ECONOMICS OF EXPORTING RENEWABLE ENERGY FROM AUSTRALIA TO ASIA USING HYDROGEN

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Overview

Recently there has been renewed interest in the possibility for the trade of hydrogen between countries. For example, there have been a range of reports focused on the future of hydrogen in Australia (ACIL Allen Consulting 2018, CSIRO 2018, Hydrogen Strategy Group 2018) and a IEA report prepared for the G20 meeting in Japan (IEA 2019). All of these reports discuss the potential for trade between Australia and key trading partners in Asia (including Japan, Singapore and South Korea). There are also national strategies that have set a goal for imported hydrogen to be cost competitive with conventional energy by 2030. For example, the one released by Japan in late 2017 (METI 2017) states that "hydrogen may be produced from renewable energy in countries or regions featuring relatively lower power generation costs and transported to Japan for local use in a sufficiently economical manner".

Hydrogen provides a way for renewable resource rich countries to export low carbon energy to countries that are less capable of decarbonising and have high energy needs. For example, IEA (2019) states that "hydrogen and hydrogen based fuels can transport energy from renewables over long distances – from regions with abundant solar and wind resources, such as Australia or Latin America, to energy-hungry cities thousands of kilometres away" (IEA 2019). It has also been proposed that Australia has an opportunity "to establish itself as hydrogen supplier of choice to Japan and other nations such as South Korea that are hungry for hydrogen as a cost-effective route to reducing emissions" (Hydrogen Strategy Group 2018).

This paper will assess the possible future economics of large-scale hydrogen production in Australia and export to Asia using a model of a hydrogen export industry. The model will be developed for different parts of Australia and incorporate a range of factors, including wind/solar capacity factors and shipping distances. It will also utilise scenarios for the cost of renewable energy for powering electrolysis and the cost of electrolysers. The modelling framework expands that used in Glenk and Reichelstein (2019) and provides specific regional applications.

The analysis will assess the potential timing of the establishment of large-scale hydrogen exports from Australia to Asia. This will be based on region-specific scenarios of the cost of hydrogen production between 2020 and 2050. The regions that will be represented in the modelling are areas of Western Australia, Queensland and the Northern Territory that have high solar/wind capacity factors and are close to existing and potential port facilities. Other areas of interest are inland areas with high renewables potential such as in New South Wales and South Australia. There are also options to produce hydrogen from lignite with CCS in Victoria, which will also be represented in the model.

Methods

This paper will build a hydrogen export model to assess the threshold conditions for hydrogen production and export to become cost competitive with natural gas. The analysis will include representations of the costs of the: - supply of wind and solar electricity, - energy from lignite with CCS, - electrolyser to create hydrogen, - storage of hydrogen, - different conversion options for transport (i.e. compression for use in pipelines and ammonia/liquefication for sea/truck/rail-based shipping), and - shipping to Asian and Australian markets. A comparison between the export of hydrogen and the export of liquid natural gas is suitable as there are similar techno-economic elements in both industries (such as liquification for international shipping).

The first component of the analysis will use existing cost estimates for renewable energy generation and hydrogen production to build cost models of different techno-economic options/scenarios. This will include projections of the cost decreases that would be needed for hydrogen to be cost competitive with natural gas.

The second component of the analysis will be matching these cost models to region-specific characteristics. These characteristics will include wind/solar capacity factors, shipping distances and the potential for pipelines or integration into the electricity grid.

The third component of the analysis will be modelling demand for different types of hydrogen based on the type of transport method (i.e. compression, liquification and ammonia via truck, rail and ship) and the life-cycle emissions of the hydrogen produced. This demand will be modelled for both a domestic and export market.

Different techno-economic scenarios will account for the difference in supply costs and demand for different types of hydrogen (which differ based on their life-cycle emissions [i.e. brown, blue and green hydrogen] and the transport method). These will be compared to supply costs and demand for liquid natural gas.

Results

The expected outcome is a flexible model that will assess the viability of different types of hydrogen production in key regions of Australia and can be used for a range of analyses. It will provide insights into threshold conditions for costs that will make large-scale hydrogen production in Australia and export to Asia economically viable.

Our analysis will provide an indication of how much further the cost of renewable energy generation and hydrogen production needs to fall, and whether carbon prices would need to be applied to fuels, in order for hydrogen exports from Australia to be cost competitive with natural gas in Asia. We will also assess which parts of Australia are likely to be suited to the export of solar-based hydrogen and which regions are better suited to supplying a domestic market for hydrogen. We will be able to produce scenarios with different timings for the viability of large-scale hydrogen exports and project how large the potential domestic and export markets might be.

Conclusions

The possibility of establishing a large-scale green hydrogen industry in Australia for export to Asia has attracted strong interest. This includes a briefing paper prepared for the Council of Australian Governments (COAG) Energy Council by a group chaired by Dr Alan Finkel, Chief Scientist of Australia (Hydrogen Strategy Group 2018). Green hydrogen trade has great potential for assisting Asia with decarbonising their energy systems. Australia is one of the countries with the potential to produce large amounts of renewable electricity and is likely to be among the most cost competitive locations. Our analysis establishes detailed, locationally differentiated threshold conditions for future green energy production costs and the costs of electrolysis for hydrogen to be cost competitive with natural gas (with and without carbon pricing).

References

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