Evaluation of Options for CO₂ Capture/Utilization/Disposal

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ABSTRACT

The project objective is to develop engineering evaluations of technologies for the capture, use, and disposal of carbon dioxide (CO₂). This project emphasizes CO₂-capture technologies combined with integrated gasification combined-cycle (IGCC) power systems. Complementary evaluations address CO₂ transportation, CO₂ use, and options for the long-term sequestration of unused CO₂. Commercially available CO₂-capture technology is providing a performance and economic baseline against which to compare innovative technologies. The intent is to provide the CO₂ budget, or an "equivalent CO₂" budget associated with each of the individual energy-cycle steps in addition to process design capital and operating costs. The value used for the "equivalent CO₂" budget is 1 kg CO₂/kWhe. The base case is a 458-MW (Gross) IGCC system using an O₂-blown Kellogg-Rust-Westinghouse (KRW) agglomerating fluidized bed gasifier, Illinois #6 bituminous coal feed and low-pressure glycol sulfur removal followed by a Claus/SCOT treatment to produce a salable product. Mining, feed preparation and conversion result in a net electric power production for the entire energy cycle of 411-MW with a 0.801 kg/kWhe CO₂ release rate. For comparison, the gasifier output was taken through water-gas shift and then to either low-pressure glycol or chilled methanol for H₂S recovery; low-pressure glycol or membranes for CO₂ recovery; and finally either a combustion turbine or fuel cell as the topping cycle. CO₂ recovery was set at 80% for all cases so that the membrane system could be compared with the glycol on a consistent basis. The combustion turbine was then fed a high hydrogen content fuel. From the IGCC plant, a 500-km pipeline took the CO₂ to geological sequestering. For the optimal case, the net electric power projection was reduced by 73-MW with a 0.277-kg/kWhe CO₂ release rate (when make-up power was considered).