THE GREEN HYDROGEN VALUE CHAIN – OPPORTUNITIES FOR TRINIDAD AND TOBAGO

Estimated read time: 5 min

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KEY TAKEAWAYS

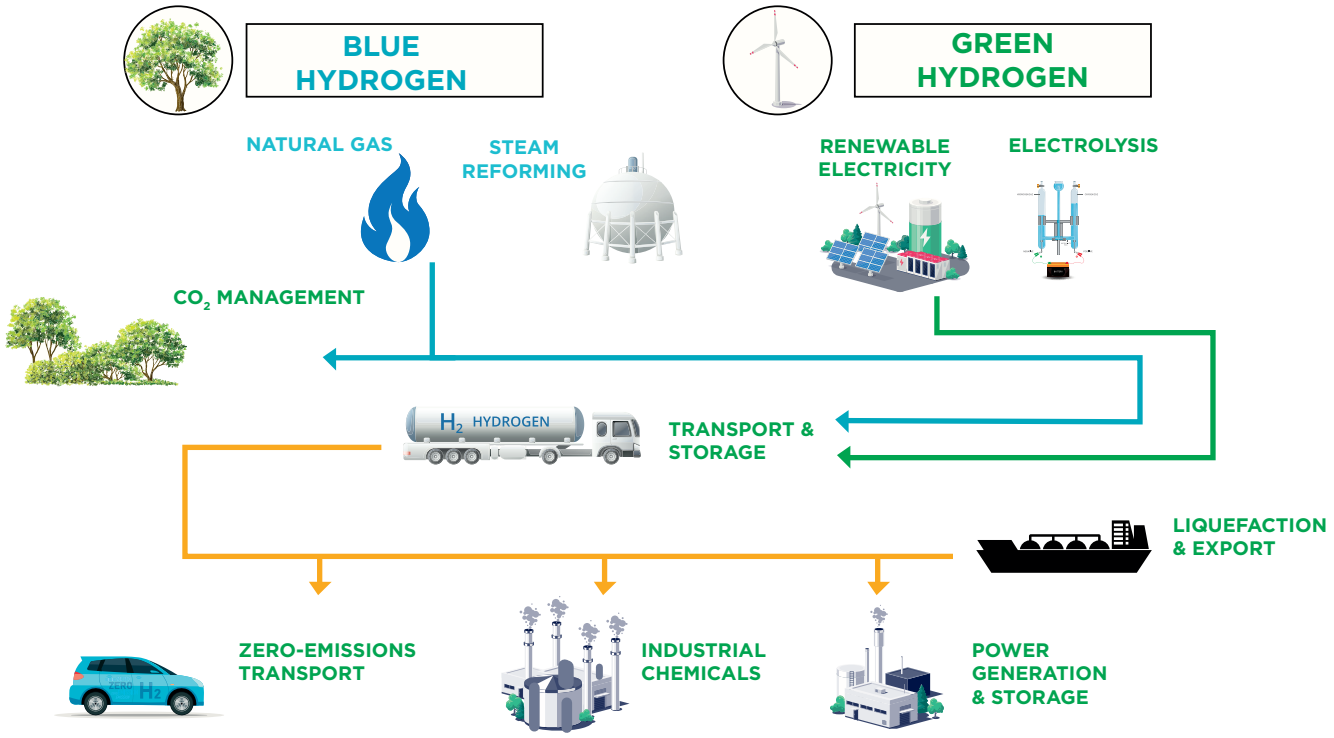
Green hydrogen can play a major role in the future of the domestic energy sector, as it can simultaneously help reduce greenhouse gas emissions, decarbonise existing petrochemicals, and potentially create new jobs.

Investment, infrastructural and regulatory challenges will need to be overcome before the country can build the value chain.

The reality of the "energy trilemma" (the need for energy sustainability, security and affordability) brought hydrogen (H_2)-based energy to the fore. Hydrogen gained traction because of its versatility (low to zero-emissions energy storage, industrial use, vehicle propulsion, etc.) and availability (hydrogen is the most abundant chemical element and can be obtained from water electrolysis and renewable energy – green H_2).

For Trinidad and Tobago, green H_2 can play a major role in the future of the energy sector, as it can simultaneously help reduce greenhouse gas emissions, decarbonise existing petrochemicals, and potentially create new jobs. However, there are also challenges that will need to be overcome.

FIGURE 1: HYDROGEN VALUE CHAIN



Source: Woodside Petroleum, via https://rcglobalfm.com.au/insights/understanding-hydrogens-role-in-energy-transition-to-help-find-investment-opportunities.html

THE GREEN H_2 VALUE CHAIN

The value chain of green hydrogen describes the steps from origin towards end-use of green hydrogen: green electricity production, H_2 production, H_2 distribution and H_2 storage, and H_2 applications. Globally, in recent years, more large energy and industrial projects based on hydrogen and harnessing the potential of hydrogen are being developed. As a result, it is now common to find major energy or industrial projects that are associated with the production and use of hydrogen.

Based on the numbers as at September 2023, annual production of low-emission hydrogen could reach 38 Mt in 2030 if all announced projects are realised. Of that total, 27 Mt will be based on electrolysis and low-emission electricity and 10 Mt on fossil fuels with carbon capture, utilisation, and storage.[1]

Green hydrogen is produced by using clean energy from surplus renewable energy sources (solar or wind power) to split water into two hydrogen atoms and one oxygen atom through a process called electrolysis.[2] The electricity used must be carbon-free to consider this hydrogen as green or renewable. Electrolysis is the most common technique for producing green hydrogen.

Value from hydrogen can be derived from several sources. Regarding green hydrogen, value can be derived from its use in zero emissions transport, production of low emissions chemicals (such as green ammonia and methanol), renewable power generation, use as stored energy, and liquefaction and export. A hydrogen production value chain is shown in Figure 1.

OPPORTUNITIES ON OFFER

For developing countries, the switch to hydrogen is relevant for several reasons. Firstly, green hydrogen can be used as a catalyst for such countries to reduce their reliance on fossil fuels and reduce carbon emissions throughout the economy. Secondly, it can help reduce reliance on imported fossil fuels, reduce energy costs and improve economic stability. Thirdly, by supporting new industries and jobs, it can help reduce poverty and improve quality of life.

For Trinidad and Tobago, it assumes even more potential significance. In an environment of natural gas supply challenges and a mature gas sector, in the long run green hydrogen can help to decarbonise the power sector.

[1]International Energy Agency. Global Hydrogen Review 2023. September 2023.
[2]Green hydrogen production: how does it work? https://www.engie.com/en/renewables/hydrogen/green-hydrogen-production

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In addition to environmental benefits from cleaner air and reduced greenhouse gas emissions, generating renewable energy - as part of green hydrogen production - means that natural gas formerly used to generate electricity (currently between 240-260 mmscf/d in Trinidad and Tobago) can be diverted to other, more profitable uses.

Green hydrogen can be used to produce low-carbon fertilisers. As a net exporter of fertiliser, this can potentially ensure that the fertiliser produced does not add to global emissions. An initiative around the production of green ammonia from hydrogen forms part of Trinidad and Tobago's current hydrogen roadmap.[3]

In addition, green hydrogen can be used to decarbonise the transportation sector. For Trinidad and Tobago, this may not necessarily be in the form of dedicated hydrogen vehicles, but in enhanced electrification of the domestic transport sector via the use of electric vehicles, (supplemented by CNG for heavy vehicles), and marine transport using green methanol.

Finally, green hydrogen can be used to produce low-carbon steel. While most of Trinidad and Tobago's steel production facilities currently lie idle, widespread adoption of green hydrogen has the potential to revive this industry, through retrofitting of plant and equipment to use renewable electricity and hydrogen as energy.

CHALLENGES

That said, several challenges remain. It is important to note that the development of the hydrogen value chain in Trinidad and Tobago will require significant investment in renewable energy facilities, notably offshore (and onshore) wind turbines. Electrolysers to separate the H_2 from water remain expensive, though production costs are expected to decline. Challenges around hydrogen storage also exist, as dedicated storage facilities for both H_2 and stored electricity would need to be established.

On the regulatory side, the quantum of investment needed would necessitate public-private partnerships (PPPs) to establish the framework for the investments needed, as well as establishing the regulatory framework. More generally, such a large shift would require a significant amount of heavy research and development to enable large-scale production, as well as agreements between firms and countries, agreements concerning trade relations, guarantees of origin, as well as sourcing the budgeting for infrastructure development that scaling up for hydrogen production requires.[4] Figure 2 shows the opportunities and challenges around green hydrogen in Trinidad and Tobago. (See page 19).

Overall, the hydrogen value chain has the potential to play a significant role in the sustainable development of Trinidad and Tobago in the long term, as it can help the country to decarbonise its economy, generate zero-emission energy, create a whole new sector, create new green jobs, and ensure that finite fossil fuel resources are reserved for its most productive uses in the energy transition. While there remain challenges around harnessing the full potential of green hydrogen in Trinidad and Tobago, these challenges are not insurmountable given Trinidad and Tobago's greatest asset: the ingenuity of the people. ■

[3]The roadmap for a green hydrogen economy in Trinidad and Tobago (iadb.org) https://publications.iadb.org/en/roadmap-green-hydrogen-economy-trinidad-and-tobago
[4]National hydrogen strategies - KPMG Global https://kpmg.com/xx/en/home/insights/2021/08/national-hydrogen-strategies.html

FIGURE 2: OPPORTUNITIES AND CHALLENGES AROUND GREEN HYDROGEN IN TRINIDAD AND TOBAGO

Opportunities in H_2 for Trinidad and Tobago

Raw materials and H_2 production
- Trinidad and Tobago can produce green H_2 competitively using offshore wind and purified ocean water
- Capabilities to produce and sell energy globally; execute large capital projects
- Carbon capture; decarbonising other products in the portfolio; potential applications in enhanced oil recovery or synthetic oil production

Storage and transport
- Network of existing natural gas pipelines for transport
- Use of existing infrastructure and capabilities to operate pipelines and ship energy products globally

End users and applications
- Continued use of existing assets that consume hydrogen, such as ammonia and steel production
- Decarbonise products such as steel and synthetic aviation and marine fuels
- Green ammonia, green methanol (fuel and base material), renewable electricity (for residential use, industrial use, internal transport), low carbon steel production; greener cement production
- Capability to develop value chain and demand to de-risk projects

Challenges in H_2 for Trinidad and Tobago

Raw materials and H_2 production
- Hydrogen, although clean and versatile, is not an energy source but an energy vector: it must be produced, transported/stored before being used (converted to other forms of energy, such as electricity or heat, or to other chemicals)
- Reduce cost of production of electroylsers through new technologies, economies of scale, improved production methods
- Very costly to establish sufficient renewable energy capability via offshore wind

Storage and transport
- New storage methods to counter low H_2 density
- Cost to store H_2

End uses and applications
- Reduced fuel cell production cost, improved fuel cell safety
- No guarantee of premium pricing for green products in long term
- Competition from other “hydrogen corridors” of industrial production in developed countries

Source: Derived from Hydrogen: opportunities and challenges of its value chain | CIC energiGUNE at https://cicenergigune.com/en/blog/hydrogen-opportunities-challenges-value-chain