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# Front-end engineering design studies: a quantitative analysis

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## Abstract

As post-combustion capture projects move towards deployment, the U.S. Department of Energy (DOE) has been sponsoring frontend 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 DOEsponsored 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 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.

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### Minnkota Power Cooperative, Inc.

- Site: Milton R. Young Station, ND
- Capture technology: Fluor Econamine FG PlusSM (EFG+)
- https://www.osti.gov/biblio/1987837

## Membrane Technology and

- Research, Inc. (MTR) • Site: Basin Electric Dry Fork Station WY
- Capture technology: MTR membranes
- https://www.osti.gov/biblio/1897679

#### Electric Power Research Institute, Inc.

- Site: California Resources Corporation Elk Hills Power Plant, CA
- Capture technology: Fluor Econamine FG Plus<sup>SM</sup>
- https://www.osti.gov/biblio/1867616

#### Enchant Energy, LLC

- Site: San Juan Generating Station, NM
  Capture technology: Mitsubishi Heavy
- Industries Americas KM CDR Process™





https://www.osti.gov/biblio/1878608

Figure 1: Summary of examined FEED studies

### ION Engineering LLC

- Site: Nebraska Public Power District Gerald Gentleman Station, NE
- Capture technology: ION ICE-21 solvent
   https://www.osti.gov/biblio/1963720

#### Board of Trustees of the University of Illinois

- Site: Prairie State Generating Company Energy Campus, IL
- Capture technology: Mitsubishi Heavy Industries Americas KM CDR Process<sup>TM</sup>
- https://www.osti.gov/biblio/1879443

#### Southern Company Services, Inc.

- · Site: Southern Company Plant Daniel, MS
- Capture technology: Linde-BASF OASE<sup>®</sup>
- blue solvent
- <u>https://www.osti.gov/biblio/1890156</u>

#### Bechtel National, Inc.

- · Site: Panda Power Sherman Power Plant, TX
- Capture technology: 35% MEA
- https://www.osti.gov/biblio/1836563

## References

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