Product design / development / engineering | Technology | Product design and testing | Unsupervised Learning

On-Site Hydrogen Production via Distributed Methane Pyrolysis

BUSINESS PROBLEM

NextEra Energy is a major investor in energy infrastructure and clean energy technology, including clean hydrogen. To initiate their hydrogen program, NextEra Energy will build a 25 MW green hydrogen facility (made from renewable electricity) and invested in a large-scale producer of turquoise hydrogen (made from natural gas without CO2 emissions). Both of these are most affordable as large-scale centralized facilities, but current transportation and storage technology can make hydrogen cost-prohibitive for small-scale consumers. For these customers, a distributed hydrogen production method may be more desirable.

APPROACH

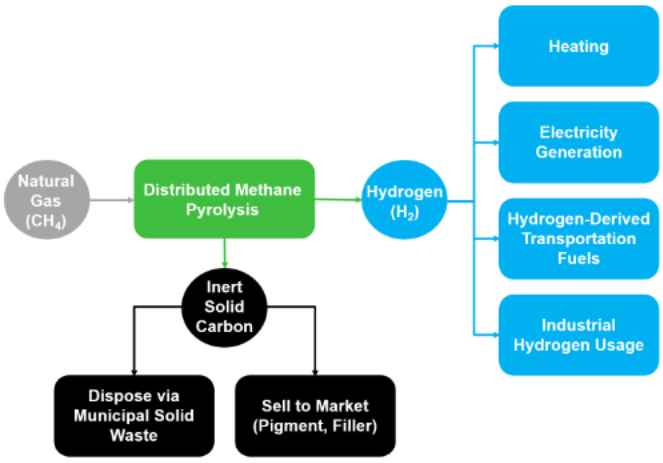
A novel method for producing low-emissions hydrogen from natural gas, known as methane pyrolysis, is unique in that it can be scaled down more economically for use in distributed hydrogen applications. This thesis provides an analysis of the economic viability and technical feasibility of this technology across several small-scale consumer applications, supported by a field demonstration.

DATA SOURCES

Publicly available historical data on residential, commercial, and industrial utility prices (electricity, natural gas, and liquid fuels) at the regional and state levels were utilized from the Energy Information Administration. Electricity costs were utilized from publicly available state-level government databases and select utility rate disclosures.

Data Types and Format

External utility data was exported in .csv format. Comparative economic data was in numerical format, mostly from conversations with stakeholders and through existing documentation.



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IMPACT

This thesis identifies economically viable uses for distributed methane pyrolysis, particularly in difficult to decarbonize industries where geographical location and/ or cost constraints limit access to traditional renewables like solar and wind and low-emissions hydrogen from centralized sources. As NextEra Energy continues to pursue new clean energy technologies, this analysis will be key to guiding future investment in and implementation of distributed methane pyrolysis for low-emissions hydrogen production at the point of consumption.

DRIVERS	A major driver for this project was the need to identify strategic technologies which can economically address difficult to decarbonize sectors while simultaneously leveraging already existing resources.
BARRIERS	Barriers to project completion included limited access to state-level public utility data, especially for commercial customers, ongoing volatility with electricity and natural gas prices, and pricing uncertainty with several early-stage technologies included in the study.
ENABLERS	This project was enabled by broad support from NexEra Energy, particularly from my project supervisor and teammates. This included support for site visits to asses the technology and a willingness to engage in cross-functional collaboration within the company, especially between the Strategy and Product Solutions and Hydrogen teams.
ACTIONS	Worked closely with distributed pyrolysis technology developers to understand the technology and unit economics in order to identify market segments where systems could be successfully deployed. Collaborated with internal stakeholders to understand the hydrogen landscape and competing technologies.
INNOVATION	Two notable innovations with this solution are the use of distributed methane pyrolysis to generate small quantities of clean hydrogen on-demand, eliminating the need for storage, and the use of a methane pyrolysis system coupled with a hydrogen-compatible generator for arbitrage while simultaneously decarbonizing critical infrastructure.
IMPROVEMENT	Identification of three new markets where distributed methane pyrolysis can provide small-scale and intermittent consumers of hydrogen with a best-value hydrogen generation solution while simultaneously leveraging already existing natural gas resources. using this technology, low-carbon hydrogen can be generated in small quantities at the point of consumption for as little as $1.70/kg.
BEST PRACTICES	Ensure a thorough understanding of the competitive landscape and how different use cases impact economic and technical viability of competing solutions.
OTHER APPLICATIONS	This project approach is broadly applicable to evaluating and commercializing emergent technologies, both inside and outside of the clean energy space.