IEAGHG 8th Post Combustion Capture Conference

16th to 18th September 2025 Marseille, France

Front-end engineering design studies: a quantitative analysis

Sally Homsy[a]*, Sydney Hughes[a,b], Timothy Fout[c], Dan Hancu[d], Gregory Hackett[a]

[a]*National Energy Technology Laboratory (NETL), 626 Cochran Mill Road, Pittsburgh PA 15236, USA*
[b]*NETL Support Contractor, 626 Cochran Mill Road, Pittsburgh PA 15236, USA*
[c]*Office of Fossil Energy and Carbon Management, U.S. Department of Energy, 3610 Collins Ferry Road, Morgantown, WV 26505, USA*
[d]*Office of Fossil Energy and Carbon Management, U.S. Department of Energy, 1000 Independence Avenue, Washington DC 20585, USA*

Abstract

As post-combustion capture projects move towards deployment, the U.S. Department of Energy (DOE) has been sponsoring front-end engineering design (FEED) studies for retrofitting existing power generating units with post-combustion capture. FEED studies are typically completed prior to final investment decisions; during the FEED phase of project development the project is thoroughly planned, and technical requirements and costs are examined in detail. FEED study reports, made publicly available after DOE-sponsored project completion, contain valuable learnings and detailed project-specific system design, performance, and cost data. The National Energy Technology Laboratory (NETL) has previously reported on learnings that emerge when examining FEED studies in aggregate. [1] This prior work specifically focused on reporting insights that arise from a qualitative comparison of design choices and performance and cost impacts across FEED studies.

Direct quantitative comparison of performance and cost data across FEED studies is generally inadvisable. Different site-specific constraints and impacts, project team-specific methodologies and philosophies, and external impacts, such as market variability and supply chains, are imbedded in the data. Attribution of performance and/or cost discrepancies across projects to specific factors is therefore challenging. Techno-economic analysis (TEA) is the recommended analysis tool for quantitative comparative examination of the impact of specific project and design assumptions on performance and cost. TEAs are completed on a standardized basis allowing isolation of specific factors and the quantitative analysis of the impact of those specific factors. NETL has developed highly cited and widely leveraged post-combustion capture models for TEA. [2] TEAs, however, typically do not account for certain real-world project considerations and report performance and cost on a hypothetical basis.

NETL has devised a methodology for normalizing FEED study metrics of interest and allowing cautious quantitative comparison across FEED studies. This presentation introduces the novel quantitative comparison methodology and presents results from utilizing this methodology to examine data presented in nine recent FEED study reports. Figure 1 summarizes the FEED studies examined in the work. The impacts of certain design decisions on performance and cost metrics of interest are probed and elucidated through statistical analysis. The quantitative methodology developed for the examination of FEED study performance and cost also allows comparison of real-world performance and costs against NETL TEA model predicted performance and cost. Learnings from examining NETL model predicted performance and cost versus real world reported values are highlighted. These learnings provide insight into NETL TEA model uncertainty and highlight opportunities for further model development and follow on work.

* Corresponding author. Tel.: +1-412-386-9166
E-mail address: sally.homsy@netl.doe.gov

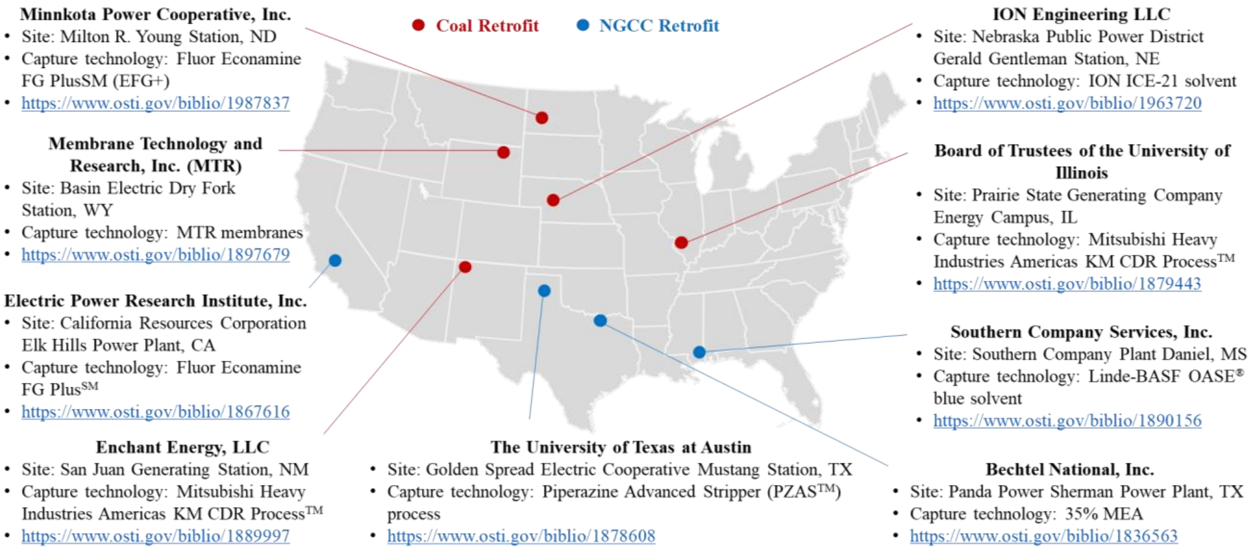

Figure 1: Summary of examined FEED studies

References

[1] S. Homsy, T. Schmitt, S. Leptinsky, H. Mantripragada, A. Zoelle, T. Fout, T. Shultz, R. Munson, D. Hancu, N. Gavvalapalli, J. Hoffmann, G. Hackett. (2025) Insights from FEED studies for retrofitting existing fossil power plants with carbon capture technology. International Journal of Greenhouse Gas Control, 140, 104268. https://doi.org/10.1016/j.ijggc.2024.104268.

[2] T. Schmitt, S. Leptinsky, M. Turner, A. Zoelle, C. White, S. Hughes, S. Homsy, M. Woods, H. Hoffman, T. Shultz, R. James. (2022). Cost and Performance Baseline for Fossil Energy Plants Volume 1: Bituminous Coal and Natural Gas to Electricity (DOE/NETL-2023/4320). National Energy Technology Laboratory, Pittsburgh, PA.

Disclaimer

Keywords: Front-end engineering design; techno-economic analysis; CO_2 capture; power generation.