



**Western States Tripartite Conference
2023**



WESTERN STATES TRIPARTITE
OWNERS + CONTRACTORS + BOILERMAKERS
SEEKING SOLUTIONS FOR A STRONGER INDUSTRY

Unlocking Renewable Hydrogen From Waste Organic Materials



Addressing the Waste Challenge

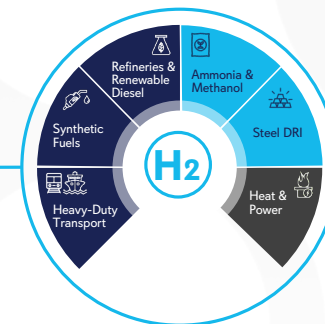
- Waste disposal currently accounts for ~3% of global greenhouse gas (“GHG”) emissions⁽¹⁾ primarily from uncaptured methane release from waste organics degradation.
- Recycling and composting need a complimentary solution to deal with contaminated organics.
- Sector is undergoing a major disruption brought on by recognition of methane leaks, PFAS⁽²⁾ contamination and China’s National Sword Policy.



H Cycle is a developer, owner and operator of organic waste-to-hydrogen facilities.

H Cycle has secured exclusive rights to deploy a proven, world-class thermal conversion technology in premier markets (Western US, Japan and South Korea).

H Cycle is creating a market leader in the conversion of the organic fraction of municipal solid waste (“MSW”) into low-cost renewable hydrogen.



Enabling the Hydrogen Economy

- The existing global hydrogen market is valued at US\$130B and is expected to grow 7%+ per year ⁽³⁾.
- Today’s production methods account for ~2% of GHG emissions⁽⁴⁾.
- Hydrogen is expected to become an important resource in the energy transition, particularly for difficult-to-decarbonize sectors.
- The ability for hydrogen to achieve this is contingent on reducing cost and CO₂ intensity of production.



1) Earth Engineering Center, Columbia University, 2019.

2) Per- and Polyfluoroalkyl Substances; widely used, long lasting chemicals, components of which break down very slowly over time. They are found in food, soil, water, and blood (EPA 2022).

3) IEA (2021), MarketsandMarkets (2021).

4) BP Statistical Review of World Energy.

The H Cycle Process: An Innovative Use of Proven Technologies



Waste Preparation Unit

Waste is minimally prepared⁽¹⁾. Such a process is routinely used in the waste sector, with hundreds of such units in operation supplying waste-to-energy facilities.



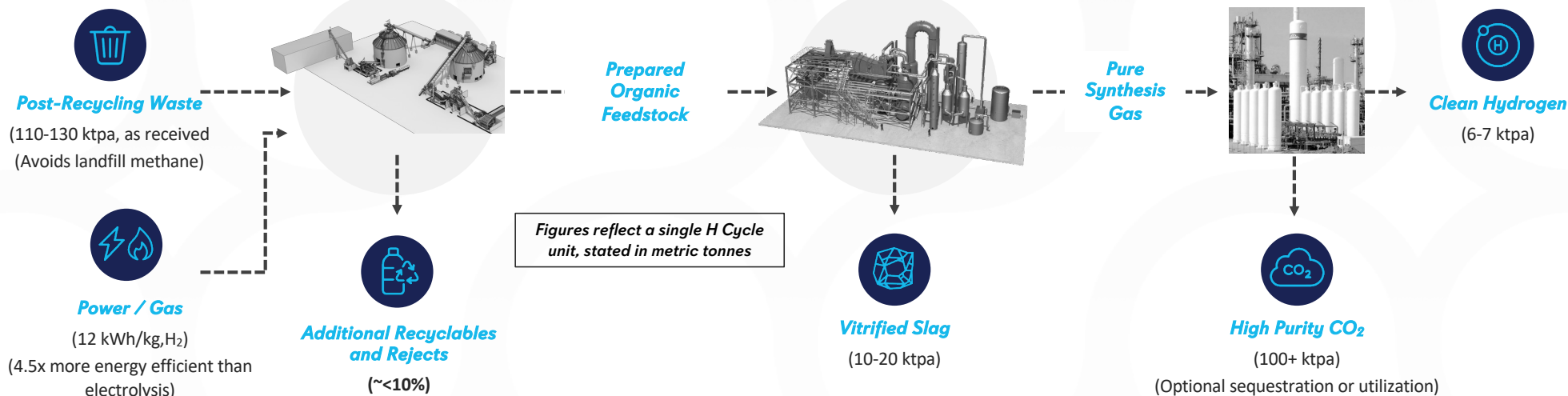
Waste Conversion Unit

Thermal conversion of feedstock to syngas utilizing Omni's process, followed by a series of cleaning steps to prepare the syngas for catalytic reaction. Over 50 of such plants in operation.^(2,3)



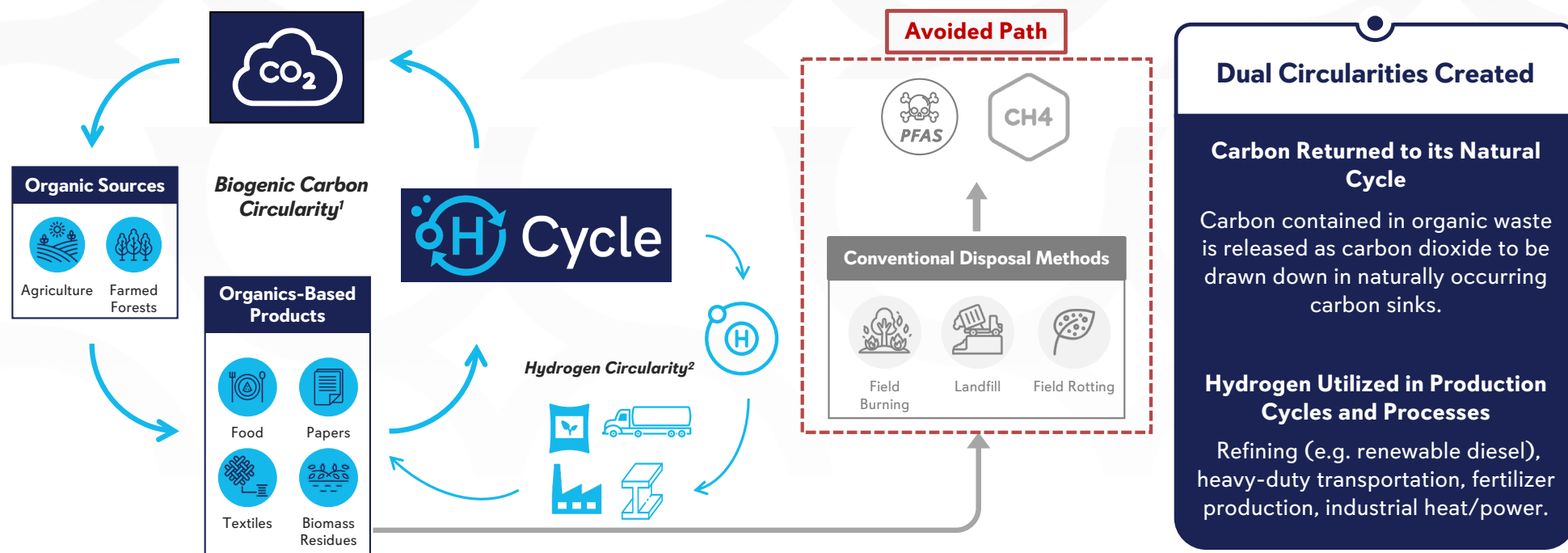
Hydrogen Production Unit

Increases the H₂ content in the syngas, following which H₂ is purified to 99.97%.⁽⁴⁾ Such hydrogen plants are commonly utilized in refineries and ammonia plants.⁽⁵⁾



- 1) Recovering some metals, glass, rocks and optionally plastics. The prepared material is then sent to drying and storage.
- 2) Typical MSW thermal conversion processes produce a syngas that is combusted to generate power, with a few cases where syngas is converted to chemicals (e.g. synthetic natural gas).
- 3) Operating Experience from Japanese Waste Gasification Plants with Direct Melting System by Tanigaki et. al (2018).
- 4) Syngas is reacted via a sour-gas-shift reaction; hydrogen is purified using a pressure swing adsorber (commonly known as a 'PSA').
- 5) Haldor Topsoe's description of sour gas shift process (topsoe.com).

Enabling a Circular Economy by Separating Hydrogen and Carbon



Organic waste is an underappreciated and untapped reserve of renewable hydrogen. Converting organic waste into its elemental components of hydrogen and carbon circumvents the ongoing generation of harmful landfill methane emissions and toxic compounds.



- 1) IPCC guidance - if the emissions are from biogenic materials and the materials are grown on a sustainable basis, then those emissions are considered simply to close the loop in the natural carbon cycle. They return to the atmosphere as CO₂ that was originally removed by photosynthesis. EPA WaRM 2020 Documentation Background Chapter.
- 2) For an illustration of circularity potential: one ton of food waste utilized by the H Cycle process generates enough hydrogen to produce the ammonia fertilizer used for that food's growth and to fuel its transportation and cold chain.

Clean Hydrogen Production from Waste Organics Offers Key Benefits in Multiple Sectors

WASTE SECTOR

Key state policy measures (e.g. California Senate Bill 1383) mandate increased organic waste diversion from landfills to mitigate methane emissions.

H Cycle diverts organic waste away from landfill disposal, assisting municipalities with a compliance solution.

TRANSPORTATION & INDUSTRIAL SECTORS

Adoption of hydrogen as a clean energy resource requires production methods that are zero-carbon and priced competitively with existing fossil hydrogen.

H Cycle achieves parity with fossil-based hydrogen production methods today, with a carbon intensity that is superior to electrolysis or steam methane reforming with carbon capture.

Economic Development

\$150MM to 250MM+ Invested Per H Cycle Plant

- Significant capital investment in local communities, with locally sourced construction jobs
- Material economies of scale achievable through scaling to two-unit facilities

Annual Operating Budget of \$6-8M Spent Locally

- People, equipment, materials and supplies
- 26 to 32 permanent, skilled operating jobs depending on number of facility units



We deliver the energy of tomorrow: Green Hydrogen

H Cycle's Partnership With the California Building Trades



150+ Construction Jobs per Project

Construction schedules up to 21 months with 1 to 2 new projects started per year in California.

Total initial California Investment \$1.4B+

H Cycle projects benefit the local community with skilled jobs, landfill organics diversion and local procurement of zero carbon hydrogen.

A Leader in Waste Conversion

Leading the Transition to Hydrogen

H Cycle, our feedstock providers and off-takers bring hydrogen to the mainstream conversation helping create a new market which needs new skills and apprenticeship opportunities.

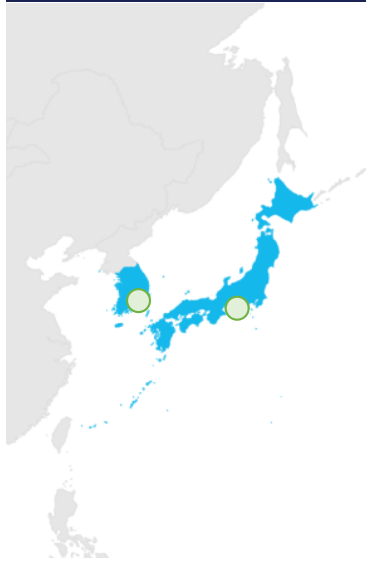
California-wide PLA

Assuring skilled, union labor on all California construction projects. Currently in discussions with the California Building Trades.



- 1) Black-bag waste refers to municipal waste collected as trash in black or grey bins; this is separate from recyclable bins, typically colored blue, and yard waste bins, typically colored green. Black-bag waste is known to be notoriously difficult to process due to its high degree of variability and levels of contamination with inert material.

H Cycle has 3 Lead Projects in Development, and 6+ Additional Opportunities in the Pipeline



Pittsburg, CA

- Single unit project
- CEQA process launched in Q4 2022
- Solid waste permit ("SWP") to launch in Q1 2023
- Full feedstock requirements under LOI with leading independent hauler/processor
- NTP target Q2 2024. COD expected mid-2025

Long Beach, CA

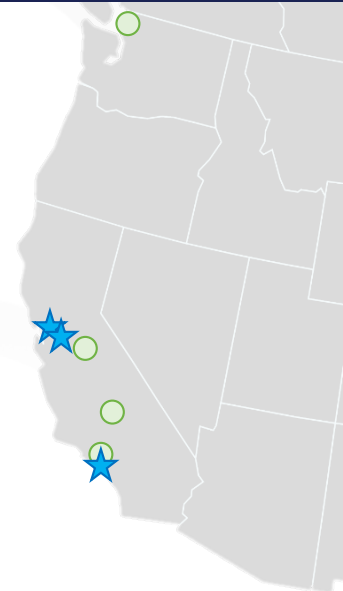
- Two-unit project in partnership with major hauler/processor for feedstock
- Site at/near Port of Long Beach, with mix of pipeline and truck-based hydrogen delivery
- CEQA/SWP permits to launch in Q2 2023
- COD expected mid-2026

Contra Costa County, CA

- Two-unit project in partnership with major refining company
- Co-located at partner facilities with hydrogen delivery by pipeline
- CEQA/SWP permits to launch in Q3 2023
- COD expected by year-end 2026

Development Pipeline

- Los Angeles County, CA – Project #2
- Modesto, CA
- Bakersfield, CA
- Ferndale, WA
- Chiba, Japan
- Ulsan, South Korea



H Cycle has selected Bechtel as our FEED and EPC delivery partner.



\$750 million of lead projects and over \$1.5 billion of project pipeline, representing 90,000 tonnes per year of expected renewable hydrogen production

The Bottom Line

Clean Renewable Hydrogen

Providing clean hydrogen to transportation and industrial consumers, while enhancing landfill diversion and reducing methane emissions.

Post-Recycling Waste Solution

Communities and regulators recognize the value of our process and are moving to include hydrogen production from waste organics as part of the global waste management toolkit.

Transitioning to the H2 Economy

Leading the waste-to-hydrogen transition in California., H Cycle is building a new industrial model in which local feedstocks become local resources, providing real-world success in reducing waste while improving the local quality of life.



H Cycle's Vision is to build a leading clean hydrogen producer to support a low-carbon energy system.



www.hcycle.com



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