

GREEN HYDROGEN Technology Innovation Digest



Government of
Maharashtra

CENTER of EXCELLENCE

for Green Hydrogen Ecosystem Development @ CSIR-NCL



Maharashtra's Blueprint for a Biogas Revolution



Maharashtra has taken a significant step by approving the Compressed Biogas (CBG) Policy in May 2026. An allocation of ₹500 Crore for this year has been designated to support this initiative.

This policy works in conjunction with various national missions, including SATAT, GOBARdhan, and the Swachh Bharat Mission, aiming to convert municipal organic waste, agricultural residues and other animal by-products into clean energy biofuels.

Key incentives of this policy include:

- Concessional Land Leases at just 0.7% of the Ready Reckoner (RR) rate
- Tax Benefits, featuring a 2.5% SGST refund on production
- Streamlined Approvals with a single-window clearance system and "priority status" for water and electricity services.

[Read more...](#)

Inside:

- Technology Reviews
- Research Articles
- Patent Survey
- Reports
- Technology Demo Projects
- New Technology Outlooks
- Startups
- Funding Opportunities

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SUPPORTED BY:



Maharashtra Energy
Development Agency (MEDA)

MAGESTIC: Maharashtra's ₹12,303 Crore Leap Towards a 50% Green Grid

Chief Minister of Maharashtra has officially inaugurated the MAGESTIC initiative (Maharashtra Accelerating Green Energy and Storage Technologies Integration in Connected Grid) with a substantial budget of ₹12,303 crore allocated for this ambitious project.

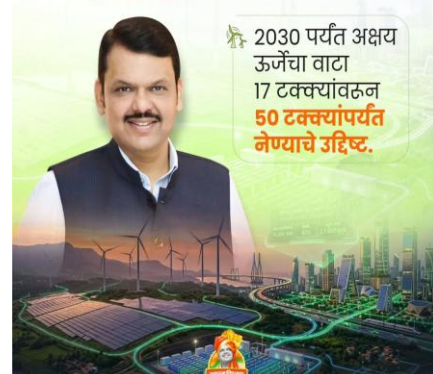
Maharashtra is set on a path to increase its share of renewable energy from the current 17% to an impressive 50% by the year 2030.

The project includes several initiatives like construction of 40 new substations and enhancements to transmission capacity along with deployment of a 16,000 MWh Battery Energy Storage System (BESS).

[Read more...](#)

**हरित ऊर्जेकडे राज्याची
वेगवान वाटचाल!**

12 हजार 303 कोटी रुपयांच्या महाराष्ट्र: अक्सलीटेटिंग
ग्रीन एनर्जी अँड स्टोरेज टेक्नॉलॉजीज इंटिग्रेशन इन कनेक्टेड
ग्रिड (MEGA-SITIC) योजनेला मंजूरी.



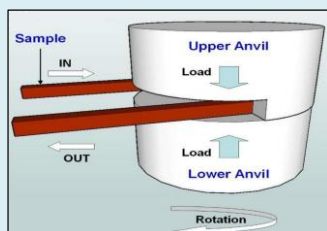
Liquid Gold: A Liquefied Efficient Engine

Liquid hydrogen (LH_2) is emerging as a crucial component for large-scale storage and long-distance transport. However, the current deployment is still limited by the liquefaction process, which consumes about 30% of hydrogen's unit calorific value. This review paper presents a thorough optimization method for meeting the future target of 6-7 kWh/kg. It emphasizes the adoption of advanced Claude cycles, centrifugal cold compression, and the transition from traditional liquid nitrogen precooling to mixed refrigerant technology for enhancing the energy efficiency in hydrogen liquefaction processes for commercial production. [Read more...](#)



Source: [International Journal of Green Energy](#)

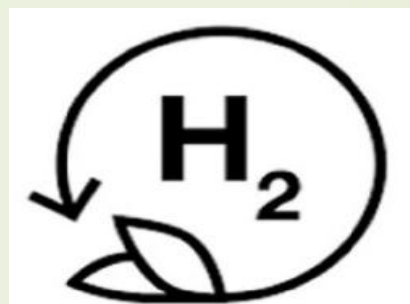
High-Pressure Torsion (HPT): an Electrocatalyst Synthesis Method



This review article focuses on the innovative production of catalyst materials using the High-Pressure Torsion (HPT) method, which facilitates severe plastic deformations via extreme shear strains. By employing the HPT technique, one can achieve remarkable microstructural control, allowing for the synthesis of non-equilibrium phases, high-entropy compounds, customizable defect populations, and vacancy-rich high-entropy oxides and oxynitrides. These materials show great promise in electrocatalytic and photocatalytic applications for hydrogen production. [Read more...](#)

Source: [Hydrogen](#)

A Global Lifecycle Audit of Hydrogen's True Climatic Impact



This review article examined 653 academic studies and gathered 906 data points from the years 2000 to 2024 to estimate hydrogen's greenhouse gas (GHG) emission footprint, expressed in grams of CO_2 equivalent per kWh ($\text{gCO}_2\text{e/kWh}$).

The study reveals that the average lifecycle carbon emission, including sourcing, production and transportation, etc., stands at 435.4 $\text{g CO}_2\text{e/kWh}$ (15.2 $\text{kg CO}_2\text{e/kg H}_2$). [Read more...](#)

Source: [Energy Research & Social Science](#)

Navigating the Blue Horizon: The Maritime Path to Net Zero 2050

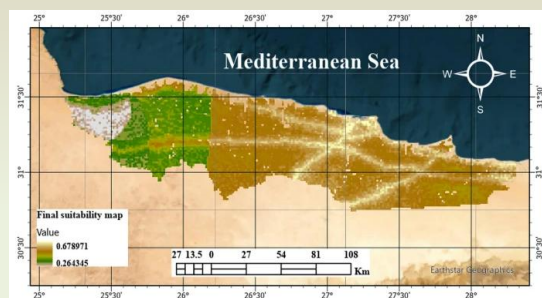
This review article examines the transition to green energy in the global maritime sector as it strives to meet the Net Zero 2050 targets established by the IEA and IMO. The analysis highlights Liquefied Natural Gas (LNG), Green Hydrogen, and Green Ammonia as the three critical pillars propelling this worldwide shift. LNG and Green Ammonia are expected to lead the charge for long-haul shipping due to their manageable storage options, while green hydrogen is earmarked for short sea shipping, given its significant storage demands requiring 7.6 times more space than traditional heavy fuel oil. In conclusion, it emphasizes the necessity for global safety standards, such as the IGF Code, alongside Market-Based Measures (MBM) to create an effective pricing mechanism for adopting green energy in the maritime industry. [Read more...](#)

Source: [Energies](#)

Geospatial Evaluation of Egypt's Green Hydrogen Future

This study utilizes a Geographic Information System (GIS) based Multi-Criteria Decision Making (MCDM) framework to identify optimal locations for Green Hydrogen production along Egypt's Northwestern coast. The findings emphasize that Egypt's geographical advantage-high solar capacity paired with access to water, positions it as a strategic hub for exporting green energy to Europe, provided that initial high capital costs are mitigated through targeted infrastructure investment and international partnerships.

[Read more...](#)



Source: [Scientific Reports](#)

Power coupling of Dry Methane Reforming and Electrolysis

This article uses an integrated system by combining biogas dry methane reforming with water electrolysis to improve green hydrogen production. Dry methane reforming converts methane and carbon dioxide into syngas, and its electrolysis supplies oxygen for oxy-fuel combustion and generates additional hydrogen. This system achieves the highest energy efficiency of about 74.62% by the utilization of the waste heat. The system also enables efficient CO₂ capture, potentially achieving negative emissions and economic benefits via carbon credits. Overall, the integration strategy improves hydrogen yield, efficiency, and sustainability compared to conventional standalone processes.

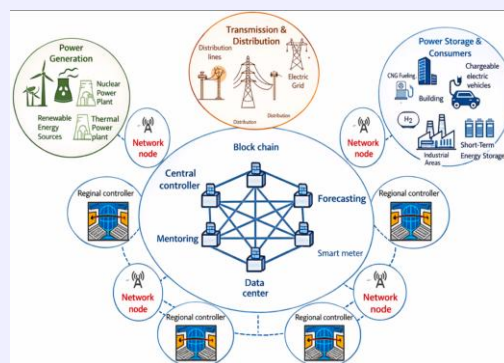
[Read more...](#)

Source: [Energy Conversion and Management](#)

Artificial Intelligence as a Driver of Green Hydrogen Technology

This article highlights the role of artificial intelligence (AI) in enhancing green hydrogen technologies for smart city applications. It explains how AI improves hydrogen production, storage, distribution, and energy management through predictive analysis, automation, and real-time optimization. The study also discusses the integration of AI with renewable energy systems and smart grids to increase efficiency, reduce operational costs, and support sustainable urban development. Overall, the paper demonstrates that AI-driven green hydrogen systems can significantly contribute to cleaner, smarter, and more energy-efficient cities.

[Read more...](#)



Source: : [International Journal of Hydrogen Energy](#)

Optimization of Green Hydrogen-Powered EV Charging Stations

This article presents a green hydrogen-powered electric vehicle (EV) charging station integrated with renewable energy sources and grid support systems. The study focuses on multi-objective optimization to improve techno-economic feasibility, energy efficiency, and reliable grid integration. It evaluates different operational strategies to reduce charging costs, minimize carbon emissions, and enhance the utilization of renewable power and hydrogen storage systems. Overall, the proposed system demonstrates a sustainable and economically viable approach for future clean transportation and smart energy infrastructure development.

[Read more...](#)



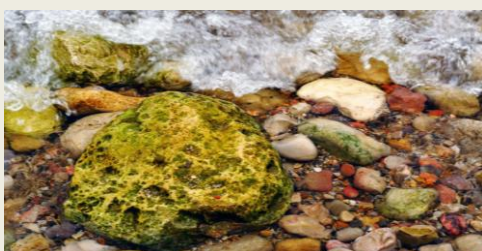
Source: [International Journal of Hydrogen Energy](#)

Powering the Future with Sun and Water

An innovative design of photoreactor panels has been developed by Photreon, a start-up initiative at Karlsruhe Institute of Technology (KIT), to enhance hydrogen production without the need for electricity, electrolyzers, and the complexities of grid connections. In regions with abundant sunlight, these panels can effectively utilize solar energy to directly dissociate water into hydrogen through the principle of photocatalysis. This economical technology is well-suited for large-scale distribution applications. These technical panels guide sunlight to penetrate their surface and illuminate the active sample inside, thereby initiating the water electrolysis process. [Read more...](#)



In-situ Hydrogen Generation via Naturally Occurring Rocks



Element One Hydrogen & Critical Minerals Corp. (CSE: EONE) has developed a technology that is in the process of being patented for generating pure hydrogen from metal-rich and naturally occurring olivine rocks. The presence of iron and nickel metals within ultramafic and mafic rock formations leads to the formation of in-situ spinel oxide catalysts, which trigger the hydrogen production via water-rock interactions at moderate temperatures and pressures. The synergistic integration of nickel-doped spinel oxides and olivine-derived fluids has enhanced hydrogen production by 1000 times. [Read more...](#)

Magnetic Field-driven Hydrogen Production



IIT Indore has successfully obtained a patent for a novel method that reduces the electrocatalytic overpotential in water-splitting reactions, paving the way for efficient hydrogen production with the application of magnetic fields. This innovative technique involves using Ni-Co and Ni-Fe alloy electrodes via the electrodeposition process on a stainless-steel substrate. [Read more...](#)

Diamond-Like Carbon Coatings: The "Iridium-Saver"

IHI Ionbond AG has introduced an innovative metallic bipolar plate consisting of a metal substrate coated with a layer of transition metal-doped diamond-like carbon (DLC). This DLC layer incorporates a selected transition metal from the 4d, 5d, or 6d groups, which is present in its carbide phase. These bipolar metal coatings offer exceptional corrosion resistance and maintain low interface contact resistance, even over extended lifetimes of over 10,000 hours. [Read more...](#)

Hydrogen Scooters with Replaceable Hydrogen Storage Canisters



Building on the Suzuki Burgman 400, Toyota is currently working on an innovation involving scooters powered by hydrogen fuel cell canisters. The newly designed interchangeable hydrogen canisters, instead of a conventional refuelling system, are the ultimate backbone of this innovation. These hydrogen canisters can be effortlessly replaced once they are empty. The design incorporates a swing-out mechanism, a linkage system, and strategic placement of the hydrogen tank to facilitate an easier, more straightforward, and user-friendly removal process. [Read more...](#)

The \$2/kg Race: India is Redefining the Green Hydrogen Economics

Published by: Renewable Energy society of India (one nation, one society)

According to the RESI 2026 report, the hydrogen sector has evolved from theoretical pilot projects to a robust industrial field, boasting over 1,500 projects and 200 committed investments. Solid oxide electrolyzers (SOEC) and biomass-derived technologies are starting to gain traction alongside alkaline electrolysis (ALK) and proton exchange membranes (PEM). In India, the ambitious energy intensity targets of 50-60 kWh/kg and the necessary infrastructure development remain unfulfilled. Despite challenges like supply chain disruptions and funding gaps, initiatives like the SIGHT scheme and a global capital investment of \$110 billion through 2026 offer promising prospects for integrating hydrogen technology into heavy industries. [Read more...](#)



Source: [Renewable Energy society of India \(one nation, one society\)](#)

The 22.9% CAGR Opportunity in Global Hydrogen Storage 2026-2033

Published by: Persistence Market Research (PMR)

The Persistence Market Research (PMR) has released a report that forecasts a remarkable Compound Annual Growth Rate (CAGR) of 22.9% for the hydrogen storage market. This growth suggests that the market value will surge from \$2.9 billion in 2026 to an impressive \$11.7 billion by 2033. Various storage methods play crucial roles, with physical storage currently holding a dominant 80% market share, while cylinders account for 42.2%. Because of the strong competition from National Green Hydrogen Mission (NGHM) in India and manufacturing hubs in China and Japan, the Asia-Pacific region is taking the lead with a substantial 37.48% market share. Vallourec's Delphy vertical storage and the European Hydrogen Backbone are working to enhance energy stability on a global scale. [Read more...](#)

Green Hydrogen Storage Market Outlook, by Product, 2026-2033



Source: [Persistence Market Research \(PMR\)](#)

Mission Green: India's Hydrogen Leap

Published by: Press Information Bureau (PIB)



This Press Information Bureau (PIB) report is underscoring several significant achievements that have already been realized. **Major inclusions are green hydrogen port establishments; the operation of the highest altitude hydrogen train in Leh; the allocation of 19 companies with hydrogen production incentives extended to 15 electrolyzer firms under the SIGHT scheme; and the price of green ammonia in fertilizer industries set at ₹55.75/kg.** Additionally, to promote transparency in the international trade market, the Green Hydrogen Certification Scheme (GHCI) imposes strict emission standards of ≤ 2 kg CO₂ per kg of H₂. [Read more...](#)

Source: [Press Information Bureau \(PIB\)](#)

Fueling Freedom: India's Vision to Green Sovereignty

Published by: Bureau of Energy Efficiency (BEE)



In February 2026, during a national address, the Director General of the Bureau of Energy Efficiency (BEE) highlighted that green hydrogen is an elixir for difficult-to-decarbonize sectors, such as fertilizers, steel, and cement. Looking ahead, the BEE envisions India positioning itself as a global frontrunner in the hydrogen market by harnessing its abundant solar and wind resources for the export of green hydrogen and ammonia, and by focusing more on domestic production of electrolyzers. [Read more...](#)

Source: [Bureau of Energy Efficiency \(BEE\)](#)

TECHNOLOGY DEMO PROJECTS

The Green Gateway: Kakinada's Global Ammonia Export

India has reached another significant milestone in its National Green Hydrogen Mission (NGHM) with the launch of the green hydrogen-to-ammonia project by AM Green in Kakinada, Andhra Pradesh. This initiative is set to become the country's largest and most ambitious renewable energy hub. The project will incorporate an impressive 1.95 GW of alkaline electrolyzers alongside 7.5 GW of renewable energy and 2 GW of pumped-storage hydro. An initial agreement with Uniper aims to supply 500,000 tonnes of green ammonia annually, with deliveries expected to commence in 2028. [Read more...](#)



Source: [Fuel Cells Works](#)

Sailing Towards Net-Zero: Kandla e-Methanol Maritime Corridor

Assam Petro-Chemicals Ltd (APL) and the Deendayal Port Authority (DPA) have come together to sign a Memorandum of Understanding on January 29, 2026, to set up a 150 Tonnes Per Day (TPD) e-Methanol plant at Kandla Port in Gujarat. This venture marks a significant milestone in India's commitment to maritime decarbonization. With a total net CAPEX of ₹1,200 crore, the project is set to generate approximately 3,500 new jobs and aims to position Kandla as a leading green bunkering hub. **The strategic location on India's western coast will facilitate the establishment of refuelling stations for vessels navigating the busy Singapore-Rotterdam trade corridor.** [Read more...](#)



Source: [Press Information Bureau \(PIB\)](#)

Bokaro's Global Milestone in Hydrogen-Powered Steel



On April 7, 2026, the Bokaro Steel Plant (BSL), a unit of SAIL, took a significant step in advancing industrial decarbonization by finalizing a key contract. This initiative will see the implementation of hydrogen energy within its blast furnace units. An important collaborator on this project is Forbes Marshall Private Limited, which positions this effort as the largest hydrogen injection endeavour in the world, marking a ground breaking milestone in green steel innovation. The project receives backing from SAIL's Research and Development Centre for Iron and Steel (RDCIS) and UK-based Primetals Technologies. [Read more...](#)

Source: [PSU Connect](#)

HPCL × Volvo's Power Pact for Hydrogen Mobility Frontier



Hindustan Petroleum Corporation Limited (HPCL) and Volvo Group India are making a strategic partnership aimed at transforming the heavy-duty transport sector through clean mobility solutions. Their collaborative goal is to advance the use of alternative renewable energy fuels, such as Liquefied Natural Gas (LNG), Bio-LNG, and Hydrogen technologies. This project aims for the implementation of a 700 bar high-pressure hydrogen fuelling solution. **This partnership is vital as it merges HPCL's extensive nationwide energy network with Volvo's top-notch automotive engineering to create crucial hydrogen refuelling station (HRS) corridors across the country.** [Read more...](#)

Source: [PSU Connect](#)

NEW TECHNOLOGY OUTLOOKS

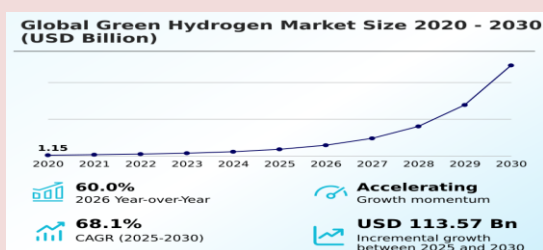
India's Green Hydrogen Strategy Needs Demand-Side Policy

According to this report by the Chintan Research Foundation, there is a significant “demand crisis” and alarmingly, 94% of the planned production capacity remains unconstructed, with only 2.8% expected to be operational by 2026. The report suggests three main solutions: implementing domestic hydrogen purchase obligations (HPOs); offering price bridging backed by government deficit coverage; and establishing Performance-Linked Incentives. [Read more...](#)



Source: [Chintan Research Foundation](#)

The \$113 Billion Surge: 2026-2030 Global Outlook of Technavio



According to a recent report from Technavio, the hydrogen market is set to experience a remarkable growth of 68.1% in its Compound Annual Growth Rate (CAGR) and is expected to expand by an impressive USD 113.57 billion by 2030. The Asia-Pacific (APAC) region plays a significant role in this increase, accounting for 57.4% of global growth. Key drivers of the green hydrogen sector include: chemical industry, government production tax subsidies, and the ongoing development of hydrogen refuelling stations (HRS). [Read more...](#)

Source: [Technavio](#)

The Electrolyser Edge: Heart of India's Green Revolution



This report from Indian Chemical News highlights the significant strides being made in the domestic production of electrolyzers in India. In addition to the support provided by government initiatives like the NGHM vision and the SIGHT scheme, major corporations such as Reliance and Adani Industries are also actively investing in alkaline, SOEC, and PEM systems. **“This collaboration between the corporate sector and government is positioning Indigenous electrolyzers to compete effectively on a global scale, particularly justifying their cost efficiency per kilogram”.** [Read more...](#)

Source: [Indian Chemical News](#)

Mapping the 2026-2033 Global Green Hydrogen Surge



Coherent Market Insights has shared its reviews on several fundamental aspects of the green hydrogen market, like the proton exchange membranes (PEMs) capture a significant 38.1% of the market share, the Middle East and Australia contribute to the solar energy sector, having a 31.8% market share, and the refining industry represents a substantial 31.5% of the market. **“Asia-Pacific and European regions are poised to become the fastest-growing markets for cross-border green hydrogen transport .”** [Read more...](#)

Source: [Coherent Market Insights](#)

Maharashtra's Renewable Rush: Strategic Outlook 2026-2035



This PowerLine report reveals that Maharashtra state's energy demand has soared to 166,224 million units (MUs) for the year 2025-26. Of the total renewable energy capacity of 31.67 GW, 19.36 GW is supplied by solar energy alone. **“Notably, Maharashtra has achieved a Guinness World Record by installing 45,911 off-grid solar pumps in just 30 days”.** The report concludes with a call to action: Maharashtra needs to ramp up its deployment efforts from 3 GW to 6.9 GW annually, with an ultimate goal of reaching 100 GW by 2035. [Read more...](#)

Source: [PowerLine](#)

GREENSTAT: Leading in the Continuous Change in the Global Energy Systems

"A green energy company" creates, owns, and runs renewable energy infrastructures with a primary focus on green hydrogen. With pilot projects almost finished, a few shovel-ready projects, feasibility studies in green hydrogen production for end-use sectors in Mobility, Marine, Industrial heating, Feedstock, Back-up power (Data Centres), and others, the company is quickly expanding its hydrogen position in India. It is also selectively maturing other projects in Sri Lanka and other Asia-Pacific regions. The names of the major collaborative partners for GREENSTAT involve Priserve Infrastructure Pvt. Ltd., Torrent Group, Petron Sciencetech Inc., and others. The crucial projects undertaken by Greenstat are with HYGREEN India Pvt Ltd, Kajari Ceramics, ABC Clean Tech, and the rest. [Read more...](#)

The logo for GREENSTAT is displayed in white capital letters on a dark green rectangular background.

Stargate Hydrogen: A Precious-metal-free Electrolyzer Manufacturing Start-up

The logo for Stargate Hydrogen features a stylized blue icon of three dots connected by lines, followed by the text "stargate hydrogen" in a lowercase, sans-serif font.

A deep-tech European electrolyser start-up advancing industrial green hydrogen production systems, energy resilience, and infrastructure projects. The company uses its precious metal-free alkaline electrolyzers in energy-intensive industries like steel, ammonia, methanol, e-methane, and others. Stargate Hydrogen, simultaneously, is also actively creating innovative technologies, such as ceramic-based electrodes, that enable clients to use proven technology now while directly witnessing the performance of the future. Some of its dedicated partners are Repsol and are trusted by several clients in Europe, Turkey, and India, including Fortum, Utilitas, ABB, and Rockfin. [Read more...](#)

Bio-Hydrogen Production from Wastewater: Ossus Biorenewables



Ossus Biorenewables Pvt Ltd, a Bangalore-based clean tech company, aims to enable industries to switch from fossil fuels to sustainable, clean hydrogen energy. With the help of their signature innovation, OB HydraCel bioreactors, industrial wastes were being converted into green hydrogen, which eliminates the need for costly imported equipment or pure water. It lowers operating expenses and carbon emissions while enabling on-site hydrogen generation. Ossus provides clean energy and environmental responsibility by combining cutting-edge bioengineering with wastewater treatment through daily manufacturing close to 2,000 kg of green hydrogen and then distributing it throughout several Indian states. The project partners of Ossus Biorenewables include Eternis Fine Chemicals Limited, Oil and Natural Gas Corporation (ONGC), and Sayaji Maize Products, to whom they deliver sustainable hydrogen while optimizing resource use. [Read more...](#)

Evolve Hydrogen: Electrolysis directly from seawater

The logo for Evolve Hydrogen features the word "evolve" in a lowercase, sans-serif font, with "HYDROGEN" in a bold, uppercase, sans-serif font below it.

The founders of Evolve Hydrogen Inc. switched from the expensive feedstock of deionized water used by conventional electrolyzers to seawater, which makes their innovation state-of-the-art. At a startling 7 degrees Celsius, their initial seawater experiment produced encouraging findings. Evolve™ was shortly granted patents with 81 noble claims in nine countries. Evolve™ is a polymer solution that can be mass-manufactured by injection moulding, eliminating the typical expensive and slow process of manufacturing by CNC milling. It is one of just nine winners of the US Department of Energy's "H-Prize" Phase One in 2022. Numerous international labs and universities, such as NREL, Calgary University, Strathclyde University, and AERTC at SUNY Stony Brook, have evaluated and validated Evolve™ R&D. [Read more...](#)

FUNDING OPPORTUNITIES

**JUNE
15**

NTPC Pudimadaka: Power Transformer Package for Green Hydrogen Hub

A Green Hydrogen Hub is set up at Pudimadaka, Anakapalli District, Andhra Pradesh, by NTPC Green Energy Limited (NGEL). The hub, which would cover over 1200 acres, will have green chemical production facilities to serve both domestic and international markets. This tender aims to provide a Power Transformer supply solution for the Green Hydrogen Hub.

In order to achieve the purpose of the specification and guarantee the operability, maintainability, and dependability of the entire work covered under this specification, the bidder shall be responsible for providing all materials, equipment, and services, whether specified or not.

[Learn more...](#)



Paradip Port Green Hydrogen/Ammonia Jetty Tender

Paradip Port Authority has invited bids (the "Authority") from interested parties (the "Bidders") in compliance with the Request for Qualification (RFQ) and Request for Proposal (RFP) papers to choose the bidder for the project, subject to national security clearance.



The Authority hereby invites both RFQ and RFP bids in a single stage. Bidders who possess a Digital Signature Certificate (DSC) issued by any agency authorized by the Controller of Certifying Authority (CCA), Government of India, and which can be traced up to the Root Certificate of CCA, may download the RFQ and RFP documents containing instructions to Bidders, Criteria for Evaluation and Selection from the CPP Portal ([Central Public Procurement Portal](#)).

[Learn more...](#)

**JUNE
26**

**JUNE
15**

POWERGRID: Development of 400 kV Gas Insulated Substation (GIS) in Tuticorin

In the region of Tuticorin, Tamil Nadu, a 400 kV Gas Insulated Substation (GIS) package is to be constructed, and for that, the Power Grid Corporation of India Limited (POWERGRID) has opened online bids. The "400 kV GIS Substation Package SS 104T" is a crucial component of the transmission infrastructure that will enable future Green Hydrogen and Green Ammonia projects in the region.

The Tariff-Based Competitive Bidding (TBCB) structure was used to offer the tender. The project is part of the Power & Energy industry, and has been made available as an open work. The opportunity is available to qualified bidders from all around India and overseas because the transmission system will support large-scale renewable energy and green fuel projects. All the interested businesses can take part via POWERGRID's electronic tendering tool, the PRANIT Portal.

[Learn more...](#)

