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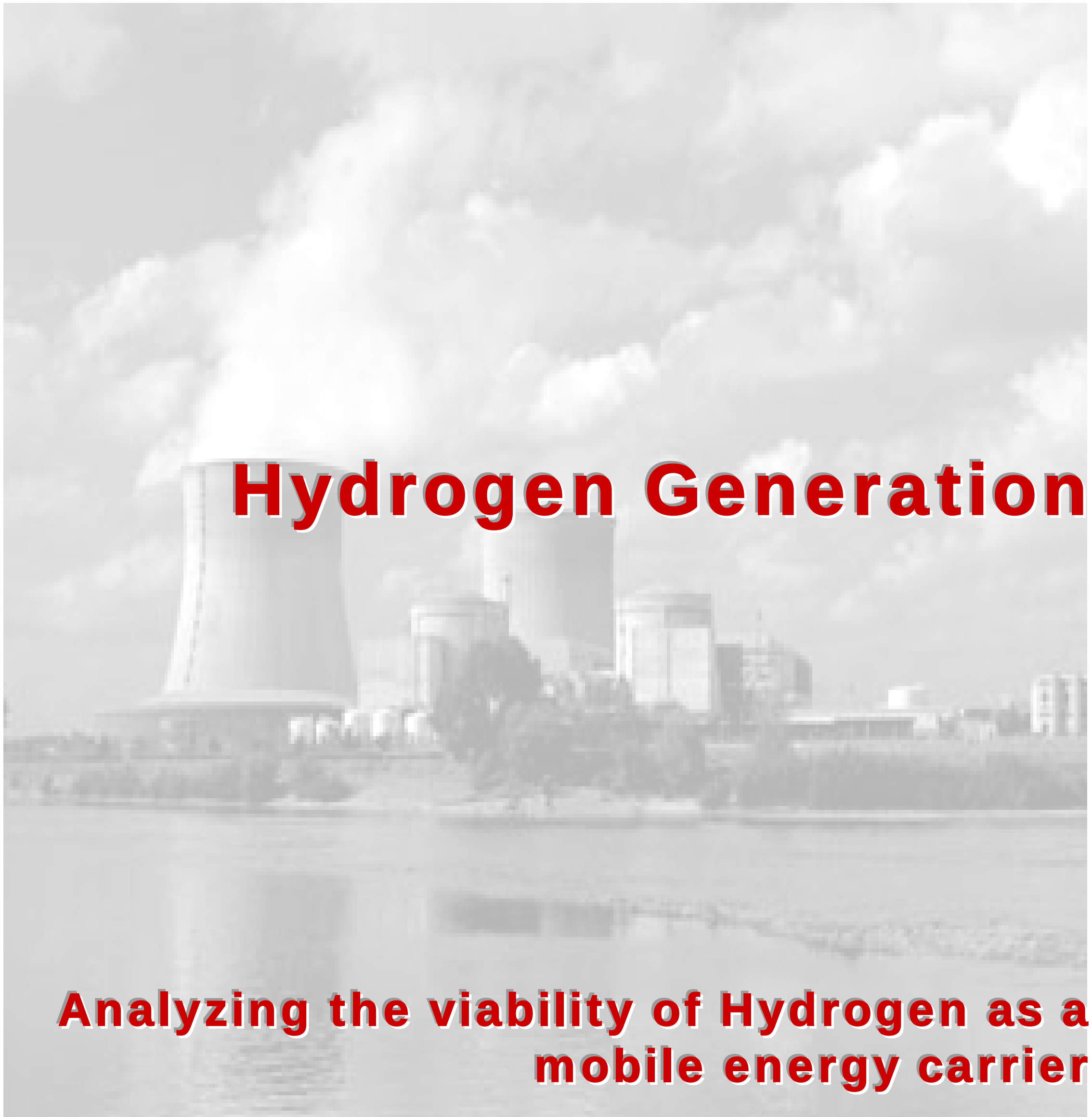

Hydrogen Generation

Analyzing the viability of Hydrogen as a mobile energy carrier

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Executive Summary

In many scientific circles, the discussion of Hydrogen production for the storage and transportation of energy is a main topic. Hydrogen is a promising energy carrier, which potentially could replace the fossil fuels used in the transportation sector of our economy. Fossil fuels are a limited resource and are mass polluters with carbon dioxide emission from their combustion holding the main responsibility for global warming.

As fossil fuel supplies decrease and oil prices increase, the transportation industry will begin to be more accepting of alternative energy sources. If a cheap, reliable method of hydrogen production is secured, hydrogen will offer the viable alternative that is sought.

Hydrogen can be produced through steam reforming or water splitting cycle. A water splitting cycle is a combination of water and heat that are fed through a series of reactions in a cycle, producing the basic elements along with waste heat. However, this method is currently more capital intensive then the steam reforming and has a higher production cost.

In this report a thermodynamic analysis of each cycle was performed, using a heat cascade, equilibrium constants and free energy of reactions. From this, the cycle efficiency was determined.

The cycle with the greatest heat cascade efficiency was the Hallett Air Products with 99.7%. A plant capable to produce 500 tonnes of hydrogen per day will be constructed and located at Hartsville, South Carolina. This is based on the knowledge that Duke Energy is constructing a new nuclear power plant using a Gas Turbine Modular Helium Reactor. The plant is scheduled to operate in 2015. The hydrogen production plant would service three major cities: Columbia, S.C., Raleigh, N.C., and Charlotte, N.C. These cities have a combined population of 965,166. Our team has used this value to aid in the calculations for production, transporting, and storing hydrogen for those cities. Our team's economic market for hydrogen is Hydrogen Fuel Cell (HFC) cars.

The total capital investment for the Hallett Air cycle required for the hydrogen plant, distribution piping, and storage facilities is **1.1 billion USD**. The energy costs would be 14 kWh (t)/kg of H_2 produced or 38.7 kWh (e)/kg. Using this process, the cost of Hydrogen to be **$2.30/kg** with a selling price of $4.75/kg of H_2. The investor's rate of return for this process is 10.28% with a NPV of $30,605,100. Comparing this to the Sulfur-Iodine process at the same location, would require a total capital investment of **1.5 billion USD**. The energy costs would be 75.7 kWh (t)/kg of H_2 produced. The resulting cost of Hydrogen would be **$1.97/kg** with a selling price of $4.75/kg of H_2. The selling price of hydrogen included the depreciation of the production plant. The investor's rate of return for this process is 8.26% with a NPV of -$247,152,500. These costs are based on the safe investment assumption of 10% and depreciation is factored. Furthermore, the costs do not include the capital cost of a new nuclear power plant.