INTERNATIONAL JOURNAL OF HYDROGEN ENERGY 45 (2020) 24159–24173

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/he

Economic, environmental, and social impacts of the hydrogen supply system combining wind power and natural gas

Chanhee You [a], Hweeung Kwon [b], Jiyong Kim [a,*]

[a] Department of Energy and Chemical Engineering, Incheon National University, Academy-ro119, Incheon, 22012, South Korea

[b] Department of Chemical and Biomolecular Engineering, Yonsei University, 50 Yonsei-ro, Seodaemun-ku, Seoul, 03722, South Korea

HIGHLIGHTS

- New hydrogen supply system using natural gas and wind power is proposed.
- The economic, environmental, and social impacts of the proposed system is analyzed.
- 13 scenarios of different sources, supply strategies and fuel stations are conducted.
- Comprehensive solutions for planning the hydrogen infrastructure are provided.

ARTICLE INFO

Article history:
Received 20 March 2020
Accepted 10 June 2020
Available online 6 August 2020

Keywords:
Hydrogen supply
Renewable energy
Process simulation
Natural gas
Korea

ABSTRACT

Hydrogen economy is one of the most attractive alternatives to the current carbon-based energy system, since it can be produced from diverse resources and used as a carbon-free energy carrier from the end-user's perspective. This study proposes a hybrid hydrogen supply system for the transport sector, which includes all the life stages from production, transport, and storage to final distribution (fueling stations). Particularly, we consider two types of resources for hydrogen production (i.e., renewable wind power and conventional natural gas) to identify the benefits and bottlenecks of hydrogen supply systems from the economic, environmental, and social perspectives. To achieve this goal, rigorous process models for the involved processes (i.e., hydrogen production by steam methane reforming from natural gas and water electrolysis using wind power, and hydrogen storage and transport) are developed. To illustrate the capability of the proposed system, we conducted a design problem within the hydrogen supply system in Jeju Island, Korea. In this case study, three scenarios were generated by combining different hydrogen production options: 1) wind power-based hydrogen production, 2) natural gas-based hydrogen production, and 3) integrated hydrogen production. As a result, we discussed the optimal hydrogen supply system, from the life cycle perspective, by identifying technical bottlenecks, major cost-drivers, and CO_2 burdens.

* Corresponding author.
E-mail address: jykim77@inu.ac.kr (J. Kim).

https://doi.org/10.1016/j.ijhydene.2020.06.095
0360-3199/