Technoeconomic Model and Analysis for Hydrogen (H_2) Pipeline Transportation

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Overview

Based on recent literature, the total length of hydrogen pipelines that are currently operating in the United State (U.S.) is about 1,600 miles, which are mainly owned by hydrogen producers serving large users such as petroleum refineries and chemical plants, mostly located in Gulf Coast region [1,2]. With the increasing demand for hydrogen nationally and internationally to replace fossil fuels and thereby reduce emissions of carbon dioxide (CO_2) to the atmosphere, there will be a need for additional infrastructure to transport hydrogen by pipeline. There are principally two options for increasing pipeline infrastructure. The first is to re-purpose existing natural gas pipelines to either transport pure hydrogen, or, more likely, to transport a blend of natural gas and hydrogen. The second option is to build new pipelines designed to transport pure hydrogen. For the first option, the main benefit is using existing infrastructure which can significantly reduce the cost of transporting hydrogen, although some elements in an existing natural gas pipeline may need equipment modifications to be able to safely transport a mixture of hydrogen and natural gas. For the second option, the major concern is the cost of constructing a new hydrogen pipeline which can be significant.

Methods

This paper reports on an open-source Excel-based technoeconomic model developed by the National Energy Technology Laboratory (NETL) which is part of the Office of Fossil Energy and Carbon Management (FECM) within the U.S. Department of Energy, the "FECM/NETL Hydrogen Pipeline Cost Model" or H2_P_COM. The H2_P_COM model estimates the technical requirements and costs for a point-to-point pipeline transporting hydrogen in the gas phase. The pipeline can have compressor stations along the pipeline to boost the pressure. The capital costs for the pipeline are based on the capital costs for natural gas pipelines with adjustment factors to convert natural gas pipeline costs to hydrogen pipeline costs [2, 3, 4, 5]. H2_P_COM includes capital costs for the compressor stations as well as operations and maintenance (O&M) costs and has a financial model that assumes the pipeline is operated by an independent profit-seeking entity that charges a user to transport hydrogen. The user supplies a price for transporting hydrogen and H2_P_COM calculates revenues, capital costs, O&M costs and taxes. Costs are subtracted from revenues to generate net earnings and these net earnings are discounted by the weighted average cost of capital to give the present value net earnings which are summed to provide the net present value (NPV) for the project. If the NPV exceeds zero, the price for transporting hydrogen is high enough to cover all costs. H2_P_COM can also calculate the break-even price which is the price where the NPV for the project is zero. This represents the lowest price the pipeline operator can charge and cover all costs including financing costs. H2_P_COM is very flexible with options to calculate revenues, costs and a variety of financial metrics for different hydrogen mass flow rates and pipeline lengths.

Results

This paper will present costs and break-even hydrogen prices for transporting different mass flow rates of hydrogen over a variety of pipeline lengths. The paper will also provide costs generated by the model with costs available in the open literature.

Conclusions

H2_P_COM is an open-source tool that is flexible and easy to use. It should allow organizations that are interested in estimating the cost of constructing and operating new hydrogen pipelines the ability to develop screening-level revenues and costs for this use.

References

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