Elixir Energy

Asia Clean Energy Forum 2023

Potential for Green Hydrogen Production and Export from Mongolia

14 June 2023

ASX:EXR

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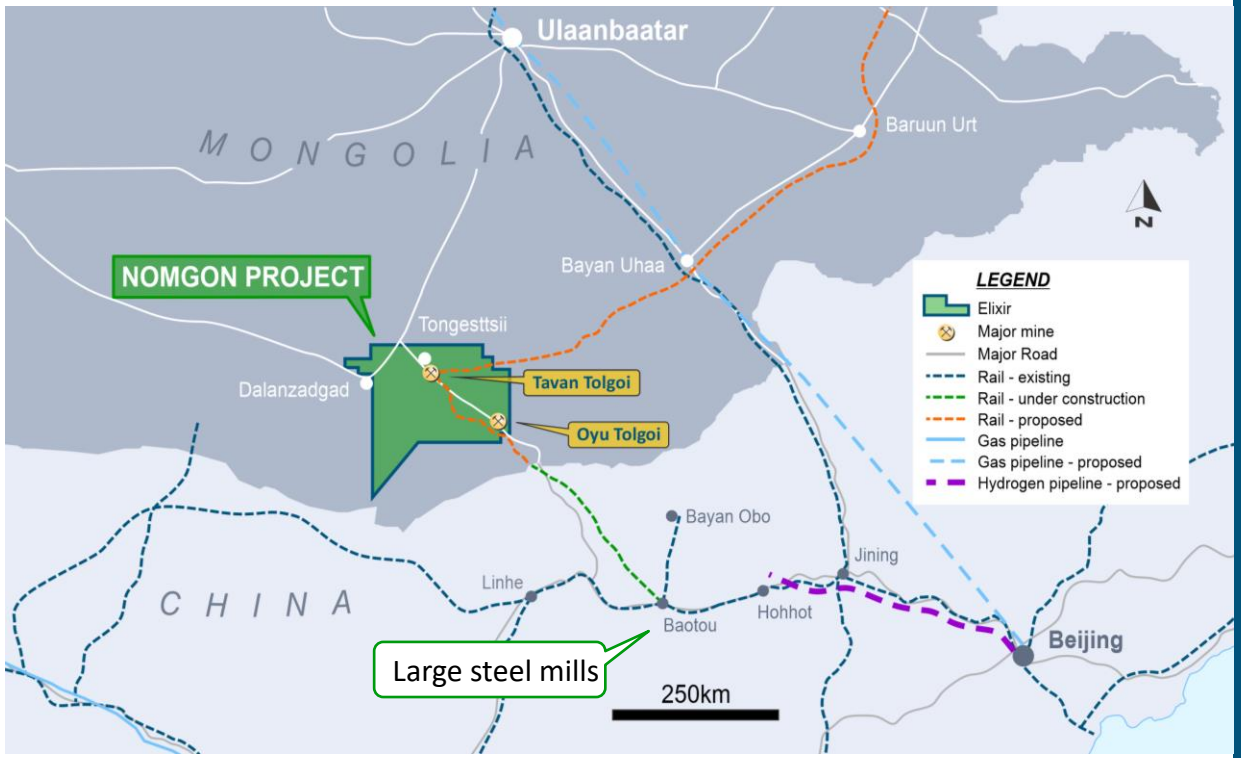
Introduction

- *Gobi H2* is Mongolia's first green hydrogen project (i.e. one where hydrogen is produced from renewable electrical energy sources)
- The project has been developed by ASX listed Elixir Energy – who has longstanding experience in Mongolia's energy sector as a natural gas explorer
- The strength of the concept behind the project was demonstrated in mid-2022 when Elixir announced the signing of a Memorandum of Understanding (MOU) over *Gobi H2* with Japan's SB Energy Corp (now Terras Energy – 85% owned by Toyota Tsusho Corp)
- Elixir procured a Pre-Feasibility Study (PFS) from global consulting firm AECOM earlier this year to give the parties confidence to advance the project – they are now aiming to enter into a binding IJV later this year
- Green hydrogen infrastructure projects in neighbouring China – including the development of a regional hydrogen pipeline transmission network – can ultimately be expanded Northwards to capture the benefits of the Gobi's exceptional renewable resources

Emerging Regional Hydrogen Infrastructure

- The location of the *Gobi H2* project provides ready access to rapidly growing Chinese H2 markets
- Elixir commissioned a H2 in China market study from global energy consultants Rystad Energy which concluded *"the scale of ramp up will likely open up imports from beneficial production sites like Elixir's"*
- Regional H2 transmission infrastructure is already emerging - with e.g. Sinopec's recent announcement of a 400km H2 pipeline in Inner Mongolia



Requirements for H2 Project Success

1. High quality renewable resources – these are superb for *Gobi H2* – top tier globally

2. Cost of renewable energy installations – favourable proximity to manufacturers in China & buying power of Terras

3. Green certification – *Gobi H2* meets emerging global (including Chinese) standards

4. Proximity to market – no location better placed to service Chinese import requirements. ***This is Gobi H2's key competitive advantage***

5. Operational skills – Terras existing wind-farm in the Gobi and Elixir's stakeholder engagement expertise in the region

6. Access to capital – *Gobi H2* is well advanced in engaging the IFIs (e.g. ADB, EBRD, etc) in Mongolia over project finance

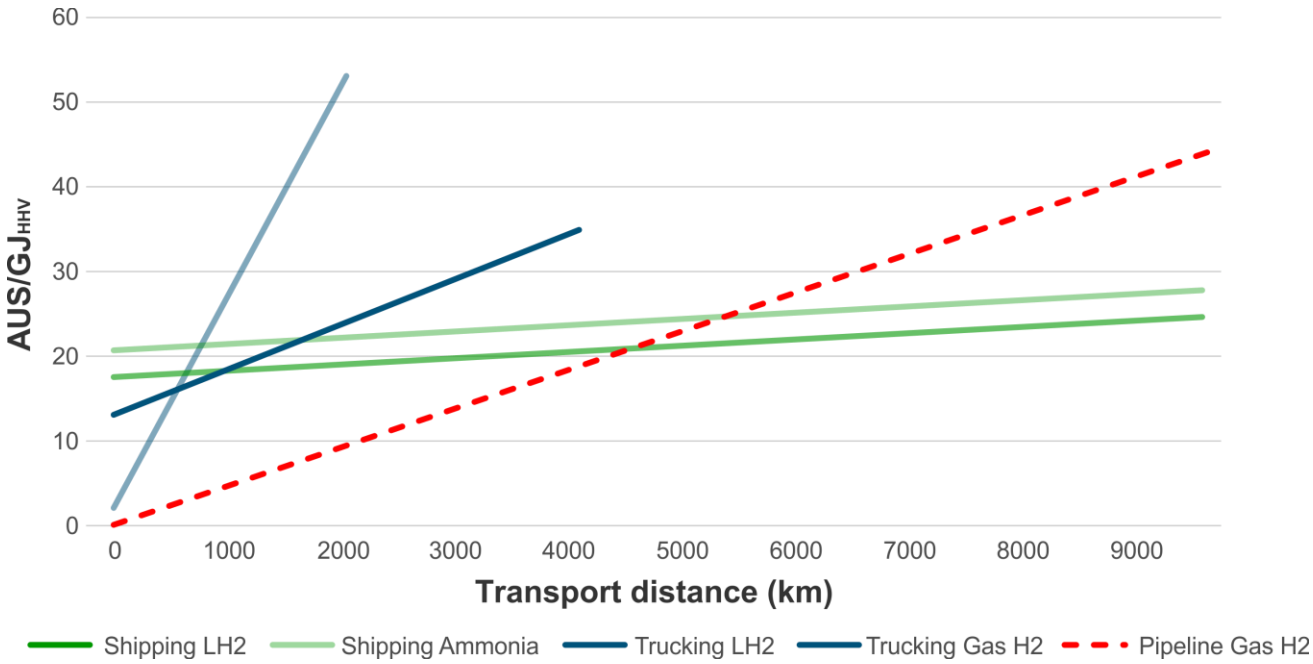
7. Scalability – ultimate renewable resources in the Gobi are many, many GWs – and long run demand in China under its net zero plans is enormous

Hydrogen Delivery Costs

- Around 2/3 of the cost of producing green H2 are the cost of renewables
- Shipping H2 by boat costs multiples (~$20/GJ) of shipping the same energy as CH4 (~$5/GJ)
- The delivered cost of H2 is therefore all about the quality of renewable energy ***and the cost of delivery***
- Access to markets by pipeline is massively advantaged over seaborne supplies – ***Mongolia can supply H2 to Chinese markets by pipeline***

Cost of gas-to-gas hydrogen transportation, including conversion and reconversion - 2030s

For hydrogen production of ~15PJ/year



Source: Rystad Energy research and analysis commissioned by Elixir Energy -

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Renewable Resource Measurements

Site comparison: 10 ktpa Hydrogen production

	Gobi Mongolia	**Ordos** China	**Pilbara** Western Australia	**H2 Magallanes** Chile
Elevation (m)	1,121	1,462	9	37
Average temperature (°C)	8.5	7.4	26.4	5.3
Solar resource (W/m2)	203	174	228	164
Wind resource (W/m2)	347	154	180	1067
Solar utilization (%)	25	23	24	21
Wind "	64	31	27	76
Combined "	46	28	26	46
Solar peak capacity (MW_{DC})	75	108	142	91
Wind peak capacity (MW_{AC})	87	246	375	76
Electrolyzer peak cap. (MW)	73	98	132	75
Electrolyzer util. (%)	***85***	***64***	***48***	***83***

The table illustrates that *Gobi H2* has the best combined renewable energy capacity factor amongst what are considered to be world class locations

(as measured by electrolyser utilization under certain standardization assumptions noted in ASX release of 11 May 2023)

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Pre Feasibility Study

PFS

Earlier this year Elixir commissioned a Pre-Feasibility Study (PFS) into a large scale pilot project for *Gobi H2* from global infrastructure consulting firm AECOM

Wind, Solar, Battery

The PFS evaluated various configurations of wind, solar, battery and a grid connection to support a 10 MW electrolyser located at a site proximate to SBE's existing operated windfarm in the South Gobi region

No Technical Issues

No technical impediments to the project were identified – ultimately feasibility is solely a commercial issue

Green Project

A green H2 project is not a "mining" venture under the ASX's Listing Rules and as such is not covered by the expectations of detailed disclosure for PFS results under these Rules

Costs are C.I.C.

Given the nascent nature of the green hydrogen industry and the estimated costs of production are commercial in confidence

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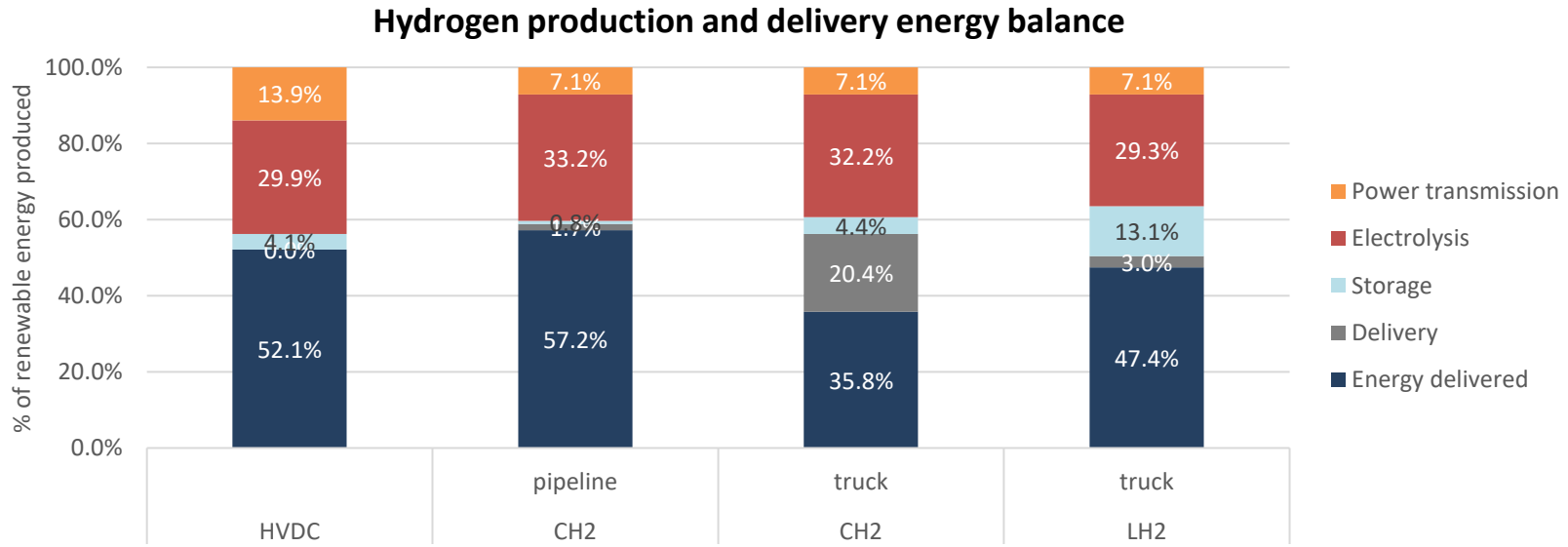
Green Hydrogen Certification

- Hydrogen has traditionally only been used in niche markets such as in oil refineries – and has generally been produced from fossil fuels, with resultant large CO2 emissions
- The more recent pursuit of green and blue hydrogen (the latter is still derived from fossil fuels but the CO2 emissions are captured and stored underground) is driven solely by emission reduction aims
- Globally this is recognized by emerging standards that must be met for hydrogen to be deemed green or blue – each major jurisdiction is developing its own rules, but these are converging towards targets based on maximum CO2 emissions per kg of H2 produced
- Unless a green H2 project can meet these targets – it does not meet its intrinsic aims. Projects which involve grid connections to electricity systems with still significant fossil fuel use (especially for production on the margin) may well struggle to be deemed green
- **Elixir's analysis illustrates that the *Gobi H2* pilot project meets the green definitions of the main global jurisdictions – including China. This is critical to procure customer and project finance support**

Green hydrogen delivery

The following table illustrates that producing hydrogen in Mongolia and piping it to China is more energy efficient than transmitting power to China for hydrogen production



Option 1: Renewable power transmitted 500 km via high voltage direct current prior to green hydrogen production at customer site. Hydrogen compressed and stored at 35 MPa at customer site.
Option 2: Green hydrogen produced at renewables site and compressed and transported 500 km to customer site via 7 MPa pipeline. Hydrogen storage via linepack.
Option 3: Green hydrogen produced at renewables site and compressed and transported 500 km by 25 MPa tube trailers. Trucks powered by hydrogen to retain "green" status at point of use.
Option 4: Green hydrogen produced at renewables site and liquified and transported 500 km by tankers. Trucks powered by hydrogen.
Assumptions: 3.7% energy loss for AC/DC stepup/down/conversion + 3.5% loss/1000 km, 98% availability; 60 kWh/kg H2 electrolyzer efficiency (including ancilliaries), 92% availability; 0.5 kWh/kg H2 pipeline compression requirement; 3.1 kWh/kg hydrogen storage compression requirement; 10.0 kWh/kg hydrogen liquefaction requirement; 0.1%/day "boil-off"; 3.0% trucking delivery losses.

Water Availability

- The key physical input into green H2 production is water
- However, in comparison to established industrial activities such as mining and coal fired generation, not that much water is required to produce material volumes of H2
- Although the South Gobi region is a semi-arid one, there are substantial local groundwater resources used at small scale for traditional herding and at much larger volumes for the more recent large scale mining operations
- For instance, the Oyu Tolgoi mine is licenced to use 1 tonne per second of groundwater – very rigorous audit processes monitor this, with no adverse consequences found
- The future trajectory for H2 demand is expected to inversely mirror coking coal demand – so water used locally for the latter's operations will become progressively available for the former
- Elixir has successfully drilled a number of water wells in the region to illustrate water availability
- Ultimately water is a more of a political rather than an engineering issue – local communities must be engaged, informed and experience project benefits

Project Summary

- The 2 main drivers of green hydrogen competitiveness are:
  - The quality of renewable energy resources
  - Proximity to market
- All the work done to date on *Gobi H2* indicates that it is a world class project with respect to these attributes
- *Gobi H2* is curre ntly owned by a strong partnership of Elixir Energy (with >10 years experience in Mongolia) and a member of the Toyota Group – in the longer term the scope for investment in green H2 in Mongolia is massive
- Green hydrogen is being increasingly regulated around the world – *Gobi H2's* PFS work indicates it qualifies under these ever stricter rules
- Moving energy from Mongolia to Chinese markets by pipeline is more energy efficient than by electricity transmission – and a regional hydrogen pipeline grid is already being developed

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