NexantECA

Technology and Costs

TECH 2021S12: Blue Hydrogen

Blue Hydrogen is one in a series of reports published as part of NexantECA's 2021 Technoeconomics – Energy & Chemicals (TECH) program.

Overview

For achieving "net-zero" emissions by 2050 for constraining global temperature rise to ***1.5 to 2.0 degrees Celsius (°C),*** negligible or minimal (low) carbon hydrogen is receiving much attention. Different types of hydrogen are based on a color palette defined by environmental footprint and impact include grey, blue, green, brown, and others. For blue hydrogen, the specific objectives of this TECH Report are to:

- Increase awareness and disseminate information
- Review viable pathways, evaluate status of commercially advanced technologies and processes, key methodologies for determining costs and tech-economics, and high-level market roadmap with review of main market drivers
- Review and evaluate case studies based on existing projects and proposed projects

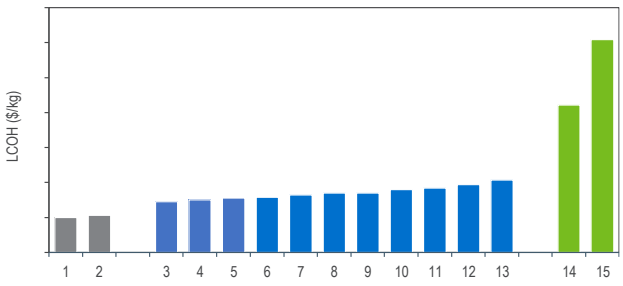
Commercial Technologies

Steam methane reforming (SMR) is the predominant commercial process technology followed by autothermal reforming (ATR) for large-scale blue hydrogen production and CO_2 capture is essential. Natural gas continues to be dominant feedstock for both processes. Key take-aways from technology providers and process licensors' options and configurations indicates good potential for high percentage of CO_2 capture via specific combinations of; 1) pressure swing absorption (PSA), 2) syngas wash process, and 3) flue gas wash process. A detailed review and evaluation are provided for blue hydrogen with respect to CO_2 and GHG emissions, overall GHG footprint, and sensitivities with respect to CO_2 emissions and fugitive methane emissions.

Process Economics

Based on technology advances and cost reductions, blue hydrogen projects are cost-effective, especially integrated with CO_2 capture and sequestration (CCS), or where national and state level subsidies or incentives are utilized. However, blue hydrogen projects bring new challenges to costs and techno-economic analysis. Projects can potentially deliver a range of end-use applications that may not always be easy to quantify, or even possible to value and monetize. CO_2 capture percentage is viewed as a techno-economic optimization and not a technical challenge. Key take-away is that for optimum balancing of CO_2 capture from a blue hydrogen plant, not only direct CO_2 emissions but also indirect emissions must be considered. NexantECA's cost of production (COP) estimates for U.S. Gulf Coast (USGC), Western Europe, and China indicate COP for syngas production USGC has lowest COP due to the region's low natural gas prices. COPs for CO (and CO_2)/hydrogen production indicate USGC has lowest COP due to the region's low syngas/natural gas costs and utilities cost. Comparative techno-economics for grey, blue, green hydrogen projects is shown in the figure below. Led by SMR and ATR processes, the levelized cost of hydrogen (LCOH) price difference between grey and blue hydrogen is predicted to narrow with lower cost natural gas prices and decline in cost of CO_2 capture. Also, the LCOH varies in different geographies as a function of natural gas price, electricity costs, renewable power resources, and infrastructure.

Comparative Techno-Economics for Projects



Commercial Overview

A high-level market roadmap with key drivers and trends indicates a combined blue and green hydrogen decarbonization scenario can potentially achieve lower average LCOH than either blue-only or green-only scenarios. Combined scenario potentially results in a LCOH less than ***$2.0 per kg*** which is lower than either of the green-only or blue-only scenarios. ***A combined blue and green hydrogen scenario also make it potentially easier to develop a "hydrogen economy".***

For more information. please contact
Technology@NexantECA.com or www.NexantECA.com

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- Chemistry
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- Overview of product applications and markets for new as well as established products
- Regional supply and demand balances for product, including capacity tables of plants in each region
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Technology and Costs comprises the Technoeconomics – Energy & Chemicals (TECH) program, the Biorenewable Insights program (BI), and the new Cost Curve Analysis. These programs provide comparative economics of different process routes and technologies in various geographic regions.

NexantECA serves its clients from over 10 offices located throughout the Americas, Europe, the Middle East, Africa, and Asia.

Americas
Tel: +1 914 609 0300
44 S Broadway,
5th Floor White Plains
NY 10601-4425
USA

Europe, Middle East & Africa
Tel: +44 20 7950 1600
110 Cannon Street
London EC4N 6EU
United Kingdom

Asia Pacific
Tel: +662 793 4600
22nd Floor, Rasa Tower I
555 Phahonyothin Road
Kwaeng Chatuchak
Khet Chatuchak
Bangkok 10900
Thailand

For more information. please contact
Technology@NexantECA.com or www.NexantECA.com