Water Research and Economic Development Using Green Hydrogen

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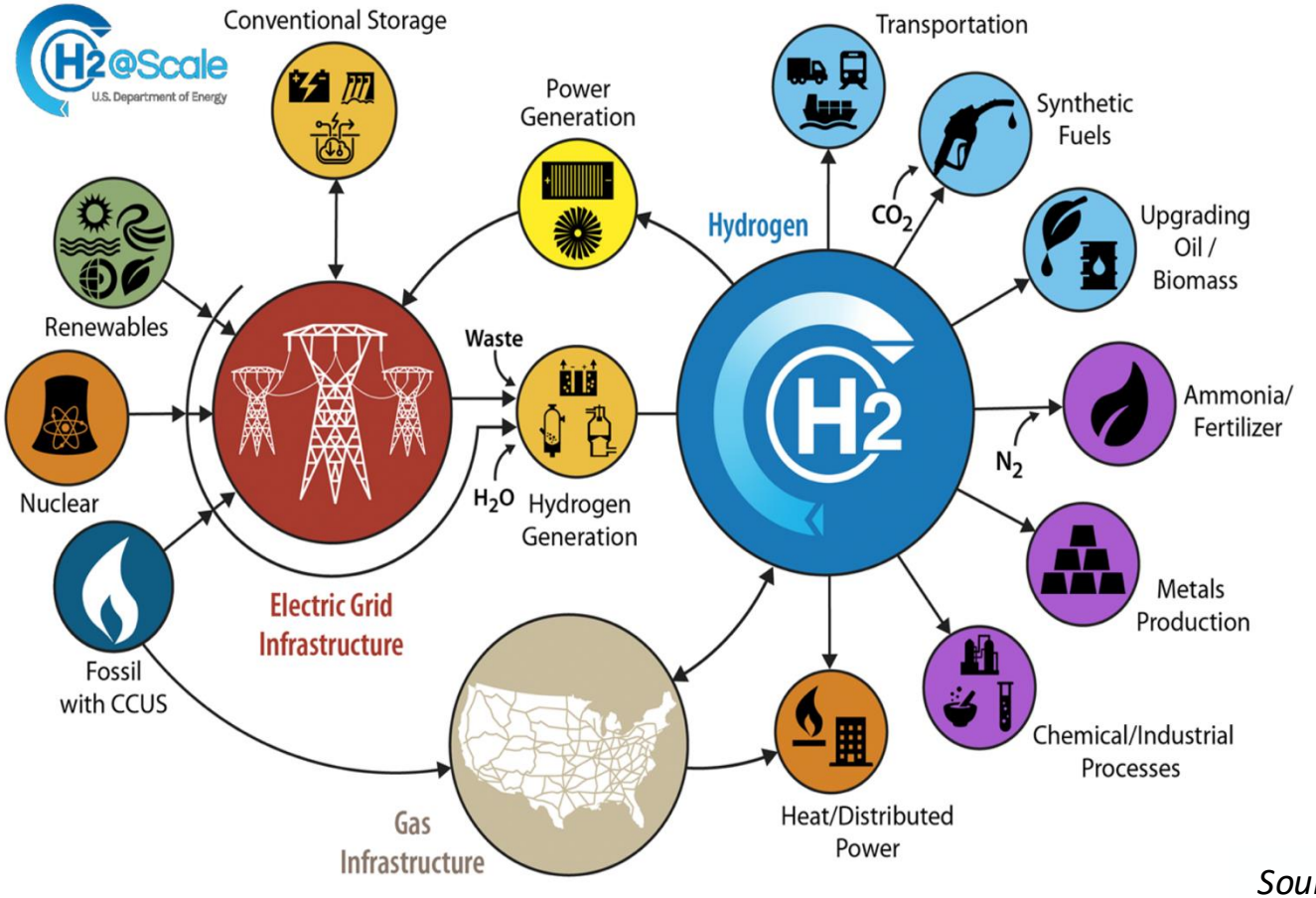
H_2 as a Clean Energy Source to Promote Economic Growth

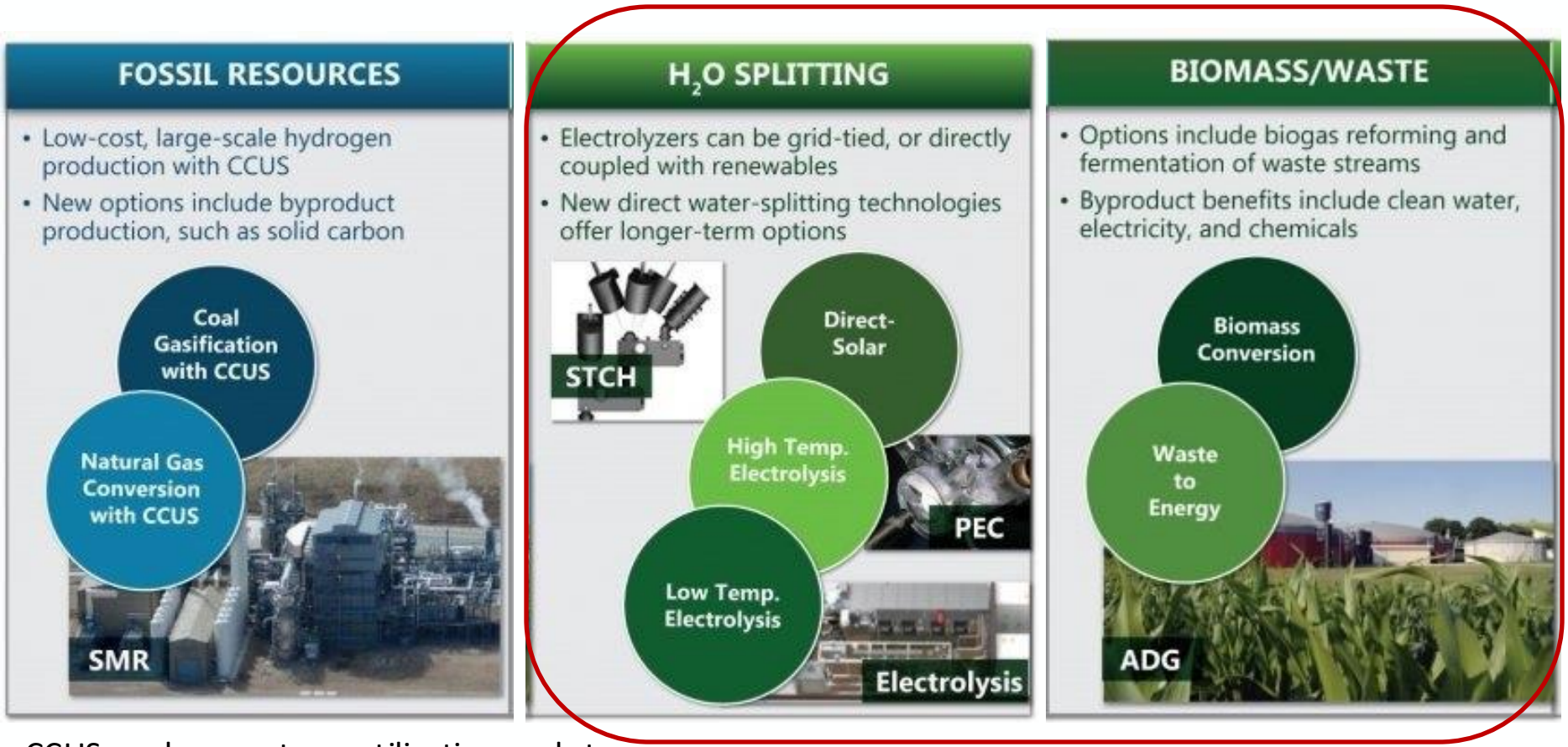


Potential

- 10 MMT of H_2/yr produced today with scenarios for ~5X growth
- 10 MMT H_2 would ~ double today's solar or wind deployment
- Industry study shows potential for $140B in revenue, 700K jobs, 16% GHG reduction. Analysis underway, including on export potential.

Source: U.S. Department of Energy

H_2 Production Technologies



CCUS: carbon capture, utilization and storage
STCH: Solar thermochemical hydrogen

Source: U.S. Department of Energy

Challenges and Opportunities for Green H_2 Production

Challenge - Water Requirements for Electrolysis

- ~ 10 – 15 liters of water per kilogram of H_2 produced, including:
  - 9 liters of ultra-pure water for the electrolysis
  - Additional water for cooling, purification, and system losses, depending on the process.
- To support a 1 MW water electrolysis plant, water demand is estimated at 1900 – 2800 gallons per day

Opportunities – Alternative Water

- Municipal wastewater, brackish water, and industrial wastewater

Challenges and Opportunities for Green H_2 Production

Challenge – Power Requirements for Electrolysis

- A 1 MW electrolyzer plant for H_2 production requires approximately 50-55 kWh of electricity to produce 1 kg of H_2, with a typical system efficiency around 70-80%.

Opportunities – Renewable Energy

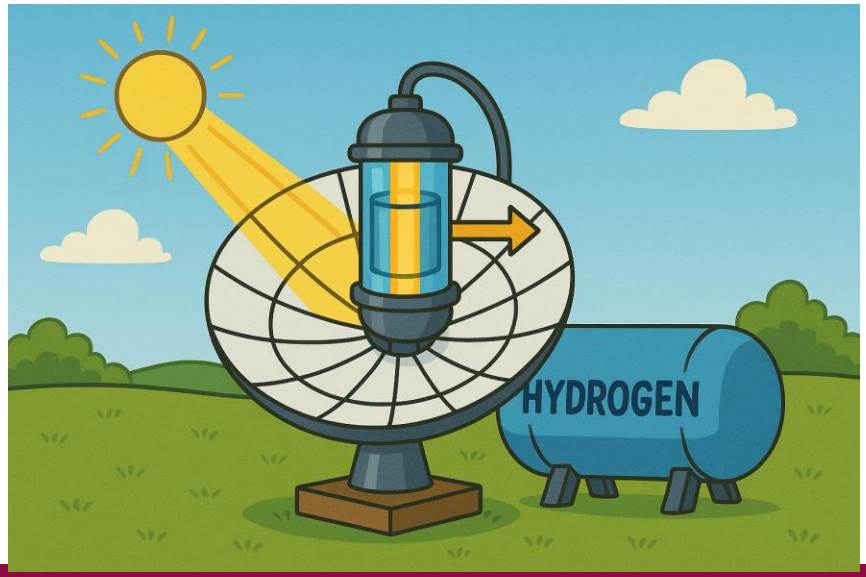
- Solar
- Wind
- Hydro
- Hybrid (PV+wind+hydro for stable operation)

R&D at NMSU for Green H_2 Production

- Collaboration with Kit Carson to identify potential water supplies and treatment processes
- Collaborate with Plug Power on evaluating and testing alternative waters for green H_2 production

R&D at NMSU for Green H_2 Production

- Funded by the New Mexico Economic Development Department, NMSU collaborates with Global Impact Ventures (GIVE) and NM local companies to pilot and demonstrate a photocatalytic water splitting technology for H_2 production using solar energy and alternative water.
- Simultaneous H_2 production and water treatment and recovery

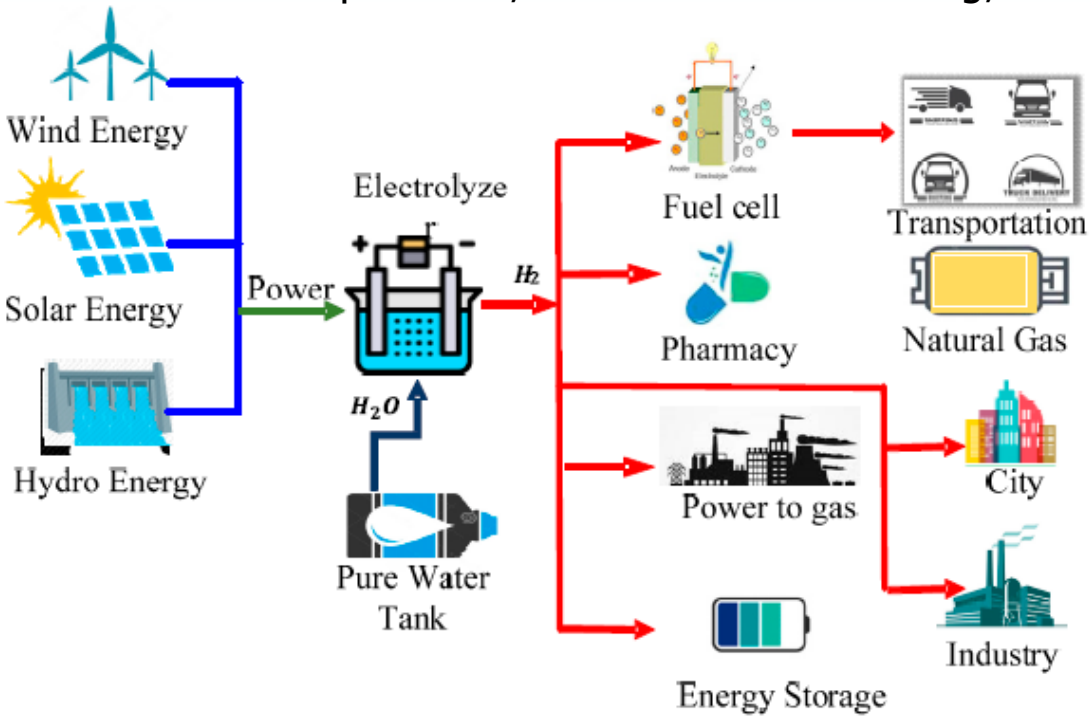


R&D at NMSU for Green H_2 Production

- Patented Green H_2 production technologies developed at NMSU
- Photocatalytic water splitting for H_2 production using wastewater, brackish water, seawater, and produced water
- Photoreforming plastic waste for H_2 production
- Cost ~$1.1-1.5/kg H_2, meeting DOE target cost of $2/kg H_2 in 2025, and working towards $1/kg H_2 in 2030

R&D at NMSU: Green H_2- based Microgrid

- **Renewable Power Input:** Wind, solar, and hydro generate clean electricity.
- **Green H_2 Production:** electrolyzer, photo-water splitting, plastic photoreforming
- **H_2 Utilization:**
  - **Store** for energy buffering.
  - **Convert to electricity** via a **fuel cell** for further use.
  - **Direct use** for transportation, chemical manufacturing, and industrial processes



Source: Alzahrani, Ahmad, et al. "A review on hydrogen-based hybrid microgrid system: Topologies for hydrogen energy storage, integration, and energy management with solar and wind energy." *Energies* 15.21 (2022): 7979.

Summary

- Developing green H_2 in New Mexico offers several strategic, environmental, and economic benefits:
  - Abundant renewable resources
  - Economic development & jobs
  - Long-duration storage: stores excess renewable energy for extended periods.
  - Zero emissions: clean power generation with no GHGs or pollutants.
  - Versatile energy: provides electricity, heat, and fuel for transport/industry.
  - Reduces reliance on fossil fuels and centralized grid.
- The cutting-edge R&D at NMSU supports green H_2 development:
  - Using alternative water supplies and waste streams (e.g., plastics) for H_2 production
  - Improving efficiency and reducing costs
  - Addressing infrastructure gaps and safety concerns: H_2 production, storage, and distribution networks.
  - Informing regulatory & policy: evolving frameworks for H_2 production, integration and microgrid operation.

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