ABI RESEARCH COMPETITIVE RANKING

SOFTWARE FOR GREEN HYDROGEN PRODUCTION

SIEMENS

OVERALL: 86.2 | INNOVATION: 92.0 | IMPLEMENTATION: 80.0 | RANK: 1

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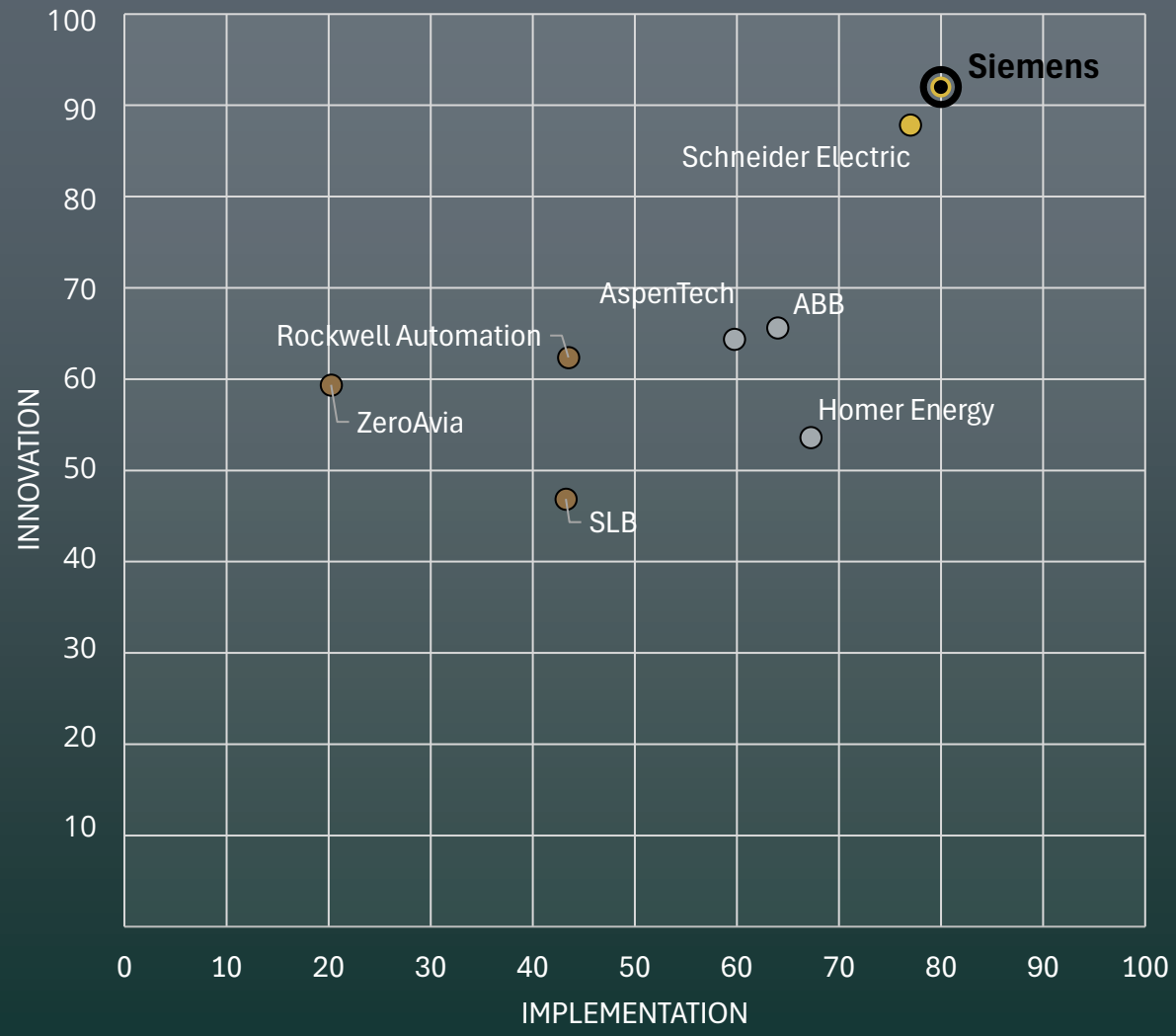
INNOVATION *VERSUS* IMPLEMENTATION MATRIX



INNOVATION

SIEMENS

INNOVATION SCORE: 92.0

Siemens AG's key offering for green H2 production is the Hydrogen Performance Suite, which is a process management and optimization solution powered by the Siemens Digital Hydrogen Plant software portfolio. The suite deploys a digital twin of the entire H2—or Power-to-X—project as an online simulation to support design, engineering, and real-time operations, enhance plant performance and output, and reduce operating costs. The digital plant aligns closely with the Siemens Programmable Logic Controller (PLC) and Distributed Control System (DCS) automation software systems for industry.

Within the Hydrogen Performance Suite, tools and workflows are included to cover the entire project lifecycle, from pre-planning and concept design to engineering, commissioning, operations, scaling, and replication. For process simulation, Siemens gPROMS provides full-system modeling of the H2 production process, with simulations used for feasibility studies, design optimization, and risk analysis. The COMOS system provides digital solutions for plant engineering, as well as extensive maintenance capabilities on both the site and fleet levels. Other tools, including Siemens SIMIT, help to commission assets and train operators efficiently. Each software applies to the development and scale-up of projects using Alkaline, PEM, or SOECs. Siemens also offers pre-configured templates for all components to both accelerate adoption and enable replication and scale-up. As the project progresses, these tools are used to construct and improve the Integrated Digital Twin, which is deployed post-commissioning as a core element of the Hydrogen Performance Suite.

Siemens AG ranked first for innovation with a score of 92. Overall, the Hydrogen Performance Suite offers a highly competitive reduction in plant CAPEX—reducing initial planning, design, and construction costs—and OPEX. This is achieved with algorithm-based, automated monitoring and optimization technology that improves energy usage and enables off-taker demands to be met as efficiently as possible. A core strength of the suite is the synergy of its constituent software. By incorporating data from across the plant lifecycle, Siemens' solution allows for easier diagnosis of problems, more accurate simulation of future scenarios, improved decision-making support, and clear indications of where to scale production to maximize green H2 output. The Digital Hydrogen Plant integrates well with other Siemens' digitalization and automation solutions to further enhance these capabilities. Importantly, users' ability to manage fleets of electrolyzer facilities using the suite makes Siemens' H2 software very valuable to large (<100 MW) and very large (<1 Gigawatt (GW)) green H2 producers—especially those with projects across several regions.

IMPLEMENTATION

SIEMENS

IMPLEMENTATION SCORE: 80.0

Siemens AG is headquartered in Germany. The Hydrogen Performance Suite is being adopted worldwide, including in key green H2 production regions: China, India, South America, Europe, and North Africa. The product is well-suited to all scales of plant, but is especially relevant for larger projects that require more extensive engineering, monitoring, scaling, and eventually replication. The suite can also be integrated with other products for monitoring and managing renewable electricity generation, as well as with other elements of the green H2 supply chain.

Siemens AG ranked first for implementation with a score of 80. Multi-regional partnerships with large producers are a strong differentiating factor in a market that will see significant scaling over the next 5 years, positioning Siemens as a go-to software provider for the industry. Furthermore, Siemens has displayed partnerships with lower-capacity producers in the majority of regions. The complete suite has also been adopted by smaller, enterprise-level green H2 producers, but the modularity of Siemens' offering also allows for rapid integration with third-party technologies and customization for niche project needs.

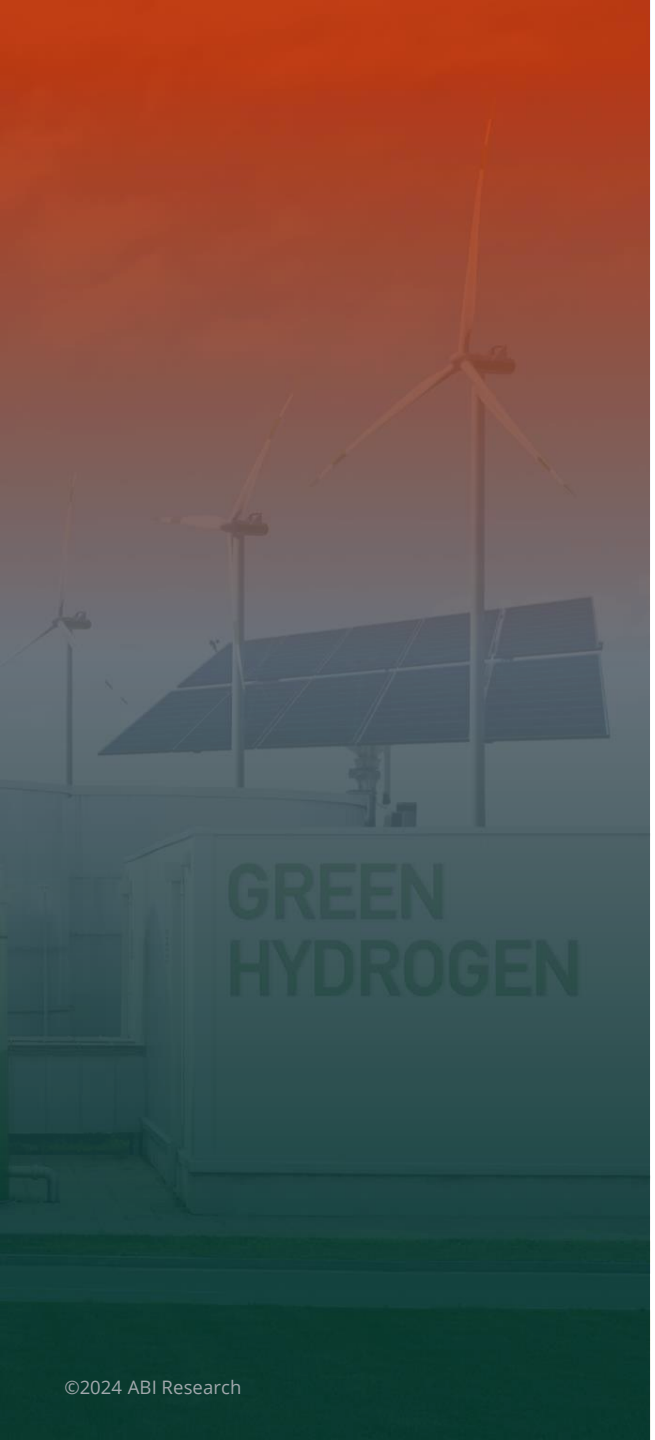
CONCLUDING REMARKS

SIEMENS

Siemens AG received an overall score of 86.2, positioning it first in the market for green H2 production software. This score was driven by both an exceptional, market-leading product offering and robust cross-regional implementation. Key to this ranking was the Siemens Hydrogen Performance Suite's suitability for the emerging green H2 market, in which large producers will play an essential role in reducing production costs for green H2 to a point at which the commodity will become economically viable, relative to alternative types. By offering modular, but interconnected, solutions across the plant lifecycle, alongside fleet-level monitoring and management tools and dedicated digital twins, Siemens AG is ideally positioned to support these changes.

Siemens' implementations via its partnerships with green H2 producers also reflect that these market trends are guiding the vendor's H2 strategy. The firm has solidly positioned itself in key regions for green H2 production and has already established partnerships with large electrolysis plants. As the industry matures, Siemens must ensure the core requirements for major clients—scaling, monitoring, and replication—are being addressed to maintain its position as the market leader.

CRITERIA AND METHODOLOGY



VENDOR MATRIX

Methodology: After individual scores are established for innovation and implementation, an overall company score is established using the Root Mean Square (RMS) method:

$$Score = \sqrt{\frac{innovation^2 + implementation^2}{2}}$$

The resulting overall scores are then ranked and used for percentile comparisons.

The RMS method, in comparison with a straight summation or average of individual innovation and implementation values, rewards companies for standout performances.

For example, using this method, a company with an innovation score of nine and an implementation score of one would score considerably higher than a company with a score of five in both areas, despite the mean score being the same. ABI Research believes that this is appropriate as the goal of these matrices is to highlight those companies that stand out from the others.

RANKING CRITERIA

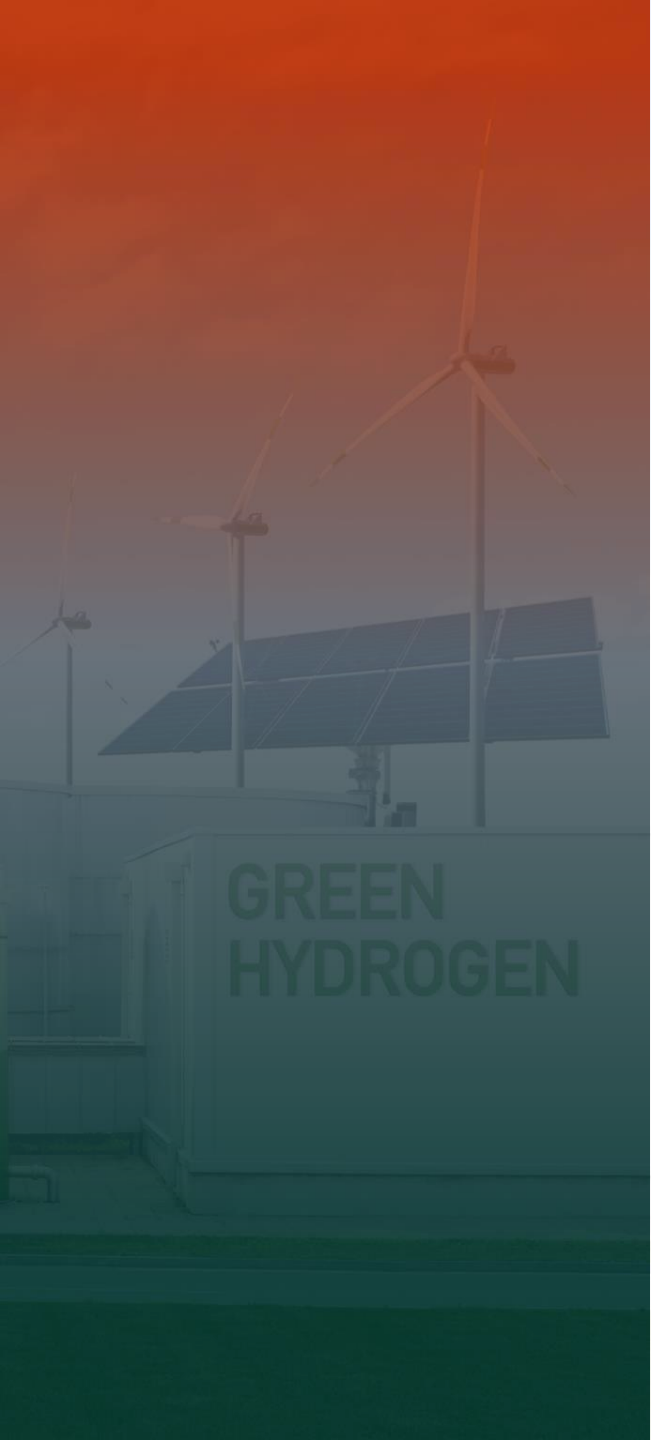
Leader: A company that receives a score of **75 or above** for its overall ranking

Mainstream: A company that receives scores **between 60 and 75** for its overall ranking

Follower: A company that receives a score of **60 or below** for its overall ranking

Innovation Leader: A company that receives a score of **75 or above** for its innovation ranking.

Implementation Leader: A company that receives a score of **75 or above** for its implementation ranking.



LEADERS, MAINSTREAM, AND FOLLOWERS

Leaders: Siemens, Schneider Electric

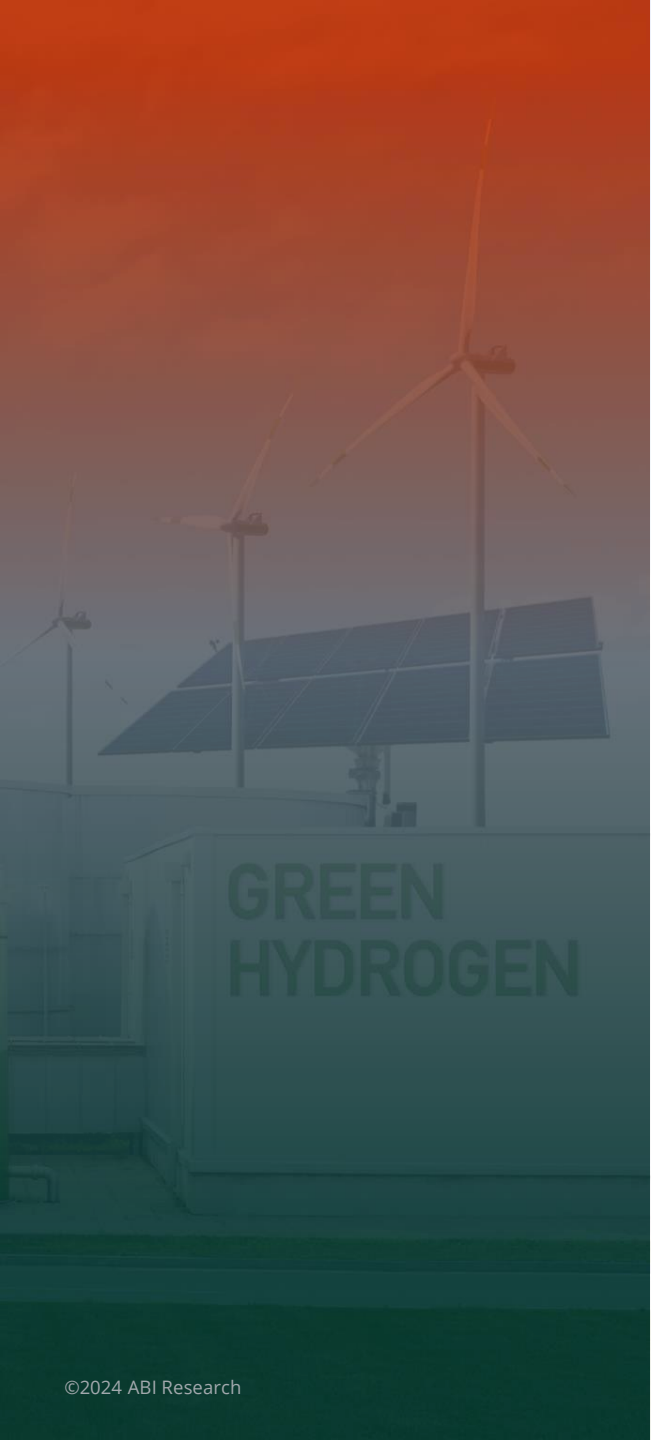
The leaders group consists of companies that deliver highly innovative, comprehensive green Hydrogen (H2) production software offerings, while demonstrating high levels of integration with large and enterprise-level partners across multiple regions.

Mainstream: ABB, AspenTech, HOMER Energy

The mainstream group consists of vendors that align with one of two categories. First, they may have reasonably innovative software suites and a number of high-profile and smaller partnerships, but do not boast the same degree of specialized, E2E products or the same degree of regional coverage as the leaders, as in the cases of ABB and AspenTech. Alternatively, they may implement extremely well, and offer enterprise clients a valuable, low-cost offering, but only address one specific element of the plant lifecycle, limiting their applicability to larger production facilities. This is the case for HOMER Energy.

Followers: Rockwell Automation, SLB, ZeroAvia

The followers group is composed of companies that do not significantly excel in either innovation or implementation criteria, or that have a unique and potentially innovative solution, but with very limited market presence.



INNOVATION CRITERIA

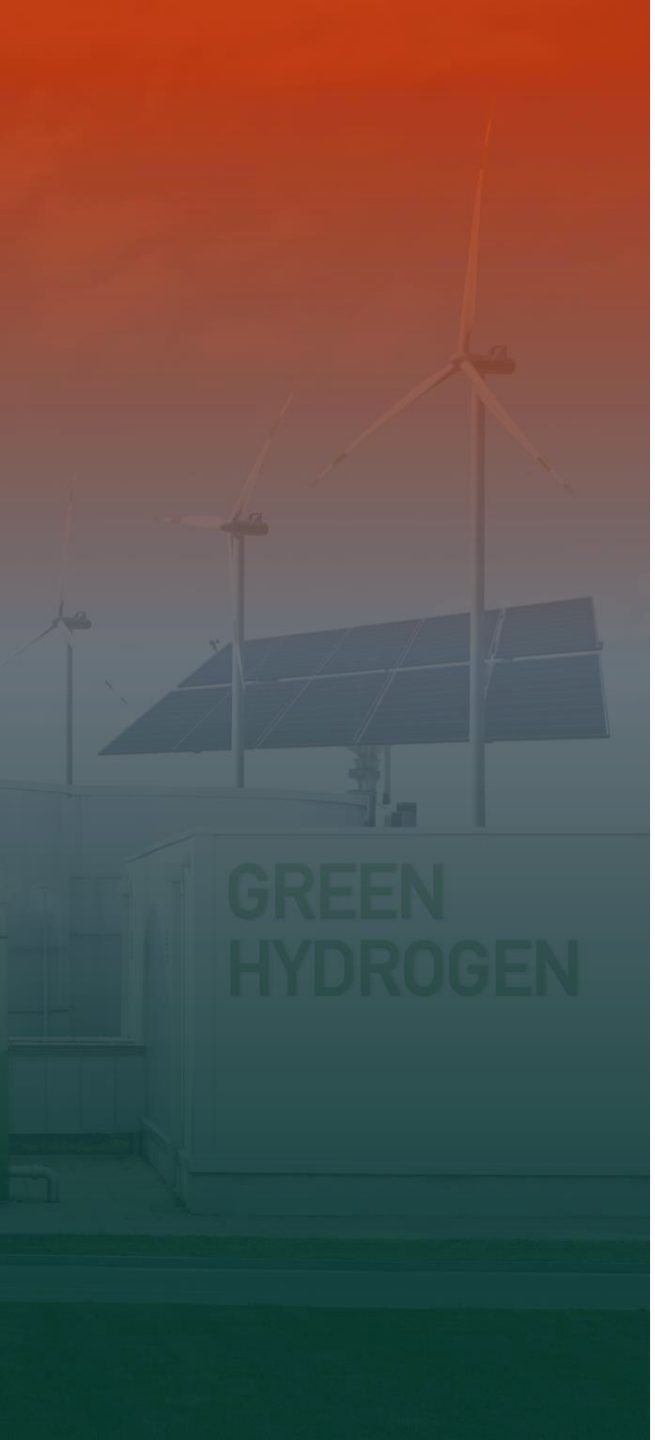
Depth and Breadth of Solution Suite: Does the software offer template technology for plant planning and construction? Can it be used to monitor and optimize an operational plant? Can it facilitate the maintenance, replacement, and updating of plant equipment? Does it offer management tools for facilitating the sale and purchase of energy to/from local grids? Does it include the capacity for "fleet" management and monitoring across multiple production facilities? Are predictive algorithms or AI integrated to achieve reductions in OPEX costs? Are digital twins integrated to reduce both CAPEX and OPEX? Can the software be used to replicate existing plant layouts to new projects, given new requirements and parameters?

CAPEX Impact: What is the potential impact of the software suite on reducing overall plant CAPEX, across the lifecycle of the plant? Are these concentrated in the initial concept, design, and engineering phases? Does the technology also offer CAPEX reductions in the scaling and replication stages of the facility's lifecycle? If digital twins are integrated into the solution, can they be used to replicate and scale the plant?

OPEX Impact: What is the potential impact of the software suite on reducing overall plant OPEX, across the lifecycle of the plant? Are these benefits limited to one plant, or can monitoring, management, and optimization also be undertaken across a fleet of plants? If predictive algorithms and/or AI-enablement is integrated into the solution, how is this used to reduce OPEX and maximize efficiency? If digital twins are integrated into the suite, can they be used to monitor and collect data from the plant, while providing maintenance support during the operational phase?

Lifecycle Support: Which stages of the green H2 plant's life does the software support? During pre-planning, can it be used to establish the scope of a project, and determine its requirements and potential outputs? During design stages, can it be used to precisely plan the layout of the plant, minimizing time spent and ensuring accuracy without physical modeling? During engineering and construction, can the suite support unexpected changes in requirements, timelines, and other technical challenges? During operation, can the software be used to monitor, maintain, optimize, and collect data for analytics? Can the software be used to expand an existing plant? Once a plant is operational, can users use the software to replicate planning for plants elsewhere?

Accommodation of Alternative Electrolysis Types: Does the software account for the technology-specific requirements of H2 production via alkaline electrolysis? Does the software account for the technology-specific requirements of H2 production via PEM electrolysis? Does the software account for the technology-specific requirements of H2 production via SOEC or Solid Oxide (SO) electrolysis?



IMPLEMENTATION CRITERIA

Regional Coverage: In which regions and countries is the vendor partnered with green H2 facilities, including pilot plants and facilities that have passed Final Investment Decision (FID)? Presence in key countries and regions (China, India, South America, North Africa, Europe) for green H2 production is essential for the ranked candidates. Additionally, companies with a global presence can better understand regional-specific requirements and sustain straightforward communication and transportation paths with customers in different locations.

Market Share: What is the vendor's share of the "software for green H2 production" market?

Partnerships with Large Producers: How many partnerships does the vendor have with plants (including pilot, demonstration, and prospective plants that have passed FID) with electrolysis capacity between 10 MW and 24 MW? How many partnerships with facilities with capacity between 25 MW to 29 MW? How many partnerships with plants with capacity between 50 MW and 100 MW? How many partnerships does the vendor have with plants with capacities greater than 100 MW? Scale will be a major factor in establishing leaders in the mass market for green H2.

Partnerships with Enterprise-Level Producers: How many partnerships does the vendor have with plants (including pilot, demonstration, and prospective plants that have passed FID) with electrolysis capacity below 10 MW? Adoption by enterprise-level facilities is an important indicator of the suitability of a vendor's solution for on-site, small-scale generation.

Integration with Complementary and Third-Party Software: How well does the product complement and/or integrate with existing software responsible for other elements of the green H2 supply chain? Does the vendor also offer software for establishing and monitoring renewable energy generation? Does the vendor also offer software for the safe transportation and/or storage of H2? Can the green H2 production software be easily integrated and used alongside these other modules? Can the software be integrated with or used in conjunction with third-party software for managing other elements of the green H2 supply chain?

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