Technical-economic analysis for a green ammonia production plant in Chile and its subsequent transport to Japan

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Green ammonia can be produced using fossil fuels or any renewable energy source combined with heat or electricity. Chile has one of the highest rates of solar irradiation and also the environmental conditions that support the development of solar industry. Other renewable sources of energy are the wind and the hydraulic dams. These energies could be used to generate ammonia by a standard method such as the Haber-Bosch process, which transforms hydrogen and nitrogen using high temperatures and a catalyst. The ammonia has several desirable characteristics that suggest its use as a way to store hydrogen. Firstly, it can be liquified under mild conditions. Secondly, the ammonia has a high weight fraction of hydrogen. Thus, it is deemed necessary to study technical and economic variables that may support the use of green ammonia as an energy carrier for hydrogen. The aim of this work is to develop a technical-economic analysis about the production of ammonia using hydrogen by means of electrolysis (carried out with solar, wind, and hydraulic renewable energies). The aforementioned green ammonia would be produced in Chile and it would be necessary to transport it to Japan. Sensitivity analysis of main parameters (plant operating hours, size of the ammonia synthesis plant - related to the capacity of the electrolysis plant size in MW-, electricity price, electrolyzer cost, Haber-Bosch cycle cost, and ammonia sales price) was performed to report what factors are primordial at the moment of carried out techno-economic analyses. An optimization process that minimize the NPV was run in order to settle the most convenient size of the electrolyser stack. A net present value (NPV) of base case is ?77,414,525 and 7.62 years of

pay-back period were calculated for this green ammonia production plant, which considered hydrogen production via electrolysis, Haber-Bosch processes, and trade values of different operational units. The sensitivity analysis has determined that the main variables affecting the NPV are the size of the ammonia synthesis plant and the electricity price. Furthermore, by considering triangular probability distribution of specific variables, it was observed that with a 95% of confidence, the NPV would be positive with a 76.1% of occurrence. The optimization process defined that a stack of 164.21 MW would be the most convenient electrolyser stack dimension, which was estimated by considering all different effects over the operational expenditure (OPEX), capital expenditure (CAPEX), and investments risk. Therefore, the hydrogen production in Chile and its transportation to Japan using ammonia as an energy carrier would be a technically viable and profitable solution, which also has environmental benefits.

Ammonia transport

Green ammonia

Haber-bosch process

Net present value

Pay-back

Viability

Ammonia

Cost benefit analysis

Costs

Economic analysis

Electrolysis

Fossil fuels

Investments

Kinetic theory

Probability distributions

Renewable energy resources

Risk perception

Sensitivity analysis

Solar power generation

Capital expenditures

Environmental benefits

Environmental conditions

Haber-Bosch process

Operational expenditures

Renewable energy source

Technical-economic analysis

Techno-Economic analysis

Hydrogen production

alternative energy

ammonia

economic analysis

electricity generation

electrokinesis

fossil fuel

hydrogen

optimization

price dynamics

transportation

Chile

Japan

Nucleopolyhedrovirus