



The transition will not be televised

Part 2 – Opportunities in storing and transforming clean electricity

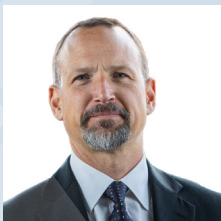
Compelling economics are driving sustained growth in new renewable power generation, in the US and globally. But renewables need to be paired with complementary technologies to overcome two key challenges in building a cheaper, cleaner, and safer energy system.

1. Renewable power generation is reliable but intermittent.

Even with more intelligent grids and demand side management, electricity storage is needed to match cheap renewable power supply with real-time patterns of energy consumption.

2. Not all industrial processes can be electrified, so other opportunities need to be pursued to decarbonize some of the biggest emitters.

Transforming surplus renewable power into hydrogen opens pathways for lowering the carbon intensity in industries like steelmaking and cement manufacturing.



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We see three fundamental drivers accelerating the energy transition

- **Decarbonization targets** – Clean electrification offers some of the lowest-hanging fruit for reducing greenhouse gas (GHG) emissions. States and municipalities are turning to clean electricity to meet their own net-zero commitments and compete for new jobs and inward investments being stimulated by the US Inflation Reduction Act (IRA).
- **Energy security and price stability** – Russia’s invasion of Ukraine in 2022 exposed the economic vulnerabilities of fossil fuel dependence. Major economies – including the US – are increasing their commitment to domestic clean power as a tool for meeting energy security objectives and improving price stability.
- **Falling technology costs** – Most electricity storage and transformation technologies are not new. Proven technologies are making a constant march towards lower costs. The costs of electricity storage technologies have fallen rapidly as installed capacity has multiplied, replicating the cost gains seen in solar and wind.

Electricity ‘midstream’ technologies are positioning for take-off

Energy storage

With the right market structures, energy storage could grow 20-fold over the course of this decade, reaching as much as 10% of total US electricity generation by 2030.

- **Short duration** – Lithium-ion batteries are the dominant technology for shifting power within a single day. Battery packs now trade for about one-tenth of prices just 15 years ago.¹
- **Long duration** – The need for electricity storage at larger scale and longer duration is bringing forward a range of electrochemical (e.g., redox flow batteries), mechanical (e.g., pumped hydroelectricity and compressed air) and thermal (e.g., using molten metals) storage technologies.

Transformation: Power-to-X

Transformation technologies – where clean electricity is transformed into green hydrogen – could reduce global GHG emissions by more than 20%. Green hydrogen (produced via electrolysis from renewable power) is an important solution for addressing the challenges of ‘hard-to-abate’ industries (including steelmaking, cement and shipping).

- **Power-to-chemicals** – The US already uses more than 10 million tonnes of hydrogen every year, nearly all of it derived from fossil fuels.² Switching to green hydrogen is an immediate opportunity to make fertilizer manufacturing and fuel refineries cleaner.
- **Power-to-gas** – Green hydrogen can be blended with other gases (like methane), combusted in advanced engines and boilers, or stored and converted back into electricity when it’s needed most. Technical studies are pointing towards a need for dedicated pipes for hydrogen blending above 20%.³

Summary

Clean power will be the backbone of a better energy system. And while the need for complementary storage and transformation technologies is clear, not every type of battery will work, nor will every potential application of hydrogen prove profitable. Which technologies end up playing leading roles in the fast-growing midstream segment of the clean energy sector is a trillion-dollar question facing investors today.

1 Office of Energy Efficiency and Renewable Energy, 4 October 2021: DOE Estimates That Electric Vehicle Battery Pack Costs in 2021 are 87% Lower than in 2008.

2 National Renewable Energy Laboratory, 2020: Study Shows Abundant Opportunities for Hydrogen in a Future Integrated Energy System

3 Rosenow, J., 27 September 2022: Is heating homes with hydrogen all but a pipe dream? An evidence review. *Joule*



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