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Project-specific considerations for retrofitting post-combustion carbon capture technology to power generating and industrial facilities

Sally Homsy[a], Troy Teel[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

Since 2019, the United States Department of Energy (DOE) has been sponsoring front-end engineering design (FEED) and pre-FEED studies aimed at examining the design, performance and cost associated with implementing post-combustion capture systems at existing power generating and industrial plants. FEED and pre-FEED studies are phases of project development during which a specific project is planned and examined in detail. During the pre-FEED phase, different conceptual designs are weighed, and the project design is finalized. The resulting defined project design then enters the FEED phase; technical requirements and overall cost of the specific project are examined in detail and the project is thoroughly planned. These studies result in a package detailing project scope and organizational structure, engineering design packages, logistics, hazard and operability studies, and cost. DOE project award terms stipulated publication of a report highlighting engineering design study findings. Details of specific DOE-funded projects can be found using the DOE CONNECT Toolkit.[1]

To date, ten DOE-sponsored FEED studies examining retrofitting existing power generating plants with capture, and seven DOE-sponsored initial engineering design studies examining retrofitting existing industrial plants with capture have been completed and published. While individually, each study focuses on a specific application and does not provide sufficient information for generalized learnings, when examined in aggregate, common themes emerge highlighting knowledge gaps and general insights that can guide carbon capture research, development, and deployment efforts and accelerate learning rates.

The National Energy Technology Laboratory (NETL) has previously reported on learnings from seven of the FEED studies examining retrofitting power plants with capture.[2] This presentation builds on this effort by highlighting additional learnings from three additional FEED studies examining retrofitting power plants with capture and seven FEED and pre-FEED studies examining retrofitting industrial plants with capture. This includes a discussion of the design, performance, and cost implications associated with (1) site-specific considerations such as water availability, land availability, and site accessibility; (2) host-plant-specific factors such as flue gas specifications, operational mode, and allowable degree of integration between the capture system and host plant.

* Corresponding author. Tel.: +1-304-285-5279
E-mail address: Gregory.Hackett@netl.doe.gov

A summary of the studies examined in this presentation is provided in Figure 1. Site-specific and host-plant specific considerations play a significant role in system design, performance and cost for capture retrofits at industrial and power plants. The examined studies highlight that; (1) in situations where land is not available near the emission source and longer ducting is needed, the presence of certain impurities in treated emissions streams compound the impact on ducting costs, (2) capture from certain industrial plants requires additional considerations due to the presence of multiple point sources and fluctuating emissions stream availability and composition, (3) different approaches for CO_2 purification, specifically O_2 removal, may be suitable for different applications, and (4) in situations where a high degree of plant integration is possible, approaches such as exhaust gas recycle or biomass co-firing may have some merit.

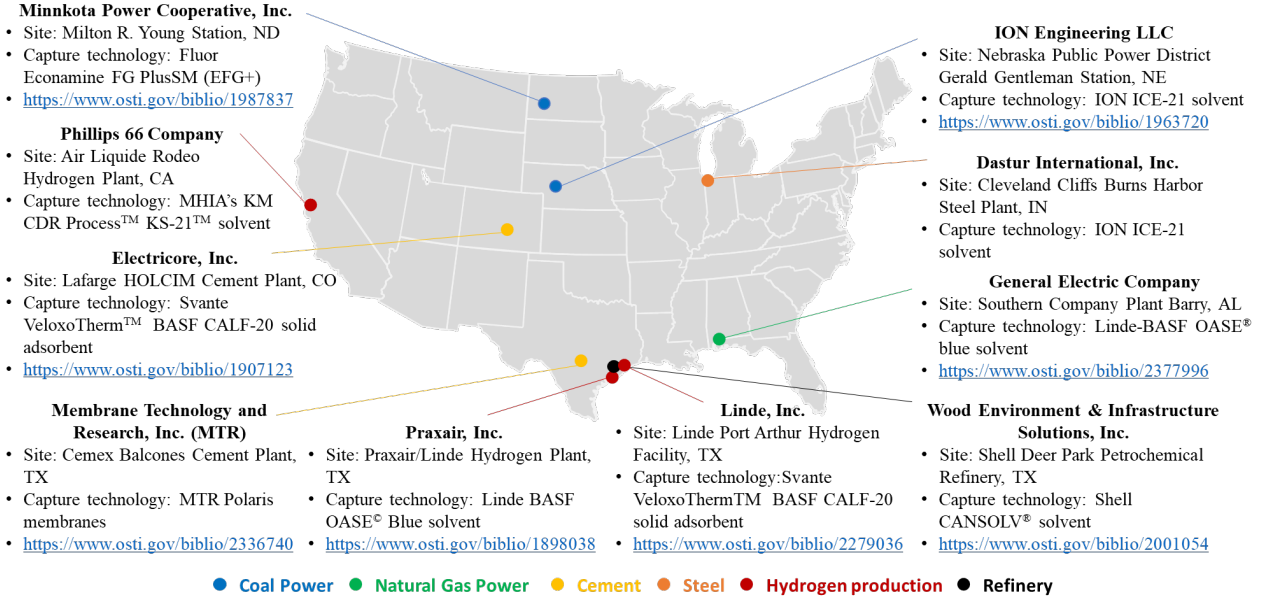

Figure 1: Summary of examined engineering studies

References

[1] https://edxspatial.arcgis.netl.doe.gov/webmaps/carbon-management-connect-toolkit-index.html
[2] 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.

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Keywords: Front-end engineering design; initial engineering design; point source capture; power generation; industrial plants.