

Design and Implementation of a 50 TPD Green Hydrogen Production Facility Using Alkaline Electrolysis Technology for LCOH < \$2/kg

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Abstract- This paper presents the design and implementation of a 50 tons per day (TPD) green hydrogen production facility utilising Alkaline Electrolysis Cell (AEC) technology, aimed at achieving a levelized cost of hydrogen (LCOH) below \$2/kg. AEC technology was selected for its long lifespan, low capital and operational expenditures, and high technology readiness level. The facility is strategically located in Gujarat, India, leveraging the region's abundant renewable energy resources and supportive government policies. The plant operates with a feedstock of 450 kL/day of deionized water sourced from the Narmada River and employs a round-the-clock renewable energy model combining 300 MW of solar, 200 MW of wind, and 140 MW of hydro power, supplemented by a 10 MW Battery Energy Storage System (BESS). The produced green hydrogen is intended for use in the fertilizer and petrochemical industries, replacing grey hydrogen and natural gas, and as an energy carrier. The project is projected to offset 274,000 tonnes of CO₂ annually, highlighting its significant environmental benefits. This paper discusses the technical design, economic feasibility, and potential impact of the facility on the green hydrogen economy.

Keywords: Email phishing, cybersecurity, phishing detection, machine learning, artificial intelligence, signature-based detection, intrusion detection, email security, anomaly detection, spam detection.

I. INTRODUCTION

The shift from fossil-based energy sources to cleaner, sustainable alternatives has become essential in mitigating climate change and reducing global carbon footprints. Hydrogen is emerging as one of the most promising energy vectors in the clean energy transition, particularly green hydrogen, which is produced via water electrolysis using renewable energy. Green hydrogen holds significant advantages over traditional hydrogen production methods such as steam methane reforming (SMR) and coal gasification, both of which are carbon-intensive processes that release substantial amounts of CO₂.

This project outlines the design and implementation of a 50 tons per day (TPD) green hydrogen production facility using Alkaline Electrolysis Cell (AEC) technology. The plant aims to achieve a levelized cost of hydrogen (LCOH) below \$2/kg, a critical milestone for the large-scale adoption of green hydrogen in industrial sectors and as an energy carrier. The proposed plant integrates

renewable energy sources in a round-the-clock (RTC) model, using a combination of solar, wind, hydropower, and battery energy storage systems (BESS), ensuring consistent and reliable power supply. By focusing on a modular, scalable approach, the facility is poised to meet growing demand while contributing to global decarbonization efforts.

II. THE IMPORTANCE OF GREEN HYDROGEN

Hydrogen, often called the "fuel of the future," is a versatile energy carrier with the potential to decarbonize several industries, including transportation, chemicals, and heavy industry. Green hydrogen, in particular, is produced using renewable energy sources, offering a carbon-free alternative to conventional "gray" or "blue" hydrogen, which are derived from fossil fuels like natural gas or coal.

Hydrogen Production Alternatives

1. Gray Hydrogen: Produced from natural gas or coal through processes such as SMR and coal gasification, gray hydrogen accounts for the

majority of global hydrogen production. However, this method generates significant CO₂ emissions, making it unsustainable in the long term.

2. Blue Hydrogen: Similar to gray hydrogen, blue hydrogen is produced from natural gas, but with carbon capture and storage (CCS) technology added to capture the CO₂ emissions. While this reduces the carbon footprint, blue hydrogen is still not entirely carbon-neutral and relies on fossil fuels.
3. Green Hydrogen: Produced through electrolysis, green hydrogen splits water molecules (H₂O) into hydrogen (H₂) and oxygen (O₂) using electricity derived from renewable sources. As it does not emit CO₂ during production, green hydrogen represents the cleanest and most sustainable form of hydrogen production, positioning it as a cornerstone in the global energy transition.

The advantages of green hydrogen over its alternatives are clear: it offers a long-term, sustainable solution to decarbonization, is versatile across various sectors, and, with proper scaling and investment, can become cost-competitive. The technology employed in green hydrogen production is also advancing rapidly, making it feasible for industrial-scale operations like the one proposed in this project.

III. GREEN HYDROGEN VALUE CHAIN

The green hydrogen value chain encompasses several stages, from production to end-use applications, each of which contributes to its role in decarbonizing industries and energy systems.

Production

The green hydrogen production process involves the electrolysis of water, where electrical energy is used to split water molecules into hydrogen and oxygen. The electricity required for this process comes from renewable sources such as solar, wind, and hydropower, ensuring that no carbon emissions are generated during production. The proposed plant will utilize AEC technology, which has proven to be

durable, cost-effective, and scalable for large-scale hydrogen production.

Storage and Distribution

Once produced, hydrogen must be stored and transported to the point of use. The plant's design includes compressed hydrogen storage systems, adhering to ISO 19884:2020 standards, which ensure safety and reliability. The integration of storage solutions also allows the plant to manage fluctuations in hydrogen demand and supply effectively.

Hydrogen can be distributed via pipelines, trucks, or ships, depending on the distance and demand. It is essential to create a robust hydrogen distribution network to ensure the efficient delivery of green hydrogen to industrial, transportation, and energy sectors.

End-Use Applications

Green hydrogen has a wide range of applications, particularly in sectors that are difficult to decarbonize through electrification alone. Some of the key end-use applications include:

Fertilizer Industry: Green hydrogen is a crucial feedstock for producing ammonia, a critical component of fertilizers. Traditionally, ammonia production relies on gray hydrogen produced through natural gas-based SMR, contributing significantly to global CO₂ emissions. By replacing gray hydrogen with green hydrogen, the fertilizer industry can significantly reduce its carbon footprint.

Petrochemical Industry: Green hydrogen is used in refining processes such as hydrocracking and desulfurization. It is also a key feedstock for the production of chemicals like methanol. The adoption of green hydrogen in the petrochemical industry reduces greenhouse gas (GHG) emissions and supports the industry's shift towards sustainable practices.

Energy Carrier: As an energy carrier, hydrogen can be stored and transported, providing flexibility in energy systems. Green hydrogen can be used in fuel cells to power vehicles and provide stationary power

generation. It also helps address the intermittency of renewable energy by storing surplus energy and releasing it when demand is high.

There are several technologies available for hydrogen production through electrolysis, including Alkaline Electrolysis (AEC), Proton Exchange Membrane (PEM) electrolysis, and Solid Oxide Electrolysis (SOE). Each technology has its own advantages and disadvantages, which we evaluated to determine the most suitable method for our project.

IV. GREEN HYDROGEN PRODUCTION TECHNOLOGIES

Parameter	Alkaline Electrolysis (AEC) (PEM) Electrolysis	Solid Oxide Electrolysis (SOE)
Operating Principle	Electrolysis of water in an alkaline medium (KOH electrolyte) membrane	Electrolysis of water using a proton-conducting polymer membrane at high temperatures using solid oxide electrolyte
Operating Temperature	60–80°C 50–80°C	700–1000°C
Efficiency	~70-80% ~60-70%	~85-90%
Current Density	Low High	High
Response Time	Moderate Fast	Slow
Startup Time	Longer Short	Long
Maturity	Mature, well-established technology newer than AEC	Commercially available but In developmental stage, limited commercial application
Cost	Low capital and Higher capital and operational costs	High CAPEX and OPEX due to complex system
Durability	Shorter operational lifespan than AEC	Long operational lifespan Durability issues due to high temperature degradation
Scalability	High scalability for large-scale production	More suited for medium to small-scale production Suitable for large-scale production, but still developing
Material Requirements	Requires expensive catalysts (e.g., platinum)	Non-noble materials required High-temperature materials required
Power Source Requirements	Requires stable power Can integrate with intermittent supply renewable sources	Can integrate with industrial waste heat
Heat Integration	Limited heat integration	Limited heat integration Can utilize waste heat for enhanced efficiency
Oxygen Byproduct	Yes Yes	Yes
Applications	Suitable for large-scale industrial hydrogen integration and fast response production needs	Suited for renewable energy high-efficiency industrial applications
Maintenance	Less frequent but expensive maintenance due to precious metals	Requires regular maintenance High maintenance due to thermal stresses and material degradation

Commercial Availability	Widely commercially available	Limited commercial availability
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Based on our evaluation, Alkaline Electrolysis Cell (AEC) technology was chosen for the following reasons:

- **Cost-Effectiveness:** AEC offers a lower CAPEX and OPEX compared to PEM and SOE, making it more suitable for achieving an LCOH below \$2/kg.
- **Mature Technology:** The long operational history and established reliability of AEC provide confidence in its scalability and durability.
- **Scalability:** The modular nature of AEC allows for easy scaling of production capacity to meet increasing hydrogen demand.
- **Operational Efficiency:** High capacity utilization and efficiency rates make AEC a viable option for large-scale hydrogen production.

V. RENEWABLE ENERGY INTEGRATION

Our Renewable Energy (RE) model for the green hydrogen plant adopts a round-the-clock (RTC) approach, utilizing a 46:30:22:2 split of Solar, Wind, Hydel, and Battery Energy Storage Systems (BESS), respectively. This diversified energy mix ensures a consistent and reliable power supply, crucial for the stable operation of AEC technology.

1. Solar Energy (46%)

- **Rationale:** Solar power is abundant in Gujarat, providing a reliable and substantial energy source for daytime operations.

Parameter	Gujarat	Tamil Nadu	Maharashtra Karnataka	Rajasthan
Rank	1	2	3 4	5
Renewable Energy Potential	High (Solar, Wind, Hydel)	Very High (Wind, Solar, Hydel)	High (Solar, High (Solar, Wind, Hydel) Wind, Hydel)	Very High (Solar), Moderate (Wind)
Solar Energy Potential	High	Good	Good High	Highest in India
Wind Energy Potential	Significant, especially coastal	Very High in southern and coastal areas	High along western coast Good	Moderate

Hydropower

Potential Moderate Moderate Significant

- **Advantages:** Low operational costs and high energy yield during daylight hours.

2. Wind Energy (30%)

- **Rationale:** Gujarat's coastal regions offer significant wind energy potential, complementing solar power during non-daylight hours.
- **Advantages:** Provides a steady energy supply, particularly during the night and monsoon seasons.

3. Hydel Energy (22%)

- **Rationale:** Hydropower provides a stable and continuous energy source, balancing the intermittency of solar and wind power.
- **Advantages:** Reliable baseload power with minimal operational fluctuations.
- **4. Battery Energy Storage Systems (BESS) (2%)**
- **Rationale:** BESS stores surplus energy generated during peak renewable production periods and supplies it during deficits.
- **Advantages:** Enhances grid stability and ensures a constant energy supply for the electrolyzers.

Key Factors for Location Selection

1. Renewable Energy Potential (RTC RE)
2. Policy Support and Tax Exemptions
3. Feedstock Availability
4. Infrastructure and Export Opportunities
5. Local Consumption of Green Hydrogen

(Western Ghats)

Significant

(Western Ghats) Low 5 Hydrogen
Policy Support Strong: Gujarat Green

Policy Support	Strong: Gujarat Green Hydrogen Policy, tax rebates, subsidies	Growing: Solar and wind policies, proposed hydrogen policies	Competitive: Emerging: Draft Proposed green hydrogen policies, good incentives support	Competitive: Focus on solar, limited hydrogen policies
Ease of Doing Business	High (Proactive regulatory framework)	Improving	Good Good	Moderate
Feedstock Availability	Abundant renewable energy sources	Abundant wind complemented by solar and hydropower	Balanced renewable energy resources mix	High solar, limited wind and hydropower
Infrastructure Development	Well-established, access to ports (Kandla, Mundra)	Good, access to ports (Chennai, Tuticorin)	Strong, access to ports Established, (Mumbai, access to JNPT) Mangalore port	Developing, no direct port access
Industrial Base for Green Hydrogen	Strong: Petrochemicals, fertilizers, heavy industries	Growing: Automotive, textiles, chemicals	Strong: Automotive, Growing: IT, petrochemicals, aerospace, manufacturing	Developing industrial demand
Export Opportunities	High (proximity to major ports)	High (access to ports)	High (access to major ports) Moderate (access to Mangalore port)	Moderate (no direct port access)
Local Consumption Potential	High	Significant, expanding	High Growing demand	Moderate
Government Incentives	Strong: Capital subsidies, tax rebates, low-interest loans	Attractive incentives for solar and wind	Robust: Capital subsidies, tax benefits	Competitive: Subsidies and tax benefits
Job Creation Potential	High (2,000-2,400 jobs projected)	High	High Moderate	Moderate
Forex Savings	High (\$28 million annually)	Moderate	High Moderate	Moderate

Comparative Analysis

Based on the factors evaluated, Gujarat emerges as the most suitable location for the green hydrogen plant. Here's a detailed comparison and reasoning for the selection:

1. Renewable Energy Potential (RTC RE)

Gujarat's combination of high solar and significant wind potential, along with moderate hydropower resources, offers a well-rounded energy mix. Rajasthan, while having the highest solar potential, lacks in wind and hydropower resources. Maharashtra, Tamil Nadu, and Karnataka have good renewable potential but are either balanced or

slightly lower in overall combined capacity compared to Gujarat.

2. Policy Support and Tax Exemptions

Gujarat offers robust policy support, including various incentives such as tax rebates, low-interest loans, and capital subsidies, making it financially attractive. While other states also offer competitive incentives, Gujarat's proactive regulatory framework specifically supports large-scale renewable energy and hydrogen projects.

3. Feedstock Availability

The abundance of renewable energy resources in Gujarat ensures consistent feedstock availability for hydrogen production. Rajasthan's reliance on solar alone and limited other renewable resources makes it less favorable. Other states have balanced but slightly less abundant renewable energy resources.

4. Infrastructure and Export Opportunities

Gujarat's proximity to major ports like Kandla and Mundra provides significant advantages for export, reducing logistical costs and facilitating efficient distribution. While Maharashtra and Tamil Nadu also have access to major ports, Gujarat's existing industrial cluster further supports infrastructure needs. Rajasthan's lack of direct port access increases logistics complexity, and Karnataka's industrial base, though strong, is less developed in comparison.

5. Local Consumption of Green Hydrogen

Gujarat's established industrial base, particularly in petrochemicals, fertilizers, and heavy industries, ensures a high local demand for green hydrogen. Other states like Maharashtra and Tamil Nadu also have significant industrial demand but are either diversified across more sectors or slightly lower in specific high-consumption industries like petrochemicals and fertilizers.

6. Financial Model

Our financial model includes a detailed breakdown of capital expenditure (CAPEX) and operational expenditure (OPEX), with strategies to achieve an LCOH below \$2/kg:

1. Capital Expenditure (CAPEX)

- **Electrolyzers:** Investment in 160 MW of AEC electrolyzers, with modular configuration for scalability. - Renewable Energy Infrastructure: Costs associated with solar panels, wind turbines, hydropower integration, and BESS.
- **Storage Systems:** Compressed hydrogen storage systems compliant with ISO 19884:2020 standards. - Ancillary Equipment: Additional equipment and infrastructure to support the production and storage processes.

2. Operational Expenditure (OPEX)

- **Energy Costs:** Costs of renewable energy generation and storage.
- **Maintenance:** Regular maintenance of electrolyzers, renewable energy systems, and storage infrastructure. - Labor: Workforce costs for operating and maintaining the facility.

3. Cost Reduction Strategies

- **Economies of Scale:** Scaling up production to reduce per-unit costs through efficient utilization of resources and infrastructure.
- **Carbon Offset Trading:** Implementing a carbon offset trading system to generate additional revenue and enhance cost-effectiveness.
- **Byproduct Utilization:** Utilizing byproducts such as oxygen to generate additional income streams. Government Incentives: Leveraging available government incentives to offset initial costs and improve financial viability.

VII. STORAGE AND SAFETY

The proposed storage solution involves compressed hydrogen storage at 250 bar, compliant with ISO 19884:2020 standards, ensuring safety and reliability. The storage system is designed to handle the production capacity effectively, with provisions for future expansion as demand grows. Safety measures include regular inspections, adherence to international standards, and the implementation of advanced monitoring systems to prevent leaks and ensure operational integrity.

VIII. IMPACT AND BENEFITS

The project's impact extends beyond economic benefits to substantial environmental and social advantages:

1. Environmental Impact

- Carbon Offset: The facility is projected to offset 274,000 tonnes of carbon annually, significantly contributing to emission reduction targets.
- Industrial Decarbonization: The hydrogen produced will aid in reducing CO₂ emissions in sectors such as steel and fertilizers by approximately 50%.

2. Economic Impact

- Job Creation: The establishment of the plant will create 2,000-2,400 jobs, supporting local economies. - Foreign Exchange Savings: By reducing dependency on imported fuels, the project is expected to save around \$28 million in foreign exchange annually.

3. Energy Security

- Stable Supply: The facility enhances energy security by providing a stable and sustainable hydrogen supply.
- Renewable Integration: The integration of renewable energy sources ensures a reliable and eco-friendly energy supply for the plant.

IX. POLICY AND REGULATORY SUPPORT

To facilitate the project's success, we recommend the introduction of robust carbon offset programs and the establishment of carbon exchanges for trading offsets. Additionally, continued government support through favorable policies and incentives will be crucial in maintaining the financial and operational viability of the facility.

Policy and regulatory support are crucial for the successful implementation of green hydrogen projects. Favorable policies can significantly reduce the financial burden through incentives, subsidies, and tax exemptions, making green hydrogen production economically viable. Regulatory frameworks ensure that projects comply with safety, environmental, and operational standards, fostering

a conducive environment for investment and development.

National Level Policies

1. National Hydrogen Mission

- Objective: Launched by the Government of India, the mission aims to develop India as a global hub for green hydrogen production and export.
- Incentives: Provides financial support for research and development, pilot projects, and infrastructure development.
- Goals: Achieve 5 million tonnes of green hydrogen production annually by 2030, reduce carbon emissions, and enhance energy security.

2. Ministry of New and Renewable Energy (MNRE) Initiatives

- Subsidies: Offers capital subsidies for setting up renewable energy projects, which can be integrated with hydrogen production facilities.
- Grants: Provides grants for research, development, and demonstration projects in the field of hydrogen energy.
- Policies: Formulates policies to promote the use of renewable energy in hydrogen production, ensuring the sustainability of the process.

3. Carbon Trading and Credits

- Carbon Offset Programs: Encourages industries to adopt green hydrogen by offering carbon credits for reducing emissions.
- Carbon Trading Platforms: Establishment of carbon trading platforms to facilitate the buying and selling of carbon credits, enhancing the economic viability of green hydrogen projects.

State-Level Policies and Incentives

Different Indian states offer various incentives and support mechanisms to promote green hydrogen production. Here's a detailed comparison:

Gujarat

• Policy Support:

- Gujarat Green Hydrogen Policy: Offers comprehensive support including tax rebates, low-interest loans, and capital subsidies for green hydrogen projects.
- Renewable Energy Policy: Supports the development of solar, wind, and hydropower

projects, which can be integrated with hydrogen production.

- Ease of Doing Business: Simplified regulatory processes and approvals for setting up renewable energy and hydrogen plants.

• Incentives:

- SGST Reimbursement: Up to 80-100% reimbursement of State Goods and Services Tax (SGST) for renewable energy projects.
- Interest Subsidy: Low-interest loans for renewable energy and hydrogen projects. ○ EPF Reimbursement: 100% reimbursement of Employee Provident Fund (EPF) for employees in the renewable energy sector.

Comparative Analysis

Based on the policy and regulatory support, Gujarat stands out as the most favourable location for setting up a green hydrogen plant. Here's a detailed comparison and reasoning:

• Policy Support and Incentives

- Gujarat: Offers comprehensive support with the Gujarat Green Hydrogen Policy, substantial SGST reimbursements, low-interest loans, and EPF reimbursements. The state's proactive policies and simplified regulatory framework further enhance the attractiveness for investors.
- Rajasthan: Provides strong support through solar and wind energy policies but lacks specific green hydrogen policies. Incentives are competitive but not as extensive as Gujarat. ○ Maharashtra: Emerging support through draft green hydrogen policies and robust renewable energy policies. Offers good incentives but is still developing specific green hydrogen frameworks.
- Tamil Nadu: Attractive incentives for solar and wind projects, with proposed green hydrogen policies. The support is growing but currently not as comprehensive as Gujarat.
- Karnataka: Provides strong support for renewable energy with proposed green hydrogen policies. Incentives are competitive but not as extensive as Gujarat.

• Ease of Regulatory Approvals

- Gujarat: Known for its ease of doing business, with simplified regulatory processes and quick approvals for renewable energy and hydrogen projects.
- Rajasthan: Moderate ease of doing business with some regulatory hurdles.
- Maharashtra: Good ease of doing business with supportive policies, but regulatory processes can be complex.
- Tamil Nadu: Improving ease of doing business with supportive policies but still faces some regulatory challenges.
- Karnataka: Good ease of doing business with supportive policies, but regulatory processes can be complex.

• Infrastructure Development

- Gujarat: Well-established infrastructure with proximity to major ports and industrial clusters. Facilitates efficient hydrogen distribution and export.
- Rajasthan: Developing infrastructure with good support for renewable energy projects but lacks direct access to ports.
- Maharashtra: Strong infrastructure with access to major ports and industrial clusters. Supports efficient hydrogen distribution and export.
- Tamil Nadu: Good infrastructure with access to ports and growing industrial base. Supports efficient hydrogen distribution.
- Karnataka: Established infrastructure with access to Mangalore port. Supports efficient hydrogen distribution but less developed compared to Gujarat.

• Feedstock Availability

- Gujarat: Abundant renewable energy resources ensure consistent feedstock availability for hydrogen production.
- Rajasthan: High solar potential but limited other renewable resources.
- Maharashtra: Balanced renewable energy resources.
- Tamil Nadu: Abundant wind energy resources complemented by solar and hydropower. ○ Karnataka: Balanced renewable energy mix.

X. CONCLUSION

Gujarat emerges as the optimal location for our 50 TPD green hydrogen production facility, considering the comprehensive policy support, favourable regulatory framework, extensive incentives, and well-established infrastructure. The state's proactive approach in promoting renewable energy and hydrogen projects, combined with its ease of doing business and abundant renewable resources, makes it the most suitable and economically viable choice for our project.

REFERENCES

1. South Asian Report on Energy - <https://sarepenergy.net/wp-content/uploads/2023/02/Session-3-System-design-of-green-hydrogen-plant.pdf>
2. Gujarat Hydrogen Policy - https://geda.gujarat.gov.in/Gallery/Media_Gallery/GreenHydrogenPolicy.pdf
3. Visual Guide to Carbon Markets - <https://www.visualcapitalist.com/sp/visual-guide-to-carbon-markets/>
4. Ministry of New and Renewable Energy - <https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/10/202310131572744879.pdf>
5. CEEW Green Hydrogen Research - <https://www.ceew.in/sites/default/files/ceew-research-on-hydrogen-decarbonisation-and-energy-secure-green-hydrogen-economy.pdf>
6. SBH4 Consulting Electrolyzer Technology Comparison - <https://www.sbh4.de/assets/electrolyser-aec-aem-pem-soe.pdf>
7. NEL Hydrogen - High Purity Hydrogen - <https://nelhydrogen.com/wp-content/uploads/2020/03/Securing-High-Purity-Hydrogen.pdf> ICGH Report on Hydrogen - https://icgh.in/ppt/S.S.Thipse_3C.pdf
8. Gujarat RE CUF - <https://connect.torrentpower.com/tplcp/media/cms/solarpolicy/tariff-2015.pdf>
9. India's Wind Potential Atlas - https://niwe.res.in/assets/Docu/India's_Wind_Potential_Atlas_at_120m_agl.pdf
10. GERC Report - <https://www.gercin.org/wp-content/uploads/document/8d4272cd-621a-465d-94b9-7ed09f8a9c7c.pdf>
11. Linde - Hydrogen Technology - <https://www.linde.com/clean-energy/our-h2-technology/electrolysis-for-green-hydrogen-production>
12. PWC Report on Carbon Markets - https://www.pwc.in/assets/pdfs/news-alert/regulatory-insights/2023/pwc_regulatory_insights_6_july_2023_ministry_of_power_notifies_carbon_credit_trading_scheme_2023.pdf Key Pillars to Drive Gujarat's Green Hydrogen Economy Leadership - <https://events.development.asia/system/files/materials/2024/04/202404-ADB-Study-Green-Hydrogen-Economy-Launched-Vibrant-Gujarat-Global-Summit-2024.pdf>
13. NITI Aayog Harnessing Green Hydrogen 2022 - https://www.niti.gov.in/sites/default/files/2022-06/Harnessing_Green_Hydrogen_V21_DIGITAL_29062022.pdf
14. WEF Green Hydrogen Enabling Measures Roadmap for India - https://www3.weforum.org/docs/WEF_Green_Hydrogen_Enabling_Measures_Roadmap_for_Adoption_in_India_2024.pdf
15. Who Certifies Carbon Credits? - <https://carboncredits.com/who-certifies-carbon-credits/>
16. CAPEX OPEX Detailed Analysis - <https://docs.google.com/spreadsheets/d/e/2PACX-1vTgylg33JY2YPiaqfOrLAY1h9S3ePs-7JYvBUslvdvEnN-6UKTpalUpexOVeYiX8gfvjT3Th5xID7XN/pubhtml?gid=0&single=true>
17. Ministry of New and Renewable Energy - National Green Hydrogen Mission - <https://mnre.gov.in/national-green-hydrogen-mission/>
18. Bennett Jones & McKinsey: Hydrogen 101 Basics

20. <https://www.bennettjones.com/Blogs-Section/Hydrogen-101-Basics-of-Hydrogen-Supply-Chains>
21. Research Documentation on Green Hydrogen - https://docs.google.com/document/d/1HjCEiKXpipmS2INWe5ngOfUCXIIInuy1ob1fmy_TyAmw/pub
22. EU ETS - Emissions Trading System - https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en
Comparison of Carbon Standards - <https://ibbn.org.in/news-related-posts/comparing-gold-standard-and-verra-certification-for-biochar-carbon-credits/>