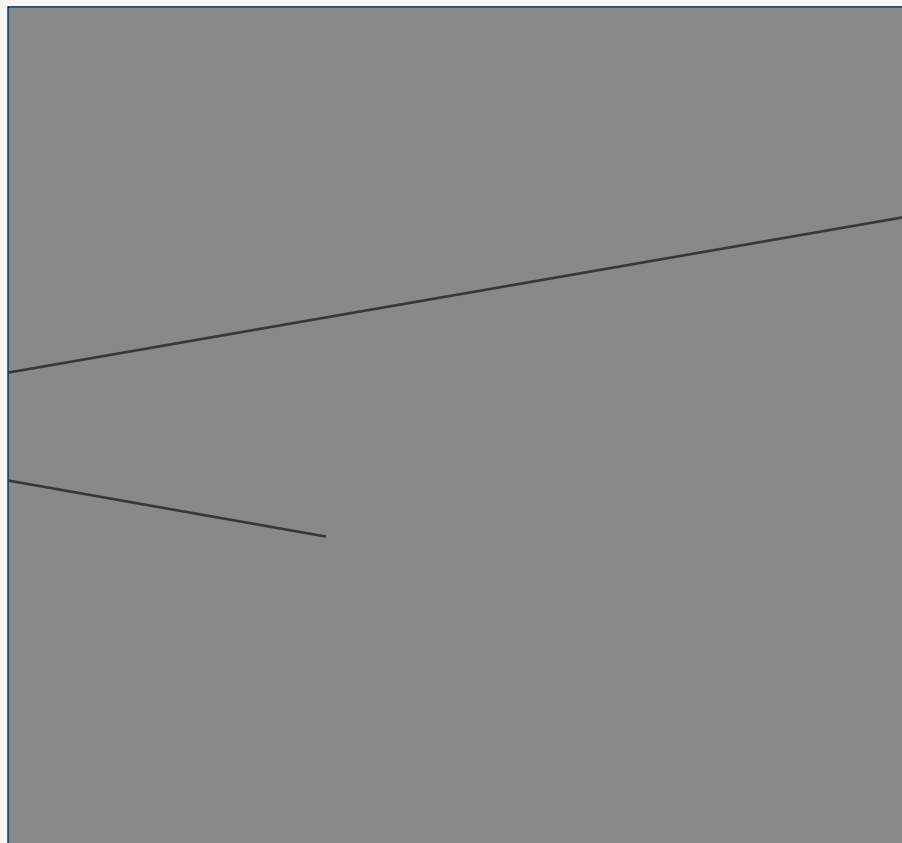


SSAE Newsletter

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VOLUME 1.4



// 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

NETL Co-leads International CCU Assessment Harmonization Group

Evaluation of environmental and economic opportunities and associated risks is vital for promoting research, development and commercialization of carbon capture, utilization and storage (CCUS) technologies.

Life cycle analysis (LCA) and techno-economic analysis (TEA) are means to quantify these opportunities and risks. For consistent conduct and transparent reporting, a common framework for LCA and TEA is required.

NETL's LCA and TEA competency, within SSAE in the Research & Innovation Center, has teamed with the Global CO₂ Initiative (GCI) to lead the International CCU Assessment Harmonization Group, a diverse alliance of 30 international researchers that will create this common framework by bringing together related efforts, analyzing differences and eliminating discrepancies.

NETL co-led multiple subteams in this effort and presented outcomes and recommendations during GCI's May 2021 webinar series. Outcomes included:

- Launch of the [AssessCCUS website](#).
- Glossary of accepted TEA and LCA terms for CCUS.
- Recommendations to conduct LCA and TEA for CCU technologies at low technology readiness level.
- Strategy to define comparison product system representatives.
- Guidelines to evaluate the technology learning curve and its implications on future performance.

The work of the group will help the U.S. Department of Energy and the world at large achieve the discovery and maturation of emerging technologies to ensure environmentally sustainable solutions for the use of captured CO₂ to reduce greenhouse gas (GHG) emissions.

International CCU Assessment Harmonization Group

// NOTICES

Tim Grant to Present at IMAGE 2021

Timothy Grant, a member of SSAE's Energy Systems Analysis Team, was selected to virtually present "Comparative Analysis of Transport, Storage and Produced Water Management Options from a CO₂ Source

Perspective" during the [International Meeting for Applied Geoscience & Energy \(IMAGE\) 2021](#) on Wednesday, September 29, 2021.

Grant will discuss research completed by NETL that explores the full suite of challenges a CO₂ source faces when determining the best option for its captured CO₂. Factors, such as brine management and transport networks required to move CO₂ from source to sink location, will be highlighted. This research evaluated several carbon capture and storage (CCS) deployment decisions and associated costs in the U.S. Northeast and Midwest from the CO₂ source's perspective using NETL-developed resources and models.

SSAE Research Featured at Project Review Meeting

Several SSAE professionals, including Federal and NETL support contractor staff, joined NETL Director Brian Anderson and other NETL experts to showcase their research at DOE-NETL's 2021 Carbon Management and Oil and Gas Research Project Review Meeting in August 2021.

The meeting consisted of virtual presentations in such areas as carbon capture, carbon storage, oil and natural gas and carbon utilization. Listed below are the SSAE professionals that presented and their respective presentation summary. Each researcher fielded questions during their session and interest in certain aspects of projects were indicated. Publication is pending for several presentations, as noted below.

- **Timothy Grant** of SSAE's Energy Systems Analysis Team presented "Examining Possible CCS Deployment Pathways: Onshore and Offshore (FWP-1022464)" (pending publication). This presentation provided an overview of four projects: 1) basin-scale CO₂ storage modeling provides an analysis of CO₂ plume and pressure evolution behavior to inform operational decisions and basin management strategies; 2) onshore CO₂-EOR offers a nation-wide volumetric estimation of CO₂ storage capacity and incremental oil recovery via CO₂ EOR; 3) offshore storage pilot project identifies technical, economic and geologic requirements for an offshore CO₂ pilot storage project in the Gulf of Mexico; and 4) financial aspects (45Q tax credit) provides identification of financial gaps and assessment of optimal tax credit monetization opportunities to bridge financial gaps.

- **Christopher Nichols** of SSAE's Energy Markets Analysis Team discussed "Modeling the Deployment and Impacts of Capture R&D" (pending publication). This presentation discussed an analysis that was performed using the techno-economic analysis model MARKAL to determine impacts of research and development (R&D) into different technology pathways under CO₂ reduction plans.
- **Timothy Fout** of SSAE's Energy Process Analysis Team presented "[Updated Costs for Carbon Capture Retrofits](#)" which featured updated results from a recent pending study on updated costs for natural gas combined cycles (NGCC) with post combustion CO₂ capture. Changes to the prior study to reflect the recently released "[Cost and Performance Baseline for Fossil Energy Plants, Volume 1: Bituminous Coal and Natural Gas to Electricity](#)," Rev 4 were discussed. Approximately 80 attendees observed the presentation.
- **Derrick Carlson**, an NETL support contractor supporting LCA for SSAE's Energy Systems Analysis Team, discussed "Bio-energy with Carbon Capture and Storage (BECCS): Achieving Net Zero and Beyond" (pending publication). Results from the recent publication "[Technoeconomic and Life Cycle Analysis of Bio-Energy with Carbon Capture and Storage \(BECCS\) Baseline](#)," including technoeconomic and LCA results, were discussed. More details can be found in the aforementioned publication.

Peter Balash to Participate in Several Energy Discussions

Peter Balash, associate director of SSAE, was invited by Oak Ridge National Laboratory to serve on the Energy Economics Panel at their virtual Energy Infrastructure Resilience and National Security Workshop on September 29, 2021. The workshop, to be held September 29-30, 2021, will focus on identifying research topics to support the needs of regulating agencies, researchers and community stakeholders in improving the resilience of energy infrastructures to climate

change that is also central to national security from the perspective of economy, policy and technological advancements.

On October 12, 2021, Balash will present the "Future of Carbon Capture and Sequestration" at the Energy Bar Association's virtual Mid-Year 2021 Energy Forum. Participation was coordinated by management in the Office of Fossil Energy and Carbon Management.

// PERSPECTIVES

PARETO Provides Options to Manage Produced Water



By 2030, oil and gas plays across the U.S. are expected to produce more than 60 million barrels of water per day. Most of this water is characterized by high concentrations of total dissolved solids (TDS), exceeding 300,000 mg/L in some plays (e.g., Marcellus Formation). Even though many upstream operators strive to reuse produced water for hydraulic fracturing, disposal continues to be the leading water management practice in the U.S. However, disposal capacity is decreasing rapidly. This reality will require the oil and gas industry to start treating (that is, desalinating) produced water at scale in the foreseeable future. Produced water is challenging to treat due to its high TDS concentrations, as well as the spatial and temporal variability in production qualities and quantities. Given the variation in water produced across and within basins, oil and gas companies need to identify custom, fit-for-purpose water management, treatment and reuse approaches. Individual market participants are faced with growing

complexity in contemplating capital-intensive investments in their produced water infrastructure, and they require computational decision-support tools to rapidly and quantitatively assess feasible options. Currently, few such software tools exist.

Based on a proposal from **Markus Drouven**, a member of SSAE's Process Systems Engineering Research Team, DOE recently launched a three-year, \$5 million produced water optimization initiative to develop, demonstrate and deploy a novel optimization framework for produced water management and beneficial reuse. The framework, which will be developed by NETL, in cooperation with Lawrence Berkeley National Laboratory, is designed to identify cost-effective and environmentally sustainable produced water management, treatment and reuse solutions. Specifically, the proposed platform will support decision-makers with: 1) coordination of produced water deliveries; 2) buildout of the produced water infrastructure; 3) selection of effective treatment technologies; 4) placement and sizing of treatment facilities; 5) identification of beneficial water reuse options; and 6) distribution of treated produced water and/or concentrated brine for beneficial reuse. The figure below illustrates the scope of this initiative

The initiative, referred to as project PARETO (acronym for **P**roduced Water **A**pplication for Beneficial **R**euse, **E**nvironmental Impact and **T**reatment **O**ptimization), will produce an open-source, optimization-based produced water decision-support application that can help the oil and gas and water end-user industries make better and faster decisions to manage, treat and reuse produced water. The application will be provided as both a downloadable executable program and source code. As such, the PARETO framework builds on NETL's leadership in the development of cutting-edge process systems engineering capabilities, including IDAES, the R&D 100 award-winning Institute for the Design of Advanced Energy Systems, and ProteusLib, the water modeling and optimization package developed as part of DOE's National Alliance for Water Innovation (NAWI). Project PARETO will leverage IDAES, as well as the library of water treatment process models made available by NAWI, to create an advanced produced water optimization platform that supports improved decision-making.

Beyond the software itself, this initiative will complete a series of detailed case studies with industry and other partners. These case studies involve the application of the proposed framework to address specific business, environmental

Illustration of the scope of the produced water optimization initiative

// PERSPECTIVES (cont'd)

or regulatory questions. Through these active collaborations, the initiative will provide guidance to DOE and industry on where and how to effectively advance research in produced water treatment and beneficial reuse.

PARETO directly addresses the key DOE goals focused on investments in water and wastewater infrastructure, remediation and reduction of legacy pollution and the development of critical clean water infrastructure. The oil and gas industry will benefit from this research by being able to identify fit-for-purpose produced water management practices, treatment concepts and beneficial reuse opportunities for widespread adoption in plays across the U.S. Expected

environmental benefits to be realized from this research include: 1) improving the utilization of the existing water infrastructure such as pipelines and storage facilities; 2) facilitating increased piping of produced water (as opposed to trucking); 3) reducing produced water disposal volumes; 4) decreasing freshwater consumption; and 5) identifying beneficial reuse opportunities for treated produced water inside and outside the oil and gas industry. There may also be opportunities to explore the establishment of domestic supply routes to recover critical minerals (e.g., lithium) and rare earth elements from oil and gas produced water.

This initiative will place a heavy emphasis on interfacing closely with a diverse yet

comprehensive group of stakeholders that represents interests from across the produced water value chain (production, treatment and beneficial reuse). In particular, the initiative will strive to include in the stakeholder board upstream operators, midstream companies, treatment technology providers, mining companies, farming associations, leading research universities, nonprofit organizations and regulatory agencies.
– Contributed by **Markus Drouven**, SSAE's Process Systems Engineering Research Team

SSAE Takes All-Hands-on-Deck Approach to Support Hydrogen Shot

Green hydrogen is receiving considerable interest as a potential long-duration, bulk energy storage (ES) solution under future high variable renewable energy (VRE) scenarios as an alternative to dispatchable fossil generation equipped with CCS or other advanced, long-duration bulk ES technologies.

Recent pre-publication National Renewable Energy Laboratory work has identified VRE-driven low-temperature electrolysis (LTE), salt cavern H₂ storage and on-demand heavy duty proton-exchange membrane fuel cells (or H₂ combustion turbine/combined cycle) power generation as a leading alternative in competition with NGCC with CCS (operating at low capacity factors).

While NGCC with CCS is a more cost-effective approach to decarbonize fossil-based power generation, the Office of Fossil Energy and Carbon Management and NETL recognize the potential for fossil fuel-derived hydrogen to decarbonize traditionally difficult-to-decarbonize segments of the economy such as

transportation or decentralized, distributed industrial applications.

On June 7, 2021, DOE announced an aggressive crosscutting initiative for hydrogen production called the Hydrogen Energy Earthshot or Hydrogen Shot. The initiative has a specific target of reducing the cost of clean hydrogen production to \$1/kg H₂ within one decade. It and other Energy Earthshot Initiatives support the Biden-Harris Administration's goal of a net-zero carbon emissions economy by 2050 while creating good-paying union jobs and growing the economy. To meet these challenges and others, SSAE has developed an all-hands-on-deck project approach, involving its multiple teams, to support the DOE's Hydrogen Shot Initiative.

Numerous references indicate that fossil-based technologies offer the lowest H₂ production cost today (see figure on next page).^{1,2,3} However, further progress in production cost reduction is required. Hydrogen production facility technological advances are insufficient absent the use of an appropriate biofuel with a negative emissions profile blended

with the coal or natural gas feedstock; consequently, opportunities to reduce upstream emissions are of interest.^{4,5} These opportunities may also contribute to feedstock cost reduction.

SSAE's planned support efforts have the objective to identify potential pathway scenarios to meet the Hydrogen Shot 2030 production cost and emissions intensity goals via screening analyses. Both natural gas and coal (particularly waste coal) primary feedstocks will be evaluated. Advancements to contemporary commercial technologies (e.g., small modular reactors, autothermal reforming and gasification), unit siting choices, application of biofuels and finance assumptions will be considered. The competing, green VRE-LTE production route will also be examined, with emphasis on its cost reduction potential for comparison (using SSAE's analysis methodology and reasonable assumption inputs); numerous entities, including the Office of Energy Efficiency & Renewable Energy, have asserted pathways achieving \$2/kg or less for this production route.

// PERSPECTIVES (cont'd)

SSAE's planned effort is broken into five tasks which will have varied participation among four teams within SSAE (see table below): Energy Process Analysis Team (EPAT), Energy Markets Analysis Team (EMAT) and Energy Systems Analysis Team (ESAT), both LCA and subsurface groups. An outline of the tasks follows:

- Task 1: Establish baseline
 - » Leverage results from SSAE's ongoing H₂ baseline work and other contemporary estimates.
 - » Summarize key process information (including LCA data).
- Task 2: Literature review/information gathering on advanced H₂ production
 - » Consider both current commercial and advanced (future) H₂-production technologies.
 - » Summarize detailed descriptions, flow diagrams, performance/cost data, strengths/weaknesses, etc.
- Task 3: Additional options for improvements (cost and emissions)
 - » Review plant siting, process intensification, financing and byproduct sales data.
 - » Study biofuels feedstock considerations and CO₂ transport and storage costs.
- Task 4: Exploratory analyses to identify candidate pathways
 - » From Tasks 2 and 3, identify/propose pathways, summarize design basis and assumptions and estimate H₂ production costs and emission intensities.
 - » Down-select four to six scenarios for detailed analyses.
- Task 5: Final analyses
 - » Refine analyses on four to six down-selected scenarios.
 - » Conduct sensitivity analyses.
 - » Complete final presentation and white paper.

	EPAT	EMAT	ESAT-LCA	ESAT-Subsurface
Fed. Team lead	Travis Shultz & Bob Stevens	Chris Nichols	Tim Skone	David Morgan
Task 1	✚		•	
Task 2	✚		•	
Task 3	•	✚	•	•
Task 4	✚	•	•	•
Task 5	✚	•	•	•

Team participation to SSAE's support of DOE's Hydrogen Shot

Levelized Cost of Hydrogen (LCOH) by H₂ generation technology

The final deliverables of this work shall be a presentation and white paper for NETL's senior management and DOE Headquarters for use in communicating with stakeholders and making programmatic decisions. The presentation shall include H₂ production cost and emissions intensity waterfalls for each identified pathway scenario, alongside brief descriptions of each stepwise improvement. A summit was held from August 31–September 1, 2021 to present this effort.

– Contributed by **Robert Stevens**, SSAE's Energy Process Analysis Team

References

- ¹ National Academy of Engineering, "The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs," Washington, D.C., The National Academies Press: <https://doi.org/10.17226/10922>, 2004.
- ² International Energy Agency, "The Future of Hydrogen: Seizing today's opportunities," France, IEA Publications: <https://www.iea.org/reports/the-future-of-hydrogen>, 2019.
- ³ U.S. Department of Energy, "Hydrogen Strategy: Enabling A Low-Carbon Economy," Washington, D.C., DOE Publications: https://www.energy.gov/sites/prod/files/2020/07/f76/USDOE_FE_Hydrogen_Strategy_July2020.pdf, 2020.
- ⁴ J. Field et al., "Robust paths to net greenhouse gas mitigation and negative emissions via advanced biofuels," *Proceedings of the National Academy of Sciences of the United States of America*, <https://doi.org/10.1073/pnas.1920877117>, 2020.
- ⁵ U.S. Department of Energy, "2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy, Volume 1: Economic Availability of Feedstocks," ORNL/TM-2005/66, Oak Ridge, TN, <http://energy.gov/eere/bioenergy/2016-billion-ton-report>, 2016.

// UPCOMING

SSAE Federal staff and NETL support contractor personnel will attend or present at the following meetings and conferences in September and October 2021:

- 38th Annual International Pittsburgh Coal Conference
Presenters: **Thomas Tarka** — Rare Earth Elements from Coal and Related Materials: An Overview of Research at the National Energy Technology Laboratory; **Travis Warner** — Section 45Q Tax Credit Impacts on Carbon Management: Case Study Findings and Modeling Developments
Participant: **Marc Turner**
Virtual, September 20–23, 2021
- The American Center for Life Cycle Assessment (ACLCA) 2021 Conference
Presenters: **Matthew Jamieson**; **Sheikh Moni** — Life Cycle Assessment of Emerging Technologies: Current State, Challenges and Recommendations; **Srijana Rai** — Accounting for Methane Emission Variability from Natural Gas Distribution Meters
Participants: **Derrick Carlson**; **Michelle Krynock**; **Scott Matthews**
Virtual, September 20 (pre-conference workshops) and 21–24 (conference), 2021
- Society of Exploration Geophysicists (SEG)/American Association of Petroleum Geologists (AAPG) International Meeting for Applied Geoscience & Energy (IMAGE) 2021
Timothy Grant (presenter) — Comparative Analysis of CO₂ Transport, Storage and Produced Water Management Options from a CO₂ Source Perspective
Hybrid (Virtual and Denver, CO), September 26–October 1, 2021
- EPRI Generation Virtual Advisory Meeting
Participants: **Eric Grol** and **Robert James**
Virtual, September 27–October 7, 2021
- Oak Ridge National Laboratory Energy Infrastructure Resilience and National Security Workshop
Peter Balash (presenter)
Virtual, September 29–30, 2021
- Global Syngas Technologies Conference
Robert Stevens (participant)
San Antonio, TX, October 10–12, 2021
- Energy Bar Association 2021 Mid-Year Energy Forum
Peter Balash (presenter)
Virtual, October 12–13, 2021
- 23rd Annual Experience Power Conference
Alexander Zoelle (participant)
San Antonio, TX, October 18–21, 2021
- 6th Post Combustion Capture Conference (PCCC-6)
Alexander Zoelle (participant)
Virtual, October 19–21, 2021

// CONFERENCES AND EVENTS

- [SPE, Sustainability and Energy Transition](#)
Virtual Workshop, August 30–September 1, 2021
- [U.S. Department of Energy \(DOE\), Hydrogen Shot Summit](#)
Virtual, August 31–September 1, 2021
- [SPE, Delaware, the Next Chapter in Unconventionals - Learning from the Past and Opportunities for the Future](#)
Virtual Forum, August 31 and September 2, 7 and 9, 2021
- [IAEE, The Outlook for Global Oil Demand During the Energy Transition](#)
Webinar, September 1, 2021
- [SPE, Offshore Europe Virtual Conference](#)
Virtual, September 7–10, 2021
- [USEA, 3rd Annual Advanced Energy Technology Forum](#)
Virtual, September 9, 2021
- [BIEE, Energy for a Net Zero Society](#)
Hybrid (Virtual and Oxford, United Kingdom), September 13–14, 2021
- [AIChE, 10th Internal Congress on Sustainability Science & Engineering](#)
Virtual, September 13–15, 2021
- [Columbia University SIPA Center on Global Energy Policy, African Perspectives on Climate and Climate Politics - Africa and Global Climate Diplomacy: Priorities, Lessons Learned, Pathways Forward](#)
Webinar, September 14, 2021

// CONFERENCES AND EVENTS

(cont'd)

- [Virtual Informational Workshop on Responsible and Sustainable Natural Gas: Challenges and Opportunities in Africa](#)
Virtual, September 14–15, 2021
- [USEA, CONSENSUS Program Briefing: CO₂ Storage, Optimizing Large Volume First Mover Projects by Managing Short and Long Term Security and Liabilities](#)
Webinar, September 15, 2021
- [Wood Mackenzie, Rare Earths: a Global Outlook for Key Market Trends](#)
Webinar, September 15, 2021
- [IAEE, Imbalance Settlement Processes: Economic Incentives for Balancing Responsible Parties in Europe](#)
Webinar, September 20, 2021
- [University of Pittsburgh, 38th Annual International Pittsburgh Coal Conference](#)
Virtual, September 20–23, 2021
- [ASME, Advanced Clean Energy Summit \(ACES\) 2021: Achieving the Clean Energy Promise](#)
Virtual, September 21–22, 2021
- [Gastech Exhibition & Conference](#)
Hybrid (Virtual and Dubai, United Arab Emirates), September 21–23, 2021
- [Gastech Hydrogen Exhibition & Conference](#)
Hybrid (Virtual and Dubai, United Arab Emirates), September 21–23, 2021
- [Global Energy Show Exhibition & Conference](#)
Calgary, Canada, September 21–23, 2021
- [SPE, Annual Technical Conference and Exhibition \(ATCE\)](#)
Hybrid (Virtual and Dubai, United Arab Emirates), September 21–23, 2021
- [The American Center for Life Cycle Assessment \(ACLCA\) 2021 Conference](#)
Virtual, September 20 (pre-conference workshops) and 21–24 (conference), 2021
- [Reuters Events, Oil & Gas Majors in Hydrogen](#)
Webinar, September 22, 2021
- [SEG/AAPG, International Meeting for Applied Geoscience and Energy \(IMAGE\) 2021](#)
Hybrid (Virtual and Denver, CO), September 26–October 1, 2021
- [IAEE, Carbon Pricing Shaping Carbon-Neutral Energy & Transport Systems: Technology Exchange, Business Cases](#)
Webinar, September 27, 2021
- [Southern States Energy Board, 61st Annual Meeting](#)
Oklahoma City, OK, September 27–29, 2021
- Oak Ridge National Laboratory Energy Infrastructure Resilience and National Security Workshop
Virtual, September 29–30, 2021
- [EPRI, Generation Virtual Advisory Meeting](#)
Virtual, September 27–October 7, 2021
- [COP 26: Moving the Needle Forward on Climate Action and Climate Technology](#)
Webinar, September 28, 2021
- [EPRI, AI and Electric Power Summit: Accelerating AI Innovation for a Clean Energy Future](#)
Virtual, September 28–29, 2021
- [SPE, CCUS Management - Achieving Net Zero Carbon and Sustainability Goals](#)
Virtual Symposium, September 28–30, 2021
- [Wood Mackenzie, 2021 Global Energy Summit](#)
Virtual, September 28–October 8, 2021
- [Columbia University SIPA Center on Global Energy Policy, How are China's Companies Responding to China's 2060 Carbon Neutrality Goal?](#)
Webinar, September 29, 2021
- [NRAP Phase II Tools Workshop](#)
Virtual, September 29, 2021
- [IEA, Clean Energy Transitions in Sahel Countries Regional Dialogue](#)
Virtual, September 30, 2021
- [Wood Mackenzie, Focus: Grid Edge, Enhancing Grid Resilience](#)
Virtual, September 30, 2021
- [50th Annual Eastern Section AAPG Meeting](#)
Hybrid (Virtual and Pittsburgh, PA), October 2–6, 2021
- [AAPG Midcontinent Section Meeting 2021](#)
Tulsa, OK, October 3–5, 2021
- [SPE, Reservoir Simulation Conference](#)
On-demand recorded presentations, October 4–6, 2021
- [2021 UCFER Annual Technical Review Meeting](#)
Virtual, October 5–6, 2021
- [SPE, Annual Caspian Technical Conference](#)
Virtual, October 5–7, 2021
- [IAEE, The Role of Fundamentals and Policy in New Zealand's Carbon Prices](#)
Webinar, October 6, 2021
- [AIChE, 3rd Battery and Energy Storage Conference](#)
Virtual, October 6–8, 2021

// CONFERENCES AND EVENTS

(cont'd)

- [ASCE 2021 Convention](#)
Virtual, October 6–8, 2021
- [GR/SPE, High-Temperature Well Cementing Workshop Part II](#)
San Diego, CA, October 7–9, 2021
- [The Geological Society of America®, Connects 2021](#)
Portland, OR, October 10–13, 2021
- [IAEE, Electricity Markets Assessments: Europe & the U.S.](#)
Webinar, October 11, 2021
- [SPE/IATMI, Asia Pacific Oil & Gas Conference and Exhibition](#)
Virtual, October 12–14, 2021
- [Reuters Events, Downstream USA 2021 Digital Conference](#)
Virtual, October 12–15, 2021
- [SPE, Russian Petroleum Technology Conference](#)
Virtual, October 12–15, 2021
- [Energy Bar Association 2021 Mid-Year Energy Forum](#)
Virtual, October 12–13, 2021
- [Reuters Events, Offshore & Floating Wind Europe Conference & Exhibition](#)
Virtual, October 13–14, 2021
- [SPE, Artificial Intelligence - Towards a Resilient and Efficient Energy Industry](#)
Virtual Symposium, October 18–19, 2021
- [23rd Annual Experience Power Conference](#)
San Antonio, TX, October 18–21, 2021
- [SPE Europepec featured at 82nd EAGE Conference and Exhibition](#)
Hybrid (Virtual and Amsterdam, The Netherlands), October 18–21, 2021
- [IEA, 8th Annual EPRI-IEA Workshop Challenges in Decarbonisation: Building a Resilient Net-Zero Future](#)
Webinar, October 19–21, 2021
- [UK CCS Research Centre, 6th Post Combustion Capture Conference \(PCCC-6\)](#)
Virtual, October 19–21, 2021
- [ACEEE, 2021 National Conference on Energy Efficiency as a Resource](#)
Virtual, October 19–21 and 26–27, 2021
- [AIChE, Carbon Capture, Transport and Sequestration: Rigorous Electrolyte Chemistry Based Process Simulation](#)
Webinar, October 20, 2021
- [Carbon Capture Technology Expo Europe](#)
Messe Bremen, Germany, October 20–21, 2021
- [Naftogaz Group, Ukraine Gas Investment Congress](#)
Kyiv, Ukraine, October 20–22, 2021
- [Reuters Events, Downstream USA 2021 Conference & Exhibition](#)
Houston, TX, October 21–22, 2021
- [Gordon Research Conference, Carbon Capture, Utilization and Storage: Permanently Removing CO₂ from Our Emissions and Atmosphere](#)
Newry, ME, October 24–29, 2021
- [Verge, The Climate Tech Event](#)
Virtual, October 25–28, 2021
- [Asia Clean Energy Summit Conference & Exhibition](#)
Hybrid (Virtual and Singapore), October 26–28 (conference) and 26–27 (exhibition), 2021
- [SPE, Sand Control and Management – Converting Past Failure and Learnings into Future Success](#)
Virtual Workshop, October 26–28, 2021
- [SPE, Haynesville Basin, the Next Chapter in Unconventionals – Learning from the Past and Opportunities for the Future](#)
Virtual Forum, October 26 and 28 and November 2 and 4, 2021
- [71st Annual Gulf Coast Geoscience Convention \(GeoGulf 2021\)](#)
Austin, TX, October 27–29, 2021
- [26th UN Climate Change Conference of the Parties \(COP26\)](#)
Glasgow, Scotland, October 31–November 12, 2021

// RECENT PUBLICATIONS

Reports

A. Noring, R. George, A. Iyengar and K. Buchheit, “[Technical Assessment of a Novel Hydrogen Producing Solid Oxide Fuel Cell Power System](#),” U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL-2021/2771, Pittsburgh, PA, June 30, 2021.

Conference Proceedings and Events

A. Wendt, A. Sheriff, C. Shih, D. Vikara and T. Grant, “[Screening and Identifying High-Suitability Offshore CCUS Storage Areas in the Gulf of Mexico Using a Multi-Criteria Evaluation Approach](#),” poster presentation at 2020 AAPG Annual Convention & Exhibition, Virtual, September 29–October 1, 2020, released May 21, 2021.

T. Grant, A. Wendt, E. Basista, C. Shih and S. Lin, “[Water Management Cost Assessment of CO₂ Storage Operations](#),” poster presentation at 2020 AAPG Annual Convention & Exhibition, Virtual, September 29–October 1, 2020, released July 2, 2021.

H. Sezer, J. Mason, I. Celik, Y. Fan, H. Abernathy, W. Epting, T. Kalapos and G. Hackett, “[A Simplified Model for Reversible Solid Oxide Fuel Cells](#),” meeting abstract for 17th International Symposium on Solid Oxide Fuel Cells (SOFC-XVII), July 18–July 23, 2021, The Electrochemical Society, Volume MA2021-03, p. 145, 2021.

H. Sezer, J. Mason, I. Celik, H. Abernathy, W. Epting, T. Kalapos and G. Hackett, “[A Transient Three-Dimensional Mathematical Model for the Local Impedance and Polarization Performance of Planar SOFCs](#),” meeting abstract for 17th International Symposium on Solid Oxide Fuel Cells (SOFC-XVII), July 18–July 23, 2021, The Electrochemical Society, Volume MA2021-03, p. 170, 2021.

J. Mason, H. Sezer, I. Celik, H. Abernathy, W. Epting, T. Kalapos and G. Hackett, “[Leveling Transient and Spatial Gradients in Planar Solid Oxide Cells Using Spatially Varied Microstructures: A Numerical Study](#),” meeting abstract for 17th International Symposium on Solid Oxide Fuel Cells (SOFC-XVII), July 18–July 23, 2021, The Electrochemical Society, Volume MA2021-03, p. 172, 2021.

T. Fout, “[Updated Costs for Carbon Capture Retrofits](#),” presentation at DOE-NETL’s 2021 Carbon Management and Oil and Gas Research Project Review Meeting – Point Source Capture: Lab, Bench and Pilot-Scale Research, Virtual, August 13, 2021.

T. Skone, “[Sustainable Water Management for Decarbonizing Fossil Power Generation](#),” EarthShift Global Brown Bag webinar on July 15, 2021, released September 6, 2021.

// REFERENCE SECTION

Models / Tools

[FE/NETL CO₂ Transport Cost Model](#)

[FE/NETL CO₂ Storage Cost Model](#)

[FE/NETL CO₂ Prophet Model](#)

[FE/NETL Onshore CO₂ EOR Cost Model](#)

[Life Cycle Analysis Models](#)

[IDAES Power Generation Model Library](#)

Key Reports

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[Life Cycle Analysis webpage](#)



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