Optimising Geospatial Distribution of Hydrogen Production in Australia, Integrated Vs. Centralised

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Recently, the chief scientist Alan Finkel has highlighted the enormous opportunities for Australia in pursuing "green" hydrogen exports in the carbon-constrained world to come. In a report commissioned by the Australian Renewable Energy Agency (ARENA), ACIL Allen Consulting estimated Australia could capture between 0.6 and 3.18 million tonnes of global demand by 2040, representing a total value of between 2.6 and 13.4 billion Australian dollars at current prices. In addition to the direct export, another major pathway is the domestic use of hydrogen produced in Australia to make 'green steel' and other products – taking special advantage of Australia's rich minerals and ore resources. In realising the great export opportunity, this study assesses the potential locations for producing green hydrogen as part of Australia's energy transition utilising Australia's low-cost renewable energy resources.

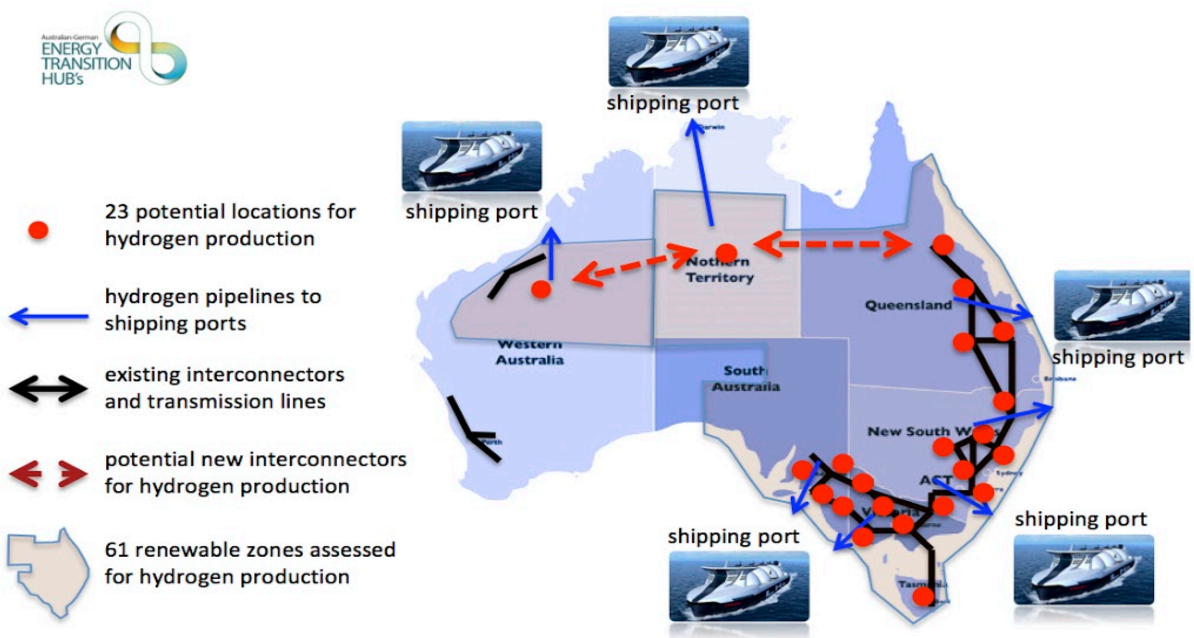
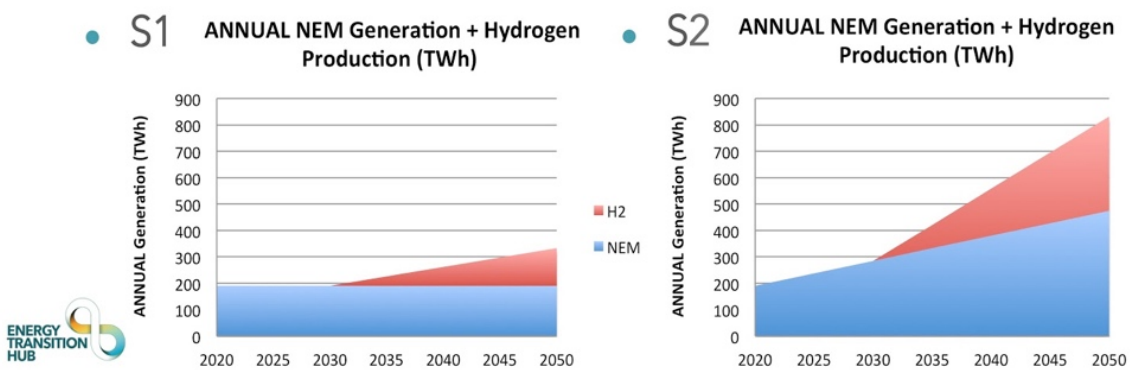


Figure 1. Schematic of the modelling scope

The scenario-based modeling using the (Melbourne/Monash University Renewable Energy Integration Lab) MUREIL model simultaneously optimises the transition pathways for both the power system and the hydrogen industry by minimising the total system cost for electricity generation, transmission, storage and hydrogen production from 2020 to 2050. Potential opportunities for hydrogen production are assessed among more than 60 renewable areas across the nation, with 43 NEM regions having potential for hosting electrolysers that can be integrated with the National Electricity Market (NEM) to produce hydrogen for export as shown in the Figure 1. A wide range of generation technologies are considered including high penetration of variable wind and solar, concentrated solar thermal, hydropower, pumped hydro energy storage, gas (open and closed cycle) and the existing black and brown coal fleets, etc. using the most updated technology cost projections from the CSIRO's GenCost 2018 report. The model takes into account requirements of inertia in the grid, and the costs of augmenting large-scale transmission to accommodate access to high quality renewable resources.

Two cases were modelled:



Scenario 1 (S1): 100% renewables for the NEM by 2050 with linear carbon abatement trajectory from 2020; no electrification of other sectors, i.e. constant NEM electricity demand as today's by 2050; 70% extra electricity is used for hydrogen production in 2050; expensive electrolysers: $3000/kW

Scenario 2 (S2): 100% renewables for the NEM by 2050 with linear carbon abatement trajectory from 2020; rapid electrification of transportation, industry sectors, i.e. electricity demand increased by 1.5 times compared to the current level by 2050; 70% extra electricity is used for hydrogen production in 2050; declining cost of electrolysers due to economies of scale from the current $3000/kW to $800 /kW by 2050.

Our research confirms the very real and great potential for Australia to produce low-cost hydrogen. Optimisation results show the optimal geospatial distribution of electrolysers is mainly determined by the capital cost of electrolysers, and the degree of electrification economy-wide. If the cost of electrolysis stays relatively high and electrification of Australia's economy is slow then the study suggests three major exporting hubs in the Pilbara, South Australia and Tasmania where renewables are the best with unconstrained port access. Alternatively, if the cost of electrolysis drops with economies of scale and we see rapid electrification of sectors including transport, commercial and industry – then hydrogen production and use becomes dispersed across the NEM. Here, electrolysers run with dynamic flexibility to produce hydrogen with renewables, providing reliability support to the grid, whilst minimising the degree of renewable generation curtailment. In this case, less storage is needed, implying a reduced power bill thanks to the extra flexibility from hydrogen production.