BECOME A SERIAL WINNER: HOW TO REPLICATE THE H2-VISION PROJECT IN THE NETHERLAND TO ELSEWHERE IN THE WORLD?

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Overview

To reach the goal of decarbonization, EU will require hydrogen at large scale that achieving energy transition. Although hydrogen is not the only source for decarbonization, it can be integrated to renewables, convert and store energy as a renewable gas. Moreover, it is a comprehensive option for decarbonization in power, transportation, building and industry.

In that, hydrogen plays a systemic role in the transformation of energy system and creates a whole value chain integrated with other energy system. It also impacts on the changes of energy mix and energy security. There are numbers of projects across Austria, Demark, Finland, France, Germany, Netherlands, and other EU countries. Among which, northern Netherlands is uniquely positioned to develop the green hydrogen economy and it's the position which is close to the North Sea natural gas market, which is available to gather the different sources for constructing a hydrogen economy. H2-vision project in the Netherland provides a useful framework to connect production, infrastructure, transportation, storage, and consumption as a full-cycle of hydrogen development.

The proposed research is interested in identifying the necessary and sufficient conditions for repeating such innovative success elsewhere in the world. To our research team there is crucial value to energy transition progress, in capturing the true value and essence of the innovation and apply to many more regions beyond the pilot project. This requires critical and economic thinking in two critical parts: understanding the innovative design and value drivers at the project level, and realistic and robust modelling of alternative energy and market conditions in different countries with various energy resources and technologies. In summary, this paper aims to draw a roadmap of applying similar concepts of H2-vision project to other parts of Europe and world to truly build momentum of hydrogen applications in areas that creates sustainable profits and value.

Methods

Based on the project in the Netherland, the value chain of hydrogen economy will be examined and separated into four segments. In each segment, the key factors and assumptions will be analysed.

- **Step one - Project level analysis:** this step focuses on analysing main segments in the H2 projects. It includes production, transportation, infrastructure and storage technologies and assumptions. This also includes the assumptions of routes to market for H2-project. A clear picture how the project is designed and assembled is shown in this step. High level quantitively assumptions would highlight the key value drivers for the success of the project, which would lead to the finding of necessary conditions. In this step, we would also include several critical pieces for value drivers of the project:
  - LNG import price and Hydrogen transportation cost via pipeline from our natural gas infrastructure model which covers the global gas market and infrastructure at detailed and project level. We would able to leverage the outcome of calculated LNG arriving at Rotterdam as a source of hydrogen production, while hydrogen could be transported through gas infrastructure from Netherlands to other parts of Europe with additional pipeline upgrades.
  - Carbon capture and storage technology assumptions and cost estimation. We would leverage the subject expert inputs on CCUS technology and applications for this project.

- **Step two - Hydrogen market analysis:** based on the existing hydrogen economy structure, the modelling approach is designed to link behaviour, choices, and desired goals to actual outcomes and focusing on the full life cycle of the hydrogen production and consumption, and explore its impacts on the trade of LNG market. On the supply side, Mulder, Perey and Moraga (2019) identified driven factors, such as natural as price, CO2 price and electricity price as well as the price of green certificates, for the analysis of the competition of different types of hydrogen production. On the demand side, combined the end-user prices including commodity prices and the taxes, we will add infrastructure costs for energy users in advance.
- **Step three - Hydrogen supporting policy:** the existing and expected hydrogen and related policy will be evaluated. We will focus on the effectiveness of the policy in each segment of the value chain, such as the costs of conducting the policy will be taken into consideration as well. Moreover, in case of a full conversion of a gas network to become a pure hydrogen network, there might be a new topic for the intervention by policymakers or regulators. In that, we would keep an eye on the missing or incomplete regulations in H2-vision project.
- **Step four - Impact on carbon emissions:** based on the recent energy mix in the Netherlands, we will use a comparison study to look at the carbon emission amount with and without a hydrogen economy in the Netherlands. Then, it will be applied to estimate the impacts in other countries or regions for considering developing a hydrogen economy.

Results

H2-vision project in the Netherland shows that hydrogen is the best choice for at-scale decarbonization in transportation, industry and buildings, and the research focuses on establishing a framework of H2-vision project with identified necessary conditions for success, which can be applied to assess similar hydrogen integrated projects, in other countries with different localized policy and supporting industry and energy system.
The results include these deliverables:

1. What is the value creation of H2-vision project – including market value and environmental impact.
2. What is the key successful factor supporting such project – including commodity and supply costs, level of infrastructure, the reliability of sources, the level and size of the market, and supporting policies.
3. Comparison of potential value and key factors in alternative location and markets – including a list of proposed markets and locations that would have some of the key factors of success to replicating such projects, and discuss missing opportunities and potential risks.

Conclusions

In this article, the key point is to figure out a replicable pathway to develop hydrogen economy in the world. According to that, this research represents the road map and key factors for developing hydrogen in the Netherlands with the specific conditions. For the comparison study, as part of the conclusion, this paper discusses the potential path and strategies for all stakeholders involved in hydrogen and natural gas industry, investors and local policy makers. It also provides a potential framework of fasten its hydrogen industry that other regions can learn from.

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