**Thesis Project Portfolio**

# Design of an Autothermal Blue Hydrogen Production Plant

(Technical Report)

# An Actor-Network Theory Analysis of the Failure to Develop California's Proposed "Hydrogen Highway Network"

(STS Research Paper)

An Undergraduate Thesis

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**Sociotechnical Synthesis**

My technical project and STS research paper are closely connected in their analysis of hydrogen and its potential to transform the current energy sector into a cleaner, greener system. Hydrogen is an energy carrier that has gained traction and popularity as a zero-emissions fuel, creating growing interest and research into a future "hydrogen economy" in which the primary commercial fuel would be hydrogen. Together, my technical project and research paper address two different facets of the obstacles to achieving a true hydrogen economy. In my technical work, my team and I tackle the need for cleaner means of hydrogen production and how this can be achieved, while my research focuses on the challenges of actually implementing hydrogen fuel in vehicle applications. The theme of improving hydrogen production, infrastructure, and implementation is present across both works.

For my technical project, my capstone team designed a blue hydrogen production plant that uses autothermal methane reforming. Hydrogen produced through traditional methods is often called "gray hydrogen" because it is made from natural gas and releases significant carbon dioxide emissions. "Green hydrogen" is the most sustainable means of production, made simply from water, but it has not yet been scaled up for commercial use. Blue hydrogen splits the middle of these two extremes, using natural gas as a feedstock, but capturing and storing the carbon dioxide that is produced to lower the carbon footprint of the plant. Additionally, our design uses autothermal reforming, in which the energy needed to sustain the hydrogen formation reactions is generated within the system itself, instead of traditional steam methane reforming in order to reduce the energy demands of the plant. In our design, we demonstrate that a profitable and more environmentally conscious route for hydrogen production is possible.

My STS research paper moves beyond the production of hydrogen and analyzes the implementation of hydrogen fuel in vehicle applications by looking at a case study in California. In this paper, I analyze how former Governor Schwarzenegger's vision of a so-called "hydrogen highway" of hydrogen fueling stations running the length of California has struggled to become a reality. I employ Actor-Network Theory to identify the various different types of actors present in the proposed network and examine how they are interrelated. Through this analysis I argue that it was not only technical shortcomings and economic obstacles that contributed to the initial failure of the hydrogen highway, but also political turnover and opposition or indifference by key social actors. The goal of my research is to understand the social, political, and conceptual factors that may hinder the successful implementation of new, zero-emissions technologies.

Both of these projects greatly benefited from being developed simultaneously. In my technical work, I learned more about the significant engineering that goes into producing pure hydrogen and gained a greater appreciation for the technical challenges involved in the development of hydrogen fueling technologies. Similarly, the research I conducted for my STS paper provided me with greater context for the political, economic, and social challenges surrounding hydrogen development. This work gave me pause to consider that although cleaner methods of hydrogen production may be ready today, society may not yet be ready for the deployment of hydrogen fuel cell applications. In total, working on both my technical project and STS research paper together this year has helped me explore hydrogen and its applications from several different perspectives and provided me with a more holistic view of the potential for a future hydrogen economy.