Coal Plants with Carbon Capture and Utilization – Potential Business Scenarios with 45Q Tax Credits and Enhanced Oil Recovery

Joel Theis, Phone: 412-386-7333, Email: Joel.Theis@netl.doe.gov  
Arun K.S. Iyengar, Ph. D.: 412-386-5860, Email: Arun.Iyengar@netl.doe.gov  
Ivonne Pena-Cabra, Ph.D.: 412-386-4654, Email: Ivonne.PenaCabra@netl.doe.gov  
Jeffrey Hoffmann, 412-386-5134, Email: Jeffrey.Hoffmann@netl.doe.gov  
Peter C. Balash, Ph.D., 412-386-5753, Email: Peter.Balash@netl.doe.gov

Overview

Coal Fueled Power Plant (CFPP) operation and economics are being greatly influenced by changes in power generation fleet including high renewable penetrations and increases in fraction of power generated using natural gas (NG) catalyzed by the prevalence of historically low NG prices. Constraints relating to the mitigation of carbon emissions may present additional challenges to CFPPs in the future. Accordingly, the National Energy Technology Laboratory (NETL) of the US department of Energy (US DOE) is focusing on innovations to enable coal plants to operate flexibly along with technologies to provide reliable, affordable, and clean power through the adoption of carbon capture and storage systems (CCS).

Questions concerning revenue sufficiency for typical CFPP with CCS and the resulting performance both in terms of efficiency and flexibility have been a focus for R&D researchers for several years. The present study examines the operations of a CFPP with CCS and the economics for the configuration of the CCS unit and the carbon capture rate in conjunction with market and technology variables. Specifically, tax incentives for captured carbon, natural gas prices, oil prices when the production is through enhanced oil recovery (EOR), and the price for ancillary services, are investigated as potential economic drivers for the captured carbon dioxide (CO₂). The main objective of this effort is to assess the possible business model configurations and market factors for commercial demonstration and deployment of carbon capture.

Methods and illustrative example

A simplified spreadsheet model developed to simulate the production costs showed that a CFPP with CCS can competitively dispatch ahead of natural gas combined cycle plants (NGCC) even under low natural gas prices if tax incentives such as the 45Q[1] and revenues from selling CO₂ for EOR are taken into consideration. To explore the impact of the additional revenues on the long-term viability of CFPP with CCS, a system configuration analogous to the commercial Petra Nova plant [2][3] was modeled as shown in Figure 1, where a conventional CFPP is retrofitted with an auxiliary power plant for CCS. The relevant plant characteristics were defined using data from NETL baseline studies.[4] The system performance and market metrics were held constant while the natural gas prices, carbon dioxide prices, and oil prices were varied. Additionally, the level of revenue streams coming from ancillary services, enabled by CCS, were modeled to evaluate revenue sufficiency to meet a 10% return on equity (ROE) once the 45Q tax credits expire (currently set to expire 12 years from the construction of the project).

Summary of key insights and results

- Revenues from CO₂ sales for EOR and tax credits similar to the current 45Q can make the coal plant competitive compared to NGCC units, even at low NG and CO₂ prices.
- Coal power plants with CCS benefit most when operating in baseload mode to maximize CO₂ revenue from sales to EOR fields, and a tax credit applying the current Section 45Q Tax Credit.
- Direct partnership with an EOR field similar to Petra Nova appears to be an attractive business model, possibly portending joint ownership opportunities between the power and oil industries.
- Ancillary services can aid in reducing the simple breakeven period by 1–2 years depending on the frequency and value of the service based on the simplified modeling used here.
Figure 1 Configuration of a coal power plant with carbon capture (CC) and an auxiliary plant for CCS

Further analysis was completed using PROMOD™, a security constrained economic dispatch (SCED) model, simulating the economic dispatch of several coal units currently operating in the PJM and SPP Regional Transmission Organization (RTO) regions. This preliminary analysis of the Petra Nova type configuration in several locations suggests that if the CFPP with CCS is operated as a price-taker at an annual capacity factor of 85% and has 90% CO₂ capture, the CO₂ sales for EOR combined with tax credits, such as the 45Q tax credits, in a joint project can be profitable for a company at several locations. The CO₂ price for EOR that makes this combination of plants viable is approximately $20 per ton and higher, and dependent on the high operational levels for both plants.[5]

These are results from preliminary cash flow analyses of the coal plants in the PJM and SPP regions. Further analyses will be to expand the PROMOD™ and cash flow analyses of a select group of plants that have characteristics that may be most suitable for CCS and CO₂ sales for EOR in various regions of the U.S.

Conclusions

A CFPP with CCS that receives the 45Q tax credit and has a revenue stream from the CO₂ sold for EOR was found to dispatch ahead of NGCCs, operating at full load, using a spreadsheet economic dispatch model. In the simulated power market, under baseload operation and provision of ancillary services these power plants show revenue sufficiency. In actual markets, namely PJM and SPP RTOs, it was found that location is very important because of local demand and resource balances that can change financial outcomes based on pricing. The investment decision relies mainly on the oil market: oil prices should be at least $60/bbl to enable break-even when combined with auxiliary plant investments within 5 years. Our analysis provides a glimpse at one type of opportunity that can lie behind the deployment of the next generation of coal power.

References