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Economic Rationale for Safety Investment in Integrated Gasification Combined-Cycle Gas Turbine Membrane Reactor Modules

EPRG Working Paper 1211

Cambridge Working Paper in Economics 1226

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Integrated Gasification Combined Cycle (IGCC) combustion of coal represents a promising technology option with the potential to secure numerous energy policy goals. IGCC chemically converts coal into a synthetic gas (syngas) for combustion in a combined cycle power plant for electrical power generation. The gas turbine and steam turbine are similar to those found in the well established technology Combined Cycle Gas turbine (CCGT), as widely used for electricity generation from natural gas. The United States, with substantial economically accessible coal reserves is supporting IGCC technology developments as a consequence of the potential IGCC has for greenhouse gas emission abatement. Integrated Gasification Combined Cycle – Membrane Reactor (IGCC-MR) power plants are capable of providing electricity and high purity hydrogen. Hydrogen is a candidate energy carrier for low carbon vehicles of the future. Membrane reactors raise a number of potential safety concerns as a consequence of the presence of toxic reagent gases and the risk of fire or explosion. Such accidents would have negative consequences for the economic operation of the plant even without consideration for potential loss of life or injury. This work quantitatively assesses these realities using a specially developed net present value (NPV) model. Accident risks sit within an already uncertain business context. Sources of irreducible uncertainty (market, regulatory and technological) are explicitly recognized, such as the power plant capacity factor, price of key consumables (palladium and gold), membrane life-time and potential CO2 prices (taxes). The effect of the above uncertainty drivers is elucidated using a Monte-Carlo

simulation technique that enables the propagation of the above uncertain inputs through the NPV-model. In this way we generate a more realistic distribution of the plant's value rather than a more narrowly focused single-point/estimate. Even for situations where loss of life and health effects are not calculated, comparatively more attractive NPV distribution profiles are obtained when concrete safety risk-reducing measures are taken into account through pre-investment in process safety (equipment) in a pro-active manner. This indicates the strength of the economic argument in favor of safety investments. Such insights are relevant to broader considerations in engineering safety. The UK for instance has a goal-oriented approach to much engineering safety allowing companies to choose how best to meet a safety requirement. The US by contrast has a more prescriptive 'check-list' approach often developed with little regard to cost. The economic assessment of safety investment discussed in this work has the potential to influence theory and practice concerning safety regulation and to provide incentives and efficiencies that arise from economically grounded decision making.

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Publication May 2012
Financial Support U.S. Department of Energy, Award No. DE-FC26-07NT43058 & DE-FE0004895