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RE: Bloom Energy submission to CSIRO-AEMO GenCost 2024-25 Draft Consultation

Bloom Energy appreciates the opportunity to provide this submission to the CSIRO-AEMO GenCost 2024-25 Draft.

Bloom Energy introduction

Established as Ion America in 2001, headquartered in San Jose, California with more 2000 staff, more than 2000 megawatts of electrolyser-equivalent installed solid oxide capacity and more than 100 customers in the United States and globally, Bloom Energy is actively working with potential customers and partners, as well as regulators in Australia.

Bloom Energy's technology offerings for distributed generation and hydrogen production are based on its solid oxide platform that is used two operating modes: (1) electrolyzers (SOEC) that produce hydrogen from electricity and water and (2) fuel cells (SOFC or "fuel cells") that use a fuel (which could include natural gas, renewable gases, hydrogen, etc) to produce electricity.

Bloom Energy's solid oxide electrolyzer platform intentionally operates at high temperatures to maximise efficiency, requiring less energy to break up water molecules to produce hydrogen, drastically reducing the cost of electrolytic hydrogen production. It is currently the most efficient commercially available electrolyzer of any electrolysis technology, offering the lowest cost production of electrolytic hydrogen.

Bloom Energy owns and operates the world's largest SOEC, in California, US, and has the world's largest electrolyzer manufacturing facility of any electrolysis technology (upwards of 3 gigawatts of annual electrolysis production capacity), also located in California.

Bloom Energy has financed more than US$5 billion in solid oxide projects globally, more than PEM and alkaline electrolyzers combined. The modular design and built-in redundancy offers a high reliability supply of hydrogen to customers. Bloom's electric generating fuel cells are designed in a modular, fault-tolerant format that is fuel agnostic and provides mission critical reliability with no downtime for maintenance. In 2023, the average availability of Bloom Energy's fleet was 99.995%. The company has installed over 1,000 of its solid oxide fuel cell systems for customers in 13 U.S. states as well as in Japan, South Korea, India, Italy, and Taiwan.

Electrolyzer analysis in CSIRO-AEMO GenCost 2024-25 Draft

Bloom Energy notes the GenCost draft refers to only proton-exchange membrane (PEM) and alkaline hydrogen electrolysers.

The GenCost Draft states: *"As the costs of both technologies fall, capital costs become less significant in total costs of hydrogen production. This development could make it attractive to sacrifice some electrolyser capacity utilisation for lower energy costs (by reducing the need to deploy storage in order to keep up a minimum supply of generation)…. Electrolyser deployment is being supported by a substantial number of hydrogen supply and end use subsidised deployments globally and in Australia. Experience with other emerging technologies indicates that this type of globally coincident technology deployment activity can lead to a scale-up in manufacturing which supports cost reductions through economies of scale."*

Background on Solid Oxide Electrolysis

Solid oxide electrolysers represent a proven approach to hydrogen production by leveraging high-temperature electrolysis, and offers significant advantages over traditional alkaline and PEM electrolysers, both in terms of efficiency and cost-effectiveness:

- Higher Electrical Efficiency: SOECs operate at elevated temperatures (typically 700-850°C), which reduces the electrical energy required for water splitting. The thermal energy required can often be sourced from waste heat, further improving system efficiency – especially for hard to decarbonize applications with excess heat like fertilizer, steel, fuel, and cement manufacturing. This contrasts with alkaline and PEM electrolysers, which rely solely on electrical energy at lower temperatures, resulting in higher energy consumption per kilogram of hydrogen produced.
- Enhanced System Integration: SOECs have proven to operate in a flexible manner accommodating ramping characteristics of renewable energy sources and steady-state constant operational conditions from industrial processes.
- Reduced Operating Costs: By consuming less electricity—often the most significant contributor to LCOH— and less water, SOECs can deliver hydrogen at a lower cost. This is particularly critical in scenarios where renewable electricity costs remain a limiting factor for competitive green hydrogen production.
- Scalability and Flexibility: SOEC systems are modular and can scale to meet varying production demands, making them suitable for both centralized and decentralized hydrogen generation.
- Regarding balance of plant (BOP) equipment for the low carbon hydrogen plant, SOEC does not require cooling water to each electrolyzer, a building, or downstream hydrogen produce deoxygenation units as PEM and Alkaline, reducing total installed capital (TIC) costs.
- SOEC has a high availability of materials and a well-established supply chain, so does not have the availability and cost risk that PEM does with rare earth metals like iridium and platinum.
- Ease of installation: SOEC systems are designed for outdoor usage, significantly reducing installation and site complexity. Furthermore, as they are air cooled, they consume less water than PEM and Alkaline alternatives which need considerable amounts of cooling water.

- Proven technology: Solid Oxide electrolysis is the reverse of the fuel cell which is a widely deployed and proven technology for Bloom Energy with over a 1.3 GW installed and operational across the globe.

Bloom Energy projects that current electrolyser costs range from USD$700/kW to USD$1400/kW for PEM, USD$500/kW to USD$1000/kW for alkaline and USD$1300/kW to USD$1600/kW for SOEC. Based on an AUD-USD exchange rate of USD$0.63, PEM electrolyser costs would range from AUD$1060/kW to AUD$2444/kW, alkaline electrolysers from AUD$793/kW to AUD$1587 and SOEC from AUD$2064 to AUD$2540.

The GenCost Draft projects the 2024-25 PEM and alkaline electrolyser costs projected in the GenCost Draft were more than AUD$2500/kW.

In terms of systems efficiency of kWh per kilogram, Bloom Energy projects alkaline electrolysis at 56kWh/kg and 52kWh/kg for PEM electrolysis compared to 37.5kWh/kg for SOEC.

For levelised cost of hydrogen (LCOH) comparisons assuming 30bar product hydrogen and a power cost of $0.05/kwh USD across all technologies, Bloom Energy projects USD$6 per kilogram for alkaline electrolysis and USD$5.7kg for PEM electrolysis compared to USD$4.8/kg for SOEC.

Similar to alkaline and PEM electrolysis, Bloom Energy regards SOEC supply readiness to be commercially mature

Bloom Energy notes from its own engagement with CSIRO and CSIRO's own publications that it has been engaged in the development of tubular SOE and the formation of Hadean Energy.

In its media statement announcing this work on 25 August 2023 "New CSIRO company pursues hydrogen game changer for heavy industry", Dr Sarb Giddey, lead scientist on hydrogen research at CSIRO is quoted to say:

"CSIRO's SOE technology has the potential to produce hydrogen at a higher efficiency and lower cost for integration with industrial processes…. It allows industrial waste heat to be integrated back into the industrial processes, which decreases the electrical energy required to produce hydrogen or syn-gas by up to 30 per cent. It's great news for industry, because integrating the hydrogen product back into industrial processes onsite also eliminates storage and transport costs while drastically reducing the use of fossil fuels in the industrial process"

Recommendation

Bloom Energy believes that solid oxide electrolysis offers a transformative and commercially-ready pathway to cost-competitive green hydrogen production at scale. Its superior efficiency, ability to leverage waste heat, and alignment with industrial decarbonization efforts position it as a critical technology for Australia's clean energy transition.

Bloom Energy recommends SOEC be included in the GenCost framework to provide a holistic and forward-looking analysis of hydrogen production technologies, and ensure an accurate representation of hydrogen production costs in the GenCost analysis.

The GenCost Draft should acknowledge SOEC's system efficiency drives lower kW/kilogram costs and lower LCOH compared to PEM and alkaline.

Bloom Energy would welcome the opportunity to share its analysis as part of the GenCost review.

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