program benefits
- Environmental life cycle analysis: cradle-to-grave emissions and impacts

These tools and approaches provide insights into new energy concepts and support the analysis of energy system interactions at the plant, regional, national and global scales.

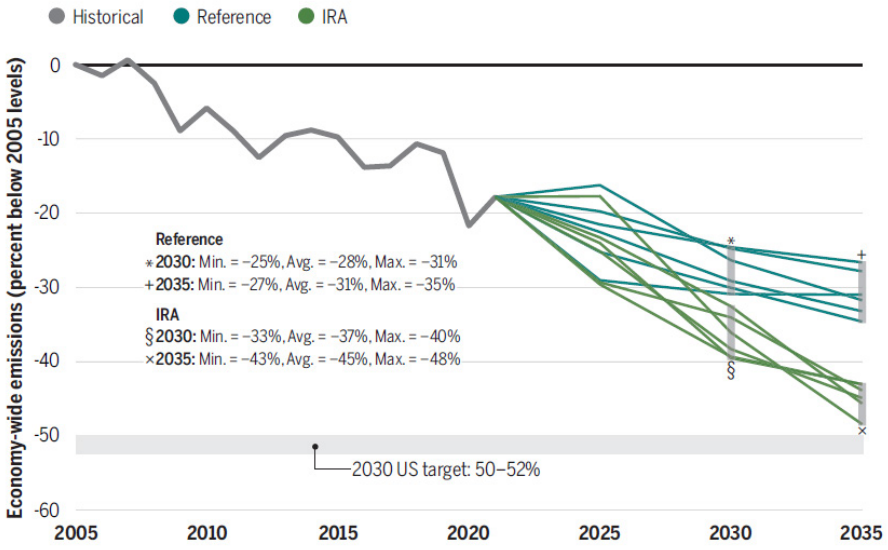
// HIGHLIGHTS

Analysis Finds Inflation Reduction Act Alone Insufficient to Achieve U.S. Climate Targets

The article "Emissions and Energy Impacts of the Inflation Reduction Act," published in the journal Science, examined the impacts of the Inflation Reduction Act (IRA) in the energy sector. SSAE's Nadejda Victor*, a senior strategic energy analyst, was a co-author and contributed model results from NETL's MARKAL-TIMES platform. The figure below compares results from six models for both the IRA and reference scenarios depicting a key finding of the study, that while the IRA accelerates decarbonization, none of the models used in the study indicate that the 2030 United States climate target would be met with IRA alone. Further development of low-carbon technologies, such as carbon capture and storage, are critical pathways to meeting national decarbonization targets.

Cross-model comparison of US emissions reductions under the Inflation Reduction Act (IRA)

Results reflect modeling of both IRA and reference scenarios, relative to the year 2005. The six models used across both panels are EPS-EI, GCAM-CGS, MARKAL-NETL, NEMS-RHG, REGEN-EPRI, and RIO-REPEAT.



Historical and projected economy-wide greenhouse gas (GHG) emissions in CO_2 equivalent terms. Historical emissions and 100-year global warming potential values (for models representing non-CO_2 GHGs) are based on the US Environmental Protection Agency's "Inventory of US Greenhouse Gas Emissions and Sinks."

SSAE Researchers Investigate Impact of Cement Plant Air Ingress

Decarbonization of industrial sectors is critical to achieving a net zero economy. Cement production contributed about 69 million tonnes (Mt) of CO_2 emissions in the United States and 2,400 Mt globally in 2020, amounting to about 1.5% of the total United States' CO_2 emissions and 6% of global emissions.

The objective of the study, "The Impact of Cement Plant Air Ingress on Membrane-Based CO_2 Capture Retrofit Cost," was to examine the impact of false air ingress — a standard cement production process occurrence that dilutes kiln CO_2 emissions — on membrane-based capture for cement plant decarbonization. The study, to be published in Carbon Capture Science & Technology, Volume 11, June 2024, was conducted by SSAE researchers Sydney Hughes*, Patricia Cvetic*, Richard Newby*, Sally Homsy, Alexander Zoelle*, Mark Woods*, Eric Grol, and Timothy Fout. Their evaluation indicates that regardless of advancements in conventional membrane performance, air ingress significantly impacts the performance and cost of membrane-based systems and should not be neglected.

SSAE's John Brewer works MAGIIC for Electricity Advisory Committee

The U.S. Department of Energy's (DOE's) Office of Electricity (OE) Electricity Advisory Committee advises OE on current and future electric grid reliability, resilience, security, sector interdependence, and policy issues. SSAE's John Brewer, a research engineer, was invited to be part of the five-person expert panel, that included the OE's Director of Grid Controls Sandy Jenkins, Acting Director of Grid Modeling, Dr. Ali Ghassemian, as well as the Federal Energy Regulatory Commission's Enforcement Counsel to the Office of Enforcement, Heather Polzin and the Office of Electric Reliability's David Huff, for OE's moderated discussion on the interrelationship between gas and electric, "Natural Gas and Electricity Interdependency" held during the Energy Electricity Advisory Committee Meeting on February 13 and 14, 2024, in Arlington, VA.

John presented relevant capabilities of SSAE's Energy Markets Analysis Team including NETL's Markets and Grid Infrastructure Interdependence Collaborative (MAGIIC) tool in his discussion of "Gas-Electric Interdependence". MAGIIC provides the capability to bring together multiple research and development (R&D) and commercially available analysis platforms within NETL and industry to integrate technology development and energy market analysis to better understand how conceptual R&D will perform. Currently integrated tools are shown in the table below. MAGIIC allows for evaluation of complex interplays between interconnected markets and infrastructure systems in North America and globally to produce informed R&D pathways, improved operational processes, detailed reliability and resource adequacy evaluations, informed infrastructure utilization and planning considering interdependencies and physics, interdependency assessments, and economic impacts and jobs estimates. The tool can help to avoid the blinders of a single-function model, providing a robust depiction that better matches the real world.

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// HIGHLIGHTS cont'd

MAGIIC's Currently Integrated Tools[1]	
Scenario Specific Tools	Engineering Process Design (ASPEN Plus), Life Cycle Assessment (GaBI, SimaPro), NETL Developed Open-Source Tools (IDEAS, FE/NETL Onshore CO_2 EOR Cost Model, FE/NETL CO_2 Prophet Model, SCoRE), Transportation and Supply Chain models
Power Systems Operations Tools	PSS/E, PSLF
High-Impact Low/Medium Frequency Events Tools	@Risk
Commodity/Infrastructure Systems Operations Tools	MarketBuilder (North America and World Gas and Oil Models)[2], NGfast[3], NGTransient[3], FE/NETL CO_2 Transport Cost Model
Electricity Production Cost Models	PROMOD, PLEXOS
Near-Term Planning Models	Hitachi Capacity Expansion, EPRI EGEAS
Mid-Long-Term Macroeconomic Models	EIA NEMS, IEA MARKAL-TIMES
Economic Impact/Econometric Models	IMPLAN, WVU EICO
Commodity/Infrastructure Market Models	MarketBuilder[2], Sim CCS, IHS Markit tools

[1] List is not meant to be all encompassing. Not all listed tools are maintained under constant license by NETL.
[2] MarketBuilder is a commercial model owned and operated by Deloitte which covers near-term natural gas market operations and long-term endogenous expansion.
[3] NGFast and NGTransient are owned and operated by Argonne National Laboratory.

Staff Spotlight

Since joining the Life Cycle Analysis (LCA) Team in October 2022, **James Clarke*** has been a key contributor to research investigating carbon conversion technologies. With his team, he has been developing a process-based modeling tool to compare the environmental performance of emerging carbon conversion technologies including synthetic natural gas (SNG) derived from CO_2; microwave-assisted catalytic pathways; algae to biofuels; mineralization of concrete products; building aggregates; and photocatalytic conversion.

James has contributed to updates of the NETL CO2U LCA Guidance Toolkit, including expansion of the existing life cycle inventory database, and co-authored "Life Cycle Analysis of Synthetic Natural Gas Production via Carbon Conversion: Impact of Different CO_2, H_2, and Methanation Pathways," Which he presented at the 2023 American Center for Life Cycle Analysis, in Burlington, Vermont. This LCA study examined SNG produced through H_2, CO_2, and methanation pathways as options to decarbonize the natural gas supply chain. James has also contributed to the completion of high-profile projects evaluating applications for government-funded emission reduction incentives including development of benchmarks for verifying substantial net reduction of greenhouse gas emissions.

James is a graduate of Johns Hopkins University with a BS and MS in Chemical and Biomolecular Engineering and is an avid frisbee player. In October 2023, he competed with his ultimate frisbee team, DC Rally, in the 2023 USA Ultimate Club Championships in San Diego, CA.

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// NOTICES

SSAE Participates in Workshop on EPA's New Set of Social Cost of Greenhouse Gases Estimates

SSAE Research Economist, Amanda Harker Steele participated in the Society for Benefit-Cost Analysis' Virtual Workshop: Understanding the Social Cost of Greenhouse Gas Estimates February 14 and 15, 2024. The workshop's purpose was to explain the methodology underlying new social cost of greenhouse gas (SC-GHG) estimates.

In December 2023, the U.S. Environmental Protection Agency finalized a set of updated social cost of greenhouse gas estimates within a rulemaking on the oil and natural gas sector. The Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances presents new estimates of the social cost of carbon (SC-CO_2), the social cost of methane (SC-CH_4), and the social cost of nitrous oxide (SC-N_2O), collectively referred to as the "social cost of greenhouse gases" (SC-GHG). The estimates reflect recent advances in the scientific literature on climate change and its economic impacts and incorporate recommendations made by the National Academies of Science, Engineering, and Medicine.

PARETO Team Attends Produced Water Society Annual Conference

"Project PARETO"—DOE's produced water optimization initiative— participated in the 2024 Produced Water Society's (PWS) Annual Conference, held in Houston, Texas. The PWS annual meeting is the premier event focused on oil and gas produced water management. This meeting attracts attendees from across the produced water community, including industrial practitioners, government and regulatory agencies, and academic researchers. Featuring presentations and panel discussions on topics such as water treatment technologies, water quality analysis, induced seismicity, critical mineral recovery, and beneficial reuse.

The PARETO NETL team - Miguel Zamarripa, Elmira Shamlou, Travis Arnold, and Philip Tominac, led by Ph.D. Markus Drouven – engaged with the broader produced water community in several ways during the trip, including:

1. Holding a stakeholder board meeting with participants from across the produced water community. Representatives were in attendance from Select Water Solutions, XRI Midstream, Aris Water, Texas Railroad Commission, New Mexico Produced Water Research Consortium, Produced Water Society, KDH Trading, OLI Systems, and others. The highlight of the meeting was an open discussion on the future of PARETO, where the team received valuable feedback directly from stakeholders on a) importance of PARETO in the community; b) framework adoption and commercialization avenues, and c) future produced water R&D areas worth pursuing.
2. Delivering a conference presentation titled "Project PARETO – DOE's Produced Water Optimization Initiative: Advancing Strategic Pathways for Produced Water Reuse Beyond Injection" during the "Beneficial Reuse of Produced Water" session. An overview of PARETO advanced capabilities, core functionalities, and recent enhancements was provided, with a particular emphasis on the project's significant role in facilitating beneficial reuse realization on a large scale.
3. Leading a roundtable session exhibiting PARETO Water Sharing tool: a market-based produced water management tool. This tool allows operators to bid for and trade produced water by adapting algorithms widely used in electricity markets. Roundtable visitors participated in a live demonstration of the tool, submitting bids through their phones.
4. Presenting the PARETO Workshop, this workshop focuses on a basic overview of PARETO toolset, how to prepare a case study, build your PW network model, analyze inputs, and optimize. Additionally, we demonstrated how to use advanced features to analyze different scenarios and compare results. Approximately fifteen participants enjoyed an interactive, hands-on-keyboard experience in the two-hour session.

PARETO's graphical user interface is available for download and source code is available on GitHub, both as open-source software. Documentation of the PARETO framework is also available online.

PARETO team members attending the meeting, pictured from left to right, are Markus Drouven, Sangbum Lee, Lisa Henthorne (LBNL), Laura Capper, Philip Tominac, Melody Shellman, Travis Arnold, Karen Work (LBNL), Michael Pesce (LBNL), and Miguel Zamarripa.

Want to learn more about SSAE's work?

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// UPCOMING CONFERENCES AND EVENTS

SSAE federal staff and NETL support contractor personnel will attend or present at the following conferences in March 2024:

- Orphan and Idle Wells Colorado Conference
  Energy Conference Network
  Presenter: Markus Drouven – The National Emissions Reduction Initiative (NEMRI): Collaborative Strategies for Preventing Future Orphan Wells
  Denver, CO, March 6, 2024
- CCUS 2024 Conference
  Society of Petroleum Engineers/American Association of Petroleum Geologists/Society of Exploration Geophysicists
  Presenters: David Morgan – Modeling the Cost of Onshore CO_2 Pipeline Transport and Onshore CO_2 Saline Storage; Mackenzie Mark-Moser – 1) Modeling cost of offshore geologic carbon storage and 2) Carbon Storage Technical Viability Approach and National Data Assessment
  Participants: Guoxiang Liu
  Houston, TX, March 11-13, 2024
- Gartner Data & Analytics Summit 2024
  Participant: Lisa Nichols
  Orlando, FL, March 11–13, 2024
- National Alliance for Water Innovation (NAWI) Spring Meeting
  Presenters: Alison Fritz – Technoeconomic Assessment of Brine Valorization from Brackish Water Desalination; Timothy Bartholomew – WaterTAP Quarterly Review
  Denver, CO, March 12, 2024

// RECENT PUBLICATIONS

Articles

- Dyer, A., Mark-Moser, M., Duran, R., Bauer, J. (Accepted) Offshore Application of Landslide Susceptibility Mapping Using Gradient-Boosted Decision Trees: A Gulf of Mexico Case Study. *Natural Hazards*, Springer, February 24, 2024.

Models/Tools/Databases

- Morgan, D., Chen, B., Pawar, R., & Benitez, J. (2024). Reduced order costs for CO_2 saline storage for use in energy market models (DOE/NETL-2024/4415). Pittsburgh, PA: National Energy Technology Laboratory, U.S. Department of Energy. January 19, 2024.

Presentations and Posters

- Mantipragada, H. and Fout, T. Direct Air Capture With Nuclear Power Sources. 2023 American Nuclear Society Winter Conference and Expo. November 13, 2023.
- Krynock, M. UPGrants LCA Overview. DOE Carbon Utilization Procurement Grants Webinar (USEA). Virtual. November 9, 2023.
- Muller, N., Connor, P., and Harker-Steele, A. Estimating the Marginal Cost for Carbon Capture and Storage for the Impact of IRA 45Q Tax Incentives on Cost of CO_2 Capture Using the Industrial Carbon Capture Retrofit Database. November 7, 2023.
- Liese, E., Weiland, N., Pidaparti, S., Teel, T., Soares-Chinen, A., Albright, J., Tumbalam-Gooty, R., Jaffe, T., and White, C. NETL Activities in Supercritical CO_2 Systems Analyses. 2023 University Turbine Systems Research and Advanced Turbines Program Review Meeting, State College, PA. October 30, 2023.
- Jamieson, M. NETL LCA of Carbon Capture. University of Wyoming Distinguished Speaker Series. October 30, 2023.
- Grol, E. Impact of IRA 45Q Tax Incentives on Cost of CO_2 Capture Using the Industrial Carbon Capture Retrofit Database [Conference Presentation]. 2023 USAEE/IAEE North American Conference, Chicago, IL. November 7. 2023.
- Morgan, D. (invited speaker) Overview of the FECM/NETL CO_2 Saline Storage Cost Model (CO2_S_COM). FECM-US Energy Association Workshop, Washington, D.C. December 12, 2023.
- Brewer, J. (invited speaker) Gas-Electric Interdependence, DOE Office of Electricity, Electricity Advisory Committee Meeting, Arlington, VA. February 13, 2024.

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// REFERENCE SECTION

Models / Tools / Databases

Carbon Capture Simulation Initiative (CCSI) Toolset

FECM/NETL CO_2 Transport Cost Model

FE/NETL CO_2 Saline Storage Cost Model

FE/NETL CO_2 Prophet Model

FE/NETL Onshore CO_2 EOR Cost Model

FECM/NETL Unconventional Shale Well Economic Model

Life Cycle Analysis Models

NETL CO2U LCA Guidance Toolkit

NETL UPGrants LCA Guidance Toolkit

IDAES Integrated Platform

IDAES Power Generation Model Library

Pulverized Coal Carbon Capture Retrofit Database (CCRD)

Natural Gas Combined Cycle CCRD

Industrial Sources CCRD

Key Reports

Baseline Studies for Fossil Energy Plants

Cost of Capturing CO_2 from Industrial Sources

Quality Guidelines for Energy System Studies

Life Cycle Analysis

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