

# 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

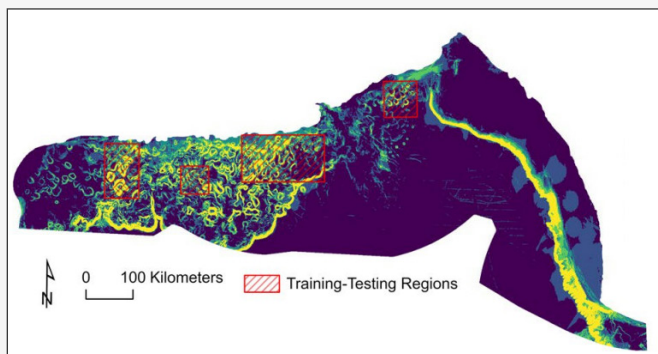
These tools and approaches provide insights into new energy concepts and support the analysis of energy system interactions at the plant, regional, national and global scales.

# // HIGHLIGHTS

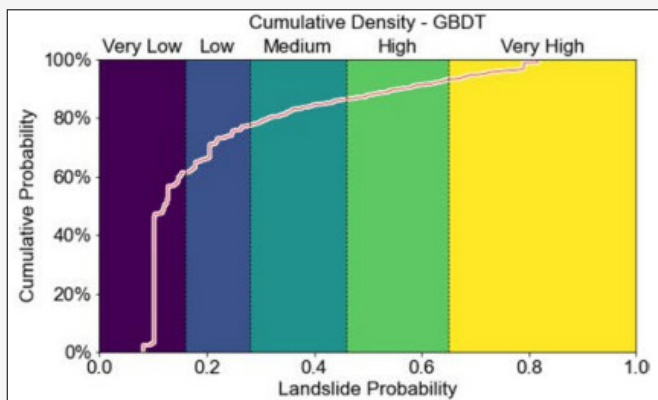
## NETL Research Integrates ML to Enhance Submarine Landslide Susceptibility Mapping

SSAE and other NETL researchers have developed a novel submarine landslide susceptibility mapping approach that incorporates machine learning (ML) to assess potentially hazardous conditions and have applied it to a case study in the offshore northern Gulf of Mexico. Adapting and training machine learning methods to analyze specific conditions can accelerate assessment and forecasting of hazards to energy systems. The approach and application were recently published in the Springer journal *Natural Hazards* as “[Offshore application of landslide susceptibility mapping using gradient-boosted decision trees: a Gulf of Mexico case study.](#)”

This approach gathers and analyzes a series of spatial data features to produce a map of areas that are more likely to have catastrophic instability, leading to submarine landslides that can imperil offshore infrastructure and operations. The full NETL study and submarine landslide data set are available for viewing. Users can also access the machine learning-informed submarine landslide susceptibility mapping tool. The study was conducted by SSAE researcher MacKenzie Mark-Moser, along with other NETL researchers including Alec Dyer, Rodrigo Duran\*, and Jennifer Bauer. [Learn more.](#)



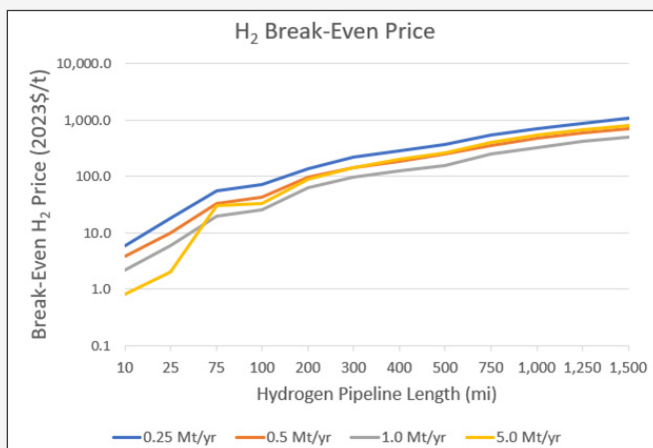
Landslide susceptibility map with predictions using gradient-boosted decision trees (GBDT) ML algorithm



Cumulative density function plot for GBDT map

## Unveiling of the Hydrogen Pipeline Cost Model

SSAE researchers have developed the [FECM/NETL Hydrogen Pipeline Cost Model](#) (H2\_P\_COM), an Excel-based tool that estimates revenues and capital, operating and financing costs and calculates the break-even price (in \$/tonne) for transporting gaseous hydrogen (H<sub>2</sub>) by a newly built point-to-point pipeline. The figure below shows the model outputs for first-year break-even price of hydrogen based on a range of hydrogen pipeline lengths and transport capacities. With its flexible interface, users can tailor the model to fit project requirements by adjusting various parameters. The H2\_P\_COM can help evaluate integrated hydrogen networks and costs (i.e., connecting a hydrogen production facility to an end user or distribution center) to facilitate the addition of hydrogen to the energy economy. The tool was developed by SSAE researchers David Morgan, Alana Sheriff\*, Matthew Wallace, Nur Wijaya\*, Derek Vikara\* and Guoxiang Liu. Along with the model, a user's manual was also released, “[FECM/NETL Hydrogen Pipeline Cost Model \(2024\): Description and User's Manual.](#)”



## Study Presents Cost and Performance Potential for Direct sCO<sub>2</sub> Power Cycles

NETL and SSAE researchers conducted a study that included performing a leveled cost of electricity (LCOE) optimization using NETL software tool FOQUS. The optimized direct-fired supercritical CO<sub>2</sub> (sCO<sub>2</sub>) power plants offered similar or slightly higher plant efficiencies than the reference NGCC plants based on the F-class gas turbine with carbon capture and storage (CCS). The LCOE of the optimized direct sCO<sub>2</sub> plants is 13–17% higher than the reference NGCC plants with CCS due to high capital costs associated with the air separation unit and sCO<sub>2</sub> power block, though there may be significant room for improvement due to the high uncertainty in component capital costs for these new plants, as well as from ongoing research and development (R&D). Recuperators make up over 50% of the sCO<sub>2</sub> power block costs. Consequently, any R&D efforts to reduce the recuperator capital costs will benefit the technology's commercialization potential. The study also

# // HIGHLIGHTS cont'd

presented preliminary results showing the impact of co-firing landfill gas and natural gas on plant efficiency, LCOE and CO<sub>2</sub> emissions.

Authored by Sandeep Pidaparti\*, Charles White\*, Eric Liese and Nathan Weiland, the study, "[Performance and cost potential for direct-fired supercritical CO<sub>2</sub> natural gas power plants](#)," was recently published in Elsevier's journal, Energy (Impact Factor = 9). See authors [link](#) available until June 23, 2024. The article was previously published and presented at the [5th European sCO<sub>2</sub> Conference for Energy Systems](#), March 14–16, 2023, and was recommended for journal publication after peer review.

## SSAE Synthesizes Literature on Measuring Impacts in Energy Communities

The benefits and costs of deploying technologies to meet decarbonization targets are not likely to be evenly distributed. Consequently, SSAE is undertaking research to develop a holistic procedure for conducting energy justice impacts assessments.

SSAE researchers Amanda Harker Steele, Luke Clahane\*, Gavin Pickenpaugh and Jason Boerst\*, performed a review of the literature to identify metrics that support energy justice impact assessments. The results, "[Energy Justice – Measuring Impacts in Energy Communities: A Synthesis of the Literature](#)," were published in the [International Association](#)

[for Energy Economics \(IAEE\) Energy Forum / First Quarter 2024](#). This paper provides a synthesis of the quantitative and qualitative measures, mapping tools, and frameworks, collectively referred to as metrics, available to support energy justice impacts assessments. Results of the review of the literature suggest multiple metrics exist to support energy justice impacts assessments. Next steps are to ensure that a just energy transition includes identifying how these metrics can be used together to collectively support analysis efforts related to energy justice impact assessments, specifically, the energy justice impacts related to designing, developing, and deploying energy technologies.



### Staff Spotlight

**Smriti Sharma** is a data scientist who has been supporting the Energy Markets Analysis Team for four years. Her interests lie in data-focused research to support a decarbonized future. In her work, she specializes in Python-programming for energy markets, energy modeling scenarios (in ETSAP-TIMES), geospatial mapping, and Tableau and Excel visualizations of analysis results. She is currently leading work interlinking outputs between multi-scale energy and electricity dispatch models for NETL's Markets and Grid Infrastructure Interdependence Collaborative (MAGIIC) tool.

Smriti is the co-author of two recent articles; [A tool for measuring the system cost of replacement energy](#), published in the journal Energy and [Market analysis for the integration of new power technologies: A case study of the deployment of hybrid fossil-based generator plus energy storage \(ES-FE\)](#), published in Applied Energy.

Before coming to SSAE, Smriti completed a master's degree in public policy and management (data analytics) at Carnegie Mellon University and a bachelor's degree in information and communication technology from Dhirubhai Ambani Institute in Gandhinagar, India.

Outside of work, she is the vice president of the [Three Rivers Chapter of the United States Association for Energy Economics \(USAEE\)](#). She is passionate about music and is a dancer-in-training in the Indian classical dance form 'Kathak.'

# // NOTICES



## Kudos for Amanda Harker Steele

SSAE Research Economist Amanda Harker Steele was one of 10 staff and researchers at NETL-Morgantown and NETL-Pittsburgh to receive an individual award from the Pittsburgh Federal Executive

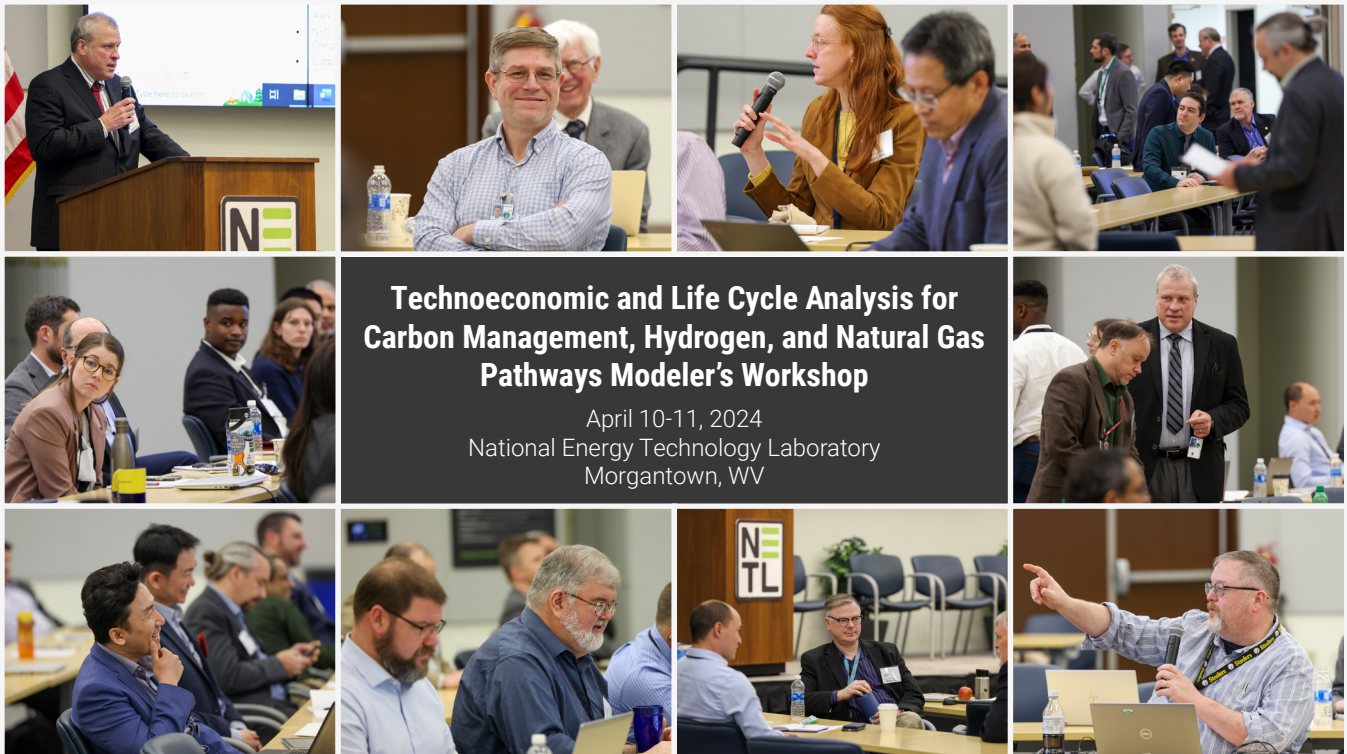
Board (FEB) and has also been identified as a West Virginia Rising Star.

Amanda received the FEB's Professional Employee Bronze Award during its 2024 Excellence in Government Awards

program that was held at Pittsburgh's Heinz History Center during Public Service Recognition Week, May 5–11, 2024. [Learn more.](#)

Additionally, Amanda is a finalist for the [WV State Journal's 2024 class of 40 under 40](#). According to the State Journal, finalists represent 40 of the best and brightest individuals under the age of 40 in West Virginia. Each of the winners is a standout in their field of endeavor and will be recognized at a reception June 19, 2024, in Clarksburg, West Virginia.

Since joining SSAE, Amanda has applied her skills as a research economist to support projects aimed at building a viable energy future that ensures America's historic power-producing communities are not left behind as the nation transitions to clean energy.



## Modelers from Across DOE Meet to Improve FECM Support

Modelers from Department of Energy Offices and National Laboratories met to improve coordination and communication across analysis efforts in support of the Office of Fossil Energy and Carbon Management (FECM) and to harmonize methods and assumptions across studies. The two-day workshop, "Technoeconomic and Life Cycle Analysis for Carbon Management, Hydrogen, and Natural Gas Pathways," was hosted by SSAE and held at NETL in Morgantown, West Virginia April 10–11, 2024.

Over 50 researchers directly involved in technoeconomic, life cycle, and/or market analysis for carbon management, hydrogen, and natural gas pathways in support of FECM engaged in detailed discussions of analysis methods and assumptions. Participants included modelers from Argonne National Laboratory, Lawrence Livermore National Laboratory, National Renewable Energy Laboratory, Pacific Northwest National Laboratory, and DOE's Offices of Loan Programs, Clean Energy Demonstrations, and Technology Transitions.

# // UPCOMING CONFERENCES AND EVENTS

SSAE federal staff and NETL support contractor have or will present or participate in the following events in May and June 2024:

- **[Offshore Technology Conference \(OTC\)](#)**  
Houston, TX, May 6–9, 2024  
Presenters: Timothy Grant - CCS Opportunity along the Gulf Coast Corridor, MacKenzie Mark-Moser - Data-driven, AI/ML tools for multi-factor offshore hazard assessment use case: Deepwater Gulf of Mexico  
Participant: Luciane Cunha
- **[Annual Merit Review and Peer Evaluation Meeting U.S. Department of Energy Hydrogen Program](#)**  
Arlington, VA, May 6–9, 2024  
Presenter: Eric Lewis  
Participants: Kyle Buchheit\* and Alexander Noring\*
- **[National Alliance for Water Innovation \(NAWI\) Workshop on Brackish Water Brine Concentrate Management](#)**  
Phoenix, AZ, May 13–14, 2024  
Participant: Alison Fritz
- **[RAPID Roadmap Workshop: Technology Valuation](#)**  
Golden, CO, May 14–15, 2024  
Panelist: Alison Fritz
- **[National Carbon Capture Center \(NCCC\) Project Review Meeting](#)**  
Birmingham, AL, May 13–16, 2024  
Participant: Sally Homsy
- **[Hitachi Energy Enterprise Software Solutions User Conference Americas 2024](#)**  
Denver, CO, May 20–23, 2024  
Participants: John Brewer, Kirk Labarbara, Erik Shuster
- **[2024 World Hydrogen North America Conference](#)**  
Houston, TX, May 21–23, 2024  
Participants: Luciane Cunha, Eric Lewis
- **[Global CO<sub>2</sub> Initiative 2024 Harmonizing Assessments of Carbon Management Approaches](#)**  
Ann Arbor, MI (also online), May 21–23, 2024  
Presenter: Michelle Krynock - Avoided Emissions  
Participant: Gregory Hackett
- **[2024 Industrial Ecology Gordon Research Conference \(GRC\)](#)**  
Les Diablerets, Switzerland, May 26–31, 2024  
Presenter: Alison Fritz
- **[Mickey Leland Energy Fellowship \(MLEF\) Program Kick-off/Welcome](#)**  
Washington, DC, May 30, 2024  
Participants: John Brewer, Amanda Harker-Steele

# // RECENT PUBLICATIONS

## Articles

- Liu, G., Wu X., and Romanov, V., [Unconventional Wells Interference: Supervised Machine Learning for Detecting Fracture Hits](#). *Applied Sciences*. 2024; 14(7):2927.
- Harker Steele, A., Clahane, L.\*, Pickenpauh, G. and Boerst, J.\* [Energy Justice – Measuring Impacts in Energy Communities: A Synthesis of the Literature](#). IAAE Energy Forum, First Quarter – 2024.
- Jalving, J., Ghouse, J.\*, Cortes, N., Gao, X., et al., [Beyond Price Taker: Conceptual Design and Optimization of Integrated Energy Systems using Machine Learning Market Surrogates](#). *Applied Energy*, 2024; 351, 121767.

## Presentations, Posters and Conference Papers

- Fritz, A., (August 13, 2023). [Process-based cost estimation framework for assessing economic viability of environmentally and socially sustainable rare earth element feedstocks](#) [Meeting Presentation] 2023 American Chemical Society Fall National Meeting Location: San Francisco, California.
- Sheriff, A.\*, McNaul, S.\*, Keairns, D.\*, Woods, M.\*, Warner, T.\*, Lewis, E., Stevens, R., & Morgan, D. (April 3, 2024). [Systems Analysis Perspectives of Methane Pyrolysis, Fossil-Based Ammonia Production, and H<sub>2</sub> and NG/H<sub>2</sub> Transport](#) (FWP-1022467 (5, 7, 8)) [Meeting Poster]. 2024 NETL Resource Sustainability Project Review Meeting. Pittsburgh, Pennsylvania.
- Shamlou, E.\*, Zamarripa, M.A.\*, Arnold, T.\*, Tominac, P.\*, Shellman, M.H.\*, & Drouven, M. (April 3, 2024). [Project PARETO–DOE's Produced Water Optimization Initiative](#) [Meeting Presentation]. 2024 NETL Resource Sustainability Project Review Meeting Pittsburgh, Pennsylvania.

# // RECENT PUBLICATIONS cont'd

- Sampath, A.\* and Adder, J. (April 3, 2024). [Methane Abatement in the Midstream Natural Gas Sector: Barriers and Solutions to Technology Commercialization](#) [Meeting Poster]. 2024 NETL Resource Sustainability Project Review Meeting. Pittsburgh, Pennsylvania.
- Creason, C.G., Rose, K., Montross, S., Maymi, N.\*, Jackson, Z.\*, O'Barr, S.\*, Bishop, E.\*, Wingo, P., Hazle, G., Skipwith, S., Moyes, A., Lindemann, G., Atkins, C., Hird, J., & Taglia, F. (April 4, 2024). [Deploying a New AI Software Tools for Rapid Characterization & Quantification of Unconventional Sources of Critical Minerals](#). [Meeting Poster]. 2024 NETL Resource Sustainability Project Review Meeting, Pittsburgh, Pennsylvania.
- Fritz, A. (April 2, 2024). [Critical Minerals: Systems Analysis Tasks](#) [Meeting Presentation]. 2024 NETL Resource Sustainability Project Review Meeting. Pittsburgh, Pennsylvania.
- Lewis, E. (April 24, 2024). [Advanced Reaction Systems \(FWP-1022405\)](#) [Meeting Presentation]. 2024 FECM/NETL Spring R&D Project Review Meeting. Pittsburgh, Pennsylvania.
- Hackett, G. (April 25, 2024). [Recent Progress in Solid Oxide Cell Technology Analysis at NETL \(Task 4 - Strategic Systems Analysis and Engineering\) \(FWP-1022411\)](#) [Meeting Presentation]. 2024 FECM/NETL Spring R&D Project Review Meeting. Pittsburgh, Pennsylvania.
- Shuster, E. (April 24, 2024). [Research and Development Opportunities for Thermal/Environmental Barrier Coatings and Ceramic Matrix Composites for Hydrogen Gas Turbines \(FWP-1022406\)](#) [Meeting Presentation]. 2024 FECM/NETL Spring R&D Project Review Meeting. Pittsburgh, Pennsylvania.
- Burgard, A. (April 23, 2024). [IDEAS Integrated Platform for Multi-Scale Modeling & Optimization \(FWP-1022423\)](#) [Meeting Presentation]. 2024 FECM/NETL Spring R&D Project Review Meeting. Pittsburgh, Pennsylvania.
- Buchheit, K. and Noring, A. (April 24, 2024). [Pathway Study for Large-Scale Hydrogen Production from Solid Oxide Electrolysis Cell Technology \(FE0025912\)](#) [Poster Presentation]. 2024 FECM/NETL Spring R&D Project Review Meeting. Pittsburgh, Pennsylvania.
- Grant, T. (May 6, 2024). [CCS Opportunity Along the Gulf Coast Corridor OTC-35130-MS](#) [Conference Paper]. 2024 Offshore Technology Conference (OTC). Houston, Texas.
- Grant, T. (May 6, 2024). [CCS Opportunity Along the Gulf Coast Corridor](#) [Meeting Presentation]. 2024 Offshore Technology Conference (OTC). Houston, Texas.
- Mark-Moser, M., Romeo, L.\*, Duran, R.\*, Bauer, J., and Rose, K. (May 6, 2024) [Advanced Offshore Hazard Forecasting to Enable Resilient Offshore Operations. OTC-35221-MS](#) [Conference Paper]. 2024 Offshore Technology Conference (OTC). Houston, Texas.
- Mark-Moser, M., (May 6, 2024). [Advanced Offshore Hazard Forecasting to Enable Resilient Offshore Operations](#) [Meeting Presentation]. 2024 Offshore Technology Conference (OTC). Houston, Texas.

## Models/Tools/Databases

- Morgan, D., Sheriff, A.\*, Wallace, M.\*, Wijaya, N.\*, Vikara, D.\*, and Lui, G., "[FECM/NETL Hydrogen Pipeline Cost Model](#)," DOE/NETL-2024/4841, Pittsburgh, Pennsylvania, March 26, 2024.

## Supporting Documentation

- D. Morgan, A. Sheriff, M. Wallace, N. Wijaya, D. Vikara, and G. Liu, "[FECM/NETL Hydrogen Pipeline Cost Model \(2024\): Description and User's Manual](#)," National Energy Technology Laboratory, DOE/NETL-2024/4841 Pittsburgh, Pennsylvania, April 19, 2024.

# // REFERENCE SECTION

## Models / Tools / Databases

[Carbon Capture Simulation Initiative \(CCSI\) Toolset](#)  
[FECM/NETL CO<sub>2</sub> Transport Cost Model](#)  
[FE/NETL CO<sub>2</sub> Saline Storage Cost Model](#)  
[FE/NETL CO<sub>2</sub> Prophet Model](#)  
[FECM/NETL Hydrogen Pipeline Cost Model](#)  
[FE/NETL Onshore CO<sub>2</sub> EOR Cost Model](#)  
[FECM/NETL Unconventional Shale Well Economic Model](#)  
[Life Cycle Analysis Models](#)  
[NETL CO<sub>2</sub>U 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<sub>2</sub> from Industrial Sources](#)  
[Quality Guidelines for Energy System Studies](#)  
[Life Cycle Analysis](#)

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