IGCC with Carbon Capture: A Comparison of Technologies, Efficiencies and Cost for Underground Storage of Hydrogen and Substitute Natural Gas for Flexible Power Generation

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Traditionally, fossil fuel power plants have been designed to satisfy base load electricity demand. The emissions from power plants and their consequences for the environment have now to be recognized. As the world electricity sector is striving to achieve a low carbon power supply, future plans for electric power generation foresee nuclear and renewables as the main sources of power. However, fossil fuels still play a significant role in the global energy mix stabilising the power and energy demand and also buffer diurnal, seasonal and weather-related fluctuations in grid demand. Coal is still the most abundant and dominant fuel in global market. Carbon capture will have to be applied to this thermal capacity in order to meet carbon dioxide (CO2) emission targets to meet the Paris climate deal which set an ambitious target to limit global warming below 2C and even talked about striving towards 1.5C above pre-industrial levels.

Integrated gasification combined cycle (IGCC) with carbon capture is a well developed technology for low-carbon power generation from coal fossil fuel. Intermediate storage of fuel gas and utilising the stored gas for peak power production increases the operating flexibility of such power plant and helps satisfy fluctuating grid demand.

This paper evaluates the options of storing hydrogen-rich gas and substitute natural gas produced from IGCC with carbon capture and storage (CCS) schemes in underground salt caverns for flexible power generation. Substitute natural gas (SNG), produced by Wood VESTA process scheme has several advantages over the usual hydrogen-combustion IGCC concept. SNG has higher energy density and can be combusted in any gas turbine, including existing combined cycle gas turbine (CCGT) capacity. The elimination of the need for dilution gas and reduced NOX formation also add to the attractiveness of the SNG scheme. However, the level of pre-combustion carbon capture achievable is lower in the SNG case, compared with the hydrogen case. The impact on overall plant efficiency, project cost and operational flexibility of power plant is assessed in detail for both hydrogen-rich and SNG storage options.