Infosys® | CONSULTING

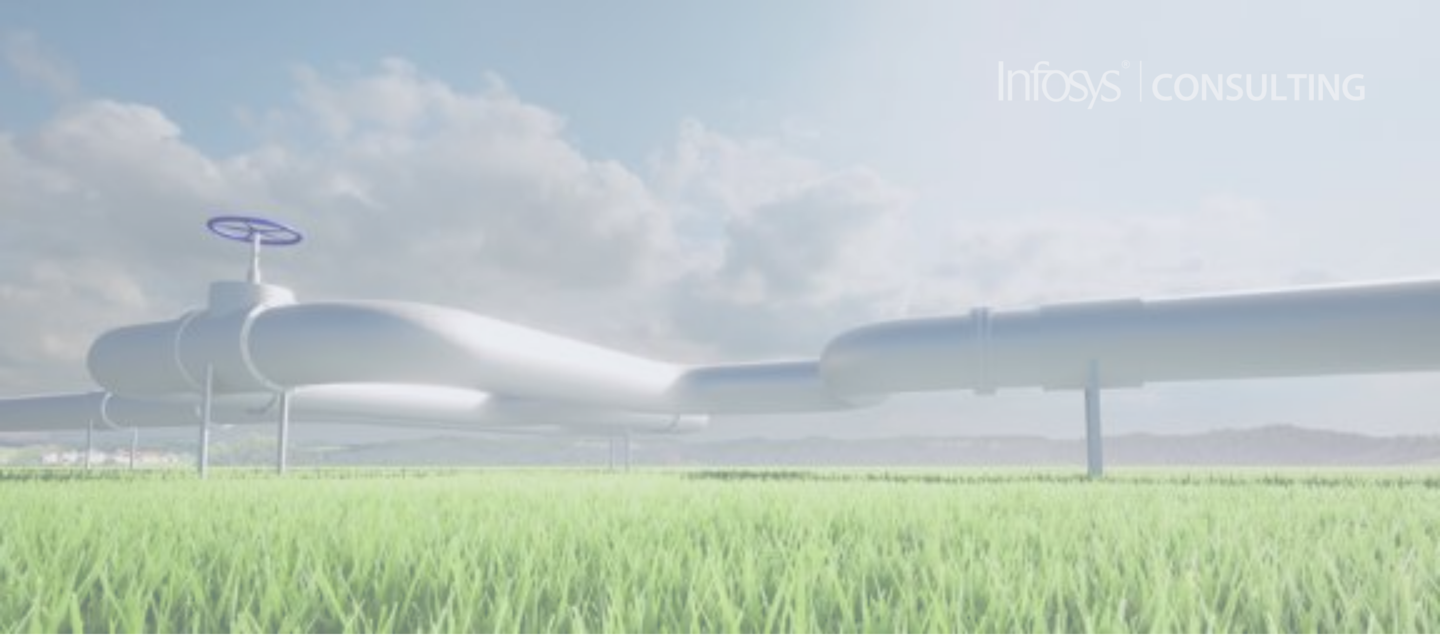
Green Hydrogen

The need for a digital response in a rapidly changing industry

An Infosys Consulting Perspective

By Amit Prakash, Prateek Bhola & Kelti Petto

Consulting@Infosys.com | InfosysConsultingInsights.com



Introduction

Hydrogen, the world's most abundant and lightest element, has a wide range of industrial applications, from refining to petrochemicals and steel manufacturing. It is also a rich source of energy, providing much higher energy density per weight compared to conventional fuels. Hydrogen demand has been increasing at a steady pace over the past four decades[1]. Conventional hydrogen generation requires the use of fossil fuels, making significant carbon emitter accounting for 6% of global natural gas use and 2% of coal consumption and being responsible for 830 MtCO2 of annual CO2 emissions[2].

Green hydrogen production, aided by advances in electrolysis technology and the falling cost of renewable energy offers a sustainable and more environmentally friendly ways to tackle the increasing global demand.

The lingering global energy crises, steady recovery from the pandemic and a fast-evolving geopolitical environment make the importance of alternative energy, such as green hydrogen, imperative in ensuring regional and global energy security and stability. Also, a favorable governmental incentive landscape for green energy / hydrogen provides additional encouragement for existing and new energy companies to penetrate this emerging space at pace.

Digital technologies play an intrinsic role in linking generation to offtake systems and delivering value for the hydrogen economy; these are fundamental in ensuring value chain connectivity, optimizing production and maximizing returns. Deploying digital technologies can aid in decreasing the levelized cost of hydrogen by technically and financially evaluating multiple value chain scenarios to identify the optimal fuel mix and system size.

How can digital help?

In this paper, we discuss some scenarios where digital technologies can enable, accelerate and amplify the viability assessment, production, shipment / storage and consumption of green hydrogen.

Optimizing for lowest levelized cost of hydrogen (LCOH)

Designing and operating end-to-end hydrogen systems comes with multi-variable technical and economic challenges. One of the main metrics to measure project success broadly used in hydrogen generation is the levelized cost of hydrogen or LCOH, which delivers a $/kg value. The aim of many hydrogen projects planning and development teams, be it in the planning or in operational phases, is to use the necessary trade-offs to optimize this metric.

During design and planning phases, digital technologies could be used to run multiple realization style analysis to explore for the optimal value of LCOH whilst meeting project objectives. This approach can be scaled at will using cloud infrastructure allowing projects the ability to explore broader ranges of uncertainty and variability in a shorter time span.

Once projects are operational, technology can be used to run systems optimally by leveraging real-time data and system connectivity to control green power sources, grid electricity, electrolysis and storage systems efficiently with the aim of minimizing costs and maximizing production.

Measuring environmental impact

The primary significance of measuring carbon intensity and other environmental metrics predominantly relies on the ability to demonstrate green hydrogen systems meet governmental criteria to qualify for incentive / grant programs. There are various methodologies in use, depending on geography and the ability to automate and deliver these metrics in the required formats, to qualify for such incentives and grants.

Even though renewable energy technologies have significantly lower carbon footprints compared to their fossil fuel counterparts, over the project lifespan their carbon emissions over can be significant especially if scope 2 and 3 are considered.

AI supported tools can help companies address this challenge by taking their measurement and tracking capabilities to the next level. Businesses can leverage these tools to automatically ingest and report data, calculate a carbon footprint, run simulations, set targets, manage a global portfolio of abatement initiatives, and more. This approach builds value and competitive advantage at the intersection of data science, technology, people, business expertise, processes and ways of working[3].

Intermittency of renewable energy sources

The primal challenge renewable energy sources face is intermittency. Wind speeds and solar radiance vary drastically depending on geographies and weather fluctuations. Whilst historical data offers a sufficient indication of overall expectations of energy generation from a particular location, the ability to predict renewable power generation at a high temporal resolution remains a challenge.

Artificial Intelligence models such as back propagation algorithm (BPA) coupled with in-situ sensors and historical data, could be an effective tool to improves solar and wind speed prediction capability. AI can utilize given meteorological parameters such as sunshine duration, relative humidity, temperature, atmospheric pressure and more to train the models. The predicted error margins are expected to reduce dramatically as these training sets learn. These models can be useful when conducting geospatial analysis for potential renewable energy areas near hydrogen demand[4].

This type on analysis can also benefit storage sizing assessments, be it for electron storage (i.e. batteries, flywheels, capacitors, etc.) or hydrogen storage (surface or subsurface). The ability to adequately size storage will benefit both the resilience of the systems to steadily hydrogen production as well as could dramatically improve long term project economics.

Equipment performance and costing data insights

Whilst there is a considerable interest in rapidly growing the use of Green Hydrogen, the industry itself is still in its early stages. This is particularly reflected in the lack of organizational data and insights for the system components, namely equipment performance, electrolyzer reliability and investment returns.

In terms of equipment performance, an understanding of operational behaviors of all systems needs to be accounted for, i.e., electrolyzer efficiencies and ramp up/down rates, wind turbine performance curves and cut off points, solar panel efficiency by tilt / azimuth, battery and hydrogen storage ramp up/down rates, etc. This type of data is imperative in being able to correctly model the behavior of an end-to-end green hydrogen production system.

In terms of costing, these inputs will have the tendency to vary by geography and would normally have a capital and operational expenditure format. This type of data will need to be applied to all parts of the system ranging from generation, electrolysis, storage all the way to land and infrastructure and is crucial for accurately modelling project costs and ultimately increasing the accuracy of values like NPV and LCOH.

Digital marketplaces offer various types of data that data scientists and business executives can use to publish data sets. The pre curated datasets mean less time is spent to find data and allow scientists to refine models that can be used for business intelligence purposes and aid in making data driven decisions. These marketplaces are often integrated with cloud services without the need for additional governance before the data is available for use.

Network optimization

As the green hydrogen industry continues to expand, the efficient management of hydrogen and/or hydrogen by-products will become an increasingly important link in the supply chain. Be it a dedicated or a shared network with varying volumes and states of hydrogen product, these systems need to operate at high safety standards due to the combustible nature of hydrogen, as well as be accountable for the quantities and transactions of product occurring though it in real time.

Digital data handling and digital communication are not new to the operation and management of distributed system. Distribution System Operators (DSO) run SCADA and computer systems in control centers and substations[5].

A low hanging fruit, which represents a solution at enterprise level, is the private cloud. Systems deployed on cloud would ease the data exchange process within each distribution business. The fluctuating nature of the distributed energy sources is a challenge such systems can manage. Also, it could aid in keeping track of hydrogen generated by different facilities and ensuring accurate transaction logging. Cloud based managed IoT services provides real-time integration with wide range of distributed physical devices enabling for faster response and situational awareness[5].

How can Infosys help in assessing digital needs

Advanced Analytics: Infosys has immense experience in capture, processing, and analytics of real-time streaming structured, semi structured and unstructured data in different formats. The static data of equipment (such as location, manufacturing information, maintenance information, warranty etc.) and the real time information provided by the sensors on the equipment (information such as electrolyzer performance, wind turbine performance, solar panel performance etc.) can be stored in data lake. The raw data can be curated to build data products using platforms such as SQL, synapse, Power BI or PowerApps. These data products can be used for varied purposes such as predictive maintenance, financial analysis and modelling, operational management and monitoring of KPIs.

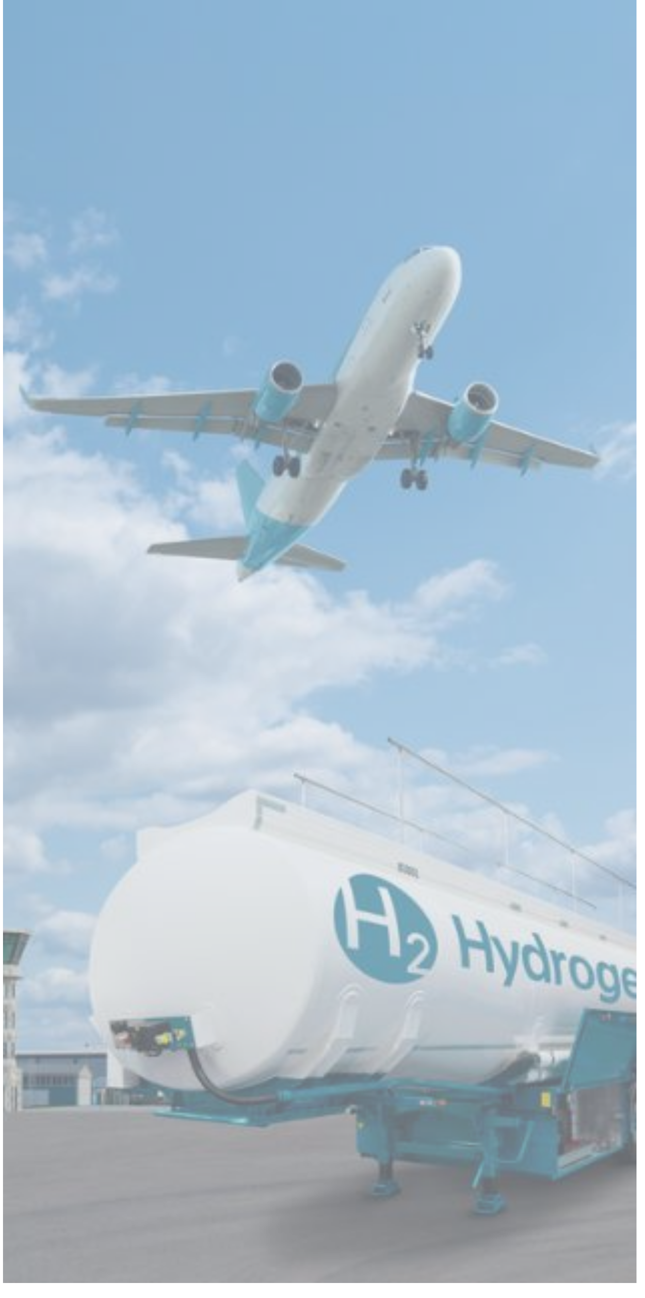
Artificial Intelligence: Keeping in mind the intermittency of renewable energy sources, predictive modelling can be used to develop probabilistic models to predict future possibilities. With historical solar or wind data available, forecasting models such as SARIMAX and Holt-winter are very much capable of including both daily trend and seasonality to make reasonable predictions.

Infosys TOPAZ platform can be used to develop user-friendly equipment downtime management applications for web and mobile platforms. It would help managers understand the cause, duration and frequency of events, and analyze downtime based on diverse criteria, including reason of failure, time period, equipment, operator, and process. Infosys built solutions could integrate the equipment downtime system with work order management and asset maintenance systems to automate actions such as prioritization of equipment maintenance and ordering of spare parts / components. In addition, downtime data is also used to develop predictive maintenance models.

Image processing applications of AI in the energy industry tracks potential breaches of safety protocol and suggest appropriate actions for enhanced workplace safety for personnel working with heavy equipment in potentially hazardous situations.

As the world is trying to achieve sustainability, many energy and utilities companies have set net-zero targets. Infosys AI applications are helping companies track volumes of greenhouse gas emissions throughout their supply chain and enabling better emission control.

Cloud solutions: Organizations have always needed to analyze business performance. In large organizations, a single team doing all the data ingestion can be problematic. Most organizations are decentralized and distributed, and hence different business units and departments handle different parts of the business operation, so data experts are typically spread out across various sectors. A new architectural pattern called data mesh was introduced recently to solve these problems. Infosys has built data mesh solutions that remarkably improve the data processing capabilities across various data domains by tapping into the immense storage and compute power available in private and public cloud.



What’s next?

It is evident that while the technology around feasibility study, efficient production, safe storage and transportation and widespread use of green hydrogen evolves over the next few months and years, digital is and will continue to play a pivotal role in its growth, maturity and operational excellence.

Green hydrogen consists of multiple areas in the value chain where digital technologies can play a pivotal role. By harnessing the power of digital technology, we have the potential to optimize levelized cost of hydrogen, measure accurate environmental impact and achieve predictive capabilities with AI.

Additionally, data marketplaces and cloud technologies will play pivotal roles in streamlining data operations and provide insights into various aspects of green hydrogen production, distribution and consumption and enable us to make data driven decisions at every stage. In combination, these technologies revolutionize the green hydrogen value chain and help us move closer to a future where green hydrogen becomes a cornerstone of sustainable energy systems, driving us toward a cleaner and more sustainable energy future.

MEET THE EXPERTS

Amit Prakash

Associate Partner - Services, Utilities, Resources and Energy Practice

Amit_prakash@infosys.com

Prateek Bhola

Senior Consultant - Services, Utilities, Resources and Energy Practice

Prateek.bhola@infosys.com

Kelti Petto

Senior Consultant - Services, Utilities, Resources and Energy Practice

Kelti.petto@infosys.com

Sources

1. The Future of Hydrogen – Analysis – IEA - https://www.iea.org/reports/the-future-of-hydrogen
2. Hydrogen - IEA - https://www.iea.org/energy-system/low-emission-fuels/hydrogen
3. Measuring Emissions Accurately | BCG - https://www.bcg.com/publications/2021/measuring-emissions-accurately
4. Artificial Intelligence Techniques for Wind Power Prediction: A Case Study (indjst.org)
5. The Digitalization of Distribution Systems - IEEE Smart Grid - https://smartgrid.ieee.org/bulletins/september-2016/the-digitalization-of-distribution-systems

Infosys® | CONSULTING

consulting@Infosys.com
InfosysConsultingInsights.com

LinkedIn: /company/infosysconsulting
Twitter: @infosysconsltng

About Infosys Consulting

Infosys Consulting is a global management consulting firm helping some of the world's most recognizable brands transform and innovate. Our consultants are industry experts that lead complex change agendas driven by disruptive technology. With offices in 20 countries and backed by the power of the global Infosys brand, our teams help the C-suite navigate today's digital landscape to win market share and create shareholder value for lasting competitive advantage. To see our ideas in action, or to join a new type of consulting firm, visit us at www.InfosysConsultingInsights.com.

For more information, contact consulting@infosys.com