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Economic and market analysis of CO_2 utilization technologies – focus on CO_2 derived from North Dakota lignite

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Abstract

Based on information obtained about the technical aspects of the technologies, several challenges are expected to be faced by any potential CO_2 utilization technologies intended for North Dakota lignite plants. The weather, alkaline content of lignite fly ash, and space limitations in the immediate vicinity of existing power plants are challenging hurdles to overcome. Currently, no CO_2 utilization option is ready for implementation or integration with North Dakota power plants. Mineralization technologies suffer from the lack of a well-defined product and insufficient alkalinity in lignite fly ash. Algae and microalgae technologies are not economically feasible and will have weather-related challenges.

Keywords: CO_2 utilization; CO_2 reuse

1. Introduction

Because of the abundant supply of coal resources such as lignite in North Dakota and some of the Midwestern states, the United States will rely on the use of fossil fuels for its energy needs for many years to come, thus sustaining or increasing the level of CO_2 emissions. Since lignite produces more CO_2 per unit of energy compared to the other ranks of coal, it will be the fuel most impacted by any move to force CO_2 emission reductions from power plants. Given that the primary use for North Dakota lignite is minemouth electrical power plants, any CO_2 regulations will potentially have more impact on the North

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Dakota power industry and economy. To lessen the impact on the state, it is important to begin exploring ways of addressing the CO_2 emission issue in a sustainable manner. To this end, approaches that focus on CO_2 capture and reuse are attractive, particularly in areas where geologic storage may not be an optimal solution. Also, finding a potential use for the captured CO_2 might generate additional revenue to help offset some of the costs associated with CO_2 capture and, hence, act as an incentive for capturing CO_2 from lignite-fired power plants.

The primary purpose of this Energy & Environmental Research Center (EERC) study was to assess existing and emerging technologies for the beneficial use of CO_2 captured from North Dakota lignite-fired power plants. In the context of this study, the best technology is defined as one that not only utilizes CO_2 efficiently and cost-effectively but also results in or produces the most marketable product. By specific recommendation of the North Dakota Industrial Commission's (NDIC's) Lignite Research Council, technologies related to enhanced oil recovery (EOR), enhanced coalbed methane (ECBM), and enhanced gas recovery (EGR) were not considered in the investigation. All other areas that show both near- and long-term promise were considered in the study.

2. Methods

While carbon capture, utilization, and storage (CCUS) technologies are developing rapidly worldwide and possess the potential to offer a significant contribution to CO_2 mitigation, there is interest in also exploring the possibility of CO_2 utilization in other end uses, such as in building material production, fuels, and chemicals. Several broad technology areas are being developed to facilitate the beneficial use of captured CO_2 from large point sources, such as coal power plants. These technologies encompass various applications, including EOR, ECBM recovery, CO_2 conversion to chemical feedstocks and fuels, biological conversion (photosynthesis) processes, and CO_2 mineralization for the production of materials. EOR is one of the largest uses of CO_2 captured from anthropogenic point sources, especially in the last few decades when there has been a greater desire to rely more on locally produced oil. During times of high natural gas prices in the United States, some of the CO_2 has been directed to ECBM recovery to boost production. In the last several years, more attention is being directed to other technologies such as algae growth, electrofuels, and chemicals as a means of providing a beneficial use for the captured CO_2, which could offset some of the high costs associated with CCUS technologies. An overview of these technologies is presented in Figure 1.