

The logo features a white circle containing the letter 'H'. Two curved arrows, one on the left and one on the right, form a circular path around the 'H'. To the left of the circle are three small white dots of varying sizes, arranged in a vertical line. The entire logo is enclosed within a white rectangular frame that is open on the top and bottom sides.

# OH Cycle

Presentation to LA County DPW – January 20, 2022

# H Cycle: Solving Problems at the Intersection of Waste Management and the Clean Hydrogen Economy

## Addressing the Waste Challenge



- While municipal solid waste generation is growing at a rate of 2-3% annually, recycling and composting have plateaued.
- Overall, waste disposal currently accounts for 3-5% of global greenhouse gas (“GHG”) emissions<sup>(1)</sup>.
- Landfills are not a long-term solution due to land constraints and uncaptured methane release.
- In 2018, China shut its borders to waste and recycled content from Western countries, disrupting the waste supply chain and causing a dramatic increase in waste and plastics going to landfills.



H Cycle is a developer, owner & operator of low-cost, low-carbon hydrogen production facilities.

H Cycle has secured the exclusive right to deploy a proven, world-class thermal waste processing technology in premier markets to create a market leader in the conversion of municipal solid waste (“MSW”) and forest/agricultural waste for hydrogen production.

H Cycle’s exclusive markets include Western US (CA, NV, AZ, OR and HI), Japan and South Korea.

## Enabling the Hydrogen Economy



- The global hydrogen market is US\$130 billion and is expected to grow 7%+ per year for the foreseeable future<sup>(2)</sup>.
- Hydrogen represents the cleanest form of energy but today’s production methods rely on fossil fuels and account for ~2% of global GHG emissions<sup>(3)</sup>.
- Hydrogen is expected to become an important resource in the energy transition, particularly in relation to difficult-to-decarbonize sectors, where, unlike the power sector, there are limited low-carbon alternative solutions.
- The ability for hydrogen to achieve this will be contingent on reducing the cost and CO<sub>2</sub> intensity of production methods.



- 1) Earth Engineering Center, Columbia University, 2019.
- 2) Deloitte, Shell, IEA, MarketsandMarkets.
- 3) BP Statistical Review of World Energy.

# Low Carbon Fuel from Waste has Key Benefits

## Hydrogen from Waste

- **An Important Option for SB 1383 Compliance**  
California's SB 1383 requires 8 million tons per year of new organic waste processing capacity by 2025.<sup>(1)</sup> Non-combustion thermal processing like H Cycle will have an important role alongside composting and anaerobic digestion (AD) as solutions.
- **H Cycle Complements other Green Waste Diversion**  
Meanwhile, as organic fractions are diverted from landfills going forward, feedstock contamination presents a serious issue for composting and AD, whether plastics, food waste, or PFAS. H Cycle processes contaminated organics, leaving the higher quality material for the others.
- **H Cycle's Hydrogen Production**  
H Cycle's levelized cost of production and carbon intensity is better than either renewable power electrolysis or steam methane reforming of natural gas + CCS.

## Economic Development

- **\$100 Million Capital Investment per Unit**  
Construction jobs are locally sourced  
Property tax base is increased with new industry = \$750-900k/yr
- **Annual Operating Budget of \$6-8 Million Spent Locally**  
People, equipment, materials and supplies  
25-35 permanent, skilled operating jobs
- **'Elemental Recycling' Drives Circular Economy**  
Partnership with waste processing companies brings waste recycling practices to best in class  
Hydrogen used for fuel enables emission-free vehicles in medium/heavy-duty truck fleets, including the waste collection and hauling companies themselves

# H Cycle is Backed by Azimuth and has Secured Strategic Partnerships

## Introduction to Azimuth Capital Management



- Azimuth Capital Management (“Azimuth”) is a private equity firm with almost 20 years of experience investing in energy transition, energy assets, E&P and technology.
- Team of 31 seasoned professionals – all firm leaders and half of the investment team have technical / operating backgrounds or have led technology-driven companies, complementing deep internal financial expertise to successfully execute scaled asset investments.
- To date, \$3.4 billion has been invested into the development of 35 energy companies across four funds and Azimuth’s co-investment program. Market AUM of \$5.0 billion<sup>(1)</sup>.
- Azimuth has direct experience in the waste-to-fuels infrastructure and logistics segment (e.g. [Recover](#)), and has commercialized novel technologies supplying clean hydrogen (e.g. [Monolith](#)).

## Key Partnerships



The Larsen and Lam  
Climate Initiative



1) Includes funds and co-invest. Total AUM includes total capital committed. Market AUM reflects realized and unrealized value as of March 31, 2021.

# H Cycle Led by a Capable, Experienced, and Dedicated Team



**Robert Morgan**

CEO

Previous roles: CEO of GE's Energy Storage business, 15 years as Executive with AES, Chief Development Officer and Chief Strategy Officer with RES Americas, President & Co-Founder of Agile Energy, and Founder/Chief Development Officer with Ausra.



**Karim Ibrik**

Acting Chief  
Technology Officer

Previous technical roles with Shell at the Pearl gas to liquids plant in Qatar. Current Vice-President with Azimuth Capital and pursuing MBA and MS from Stanford University.



**Scott Gardner**

Chief Commercial  
Officer

Previous roles as Senior Vice President at Partners Group / Infrastructure Fund, Senior Vice President with WesPac Midstream, Managing Director with US Renewables Group, and Vice President with the AES Corporation.



**Dan Baublis**

Chief Engineering  
Officer

Previous roles as Senior VP of Engineering & Construction for InterGen, Executive VP of Global Power Operations for CH2M HILL, Managing Director for Riverstone Intellectual Capital, and VP of Global Project Delivery for ViZn Energy Systems.



**Wesley Lien**

Commercial  
Manager

Graduate of Northwestern University (B.A., Chemistry). Previous roles as Strategic Development and Finance Manager with Pattern Energy Group, finance and operations with SunEdison. Clean Energy Leadership Institute Fellow.



**Taylor Huff**

Project Director/ VP  
H2 Marketing

Graduate of University of Oklahoma (B.Sc., ChemEng). Joint MBA/MS Kellogg School of Mgmt. and Stanford University. Previous operating roles at BP and co-founder of Origen Energy (now evolOH).



**Ryan Patryluk**

Board Member &  
Advisor

Previous roles as Partner with Hennan Blaikie LLP and Founding Partner MEP Business Council. Current Vice-President Commercial with Steelhead LNG, Chief Operating Officer of ACM LNG, and Managing Director at Azimuth Capital.



**Pete Johnson**

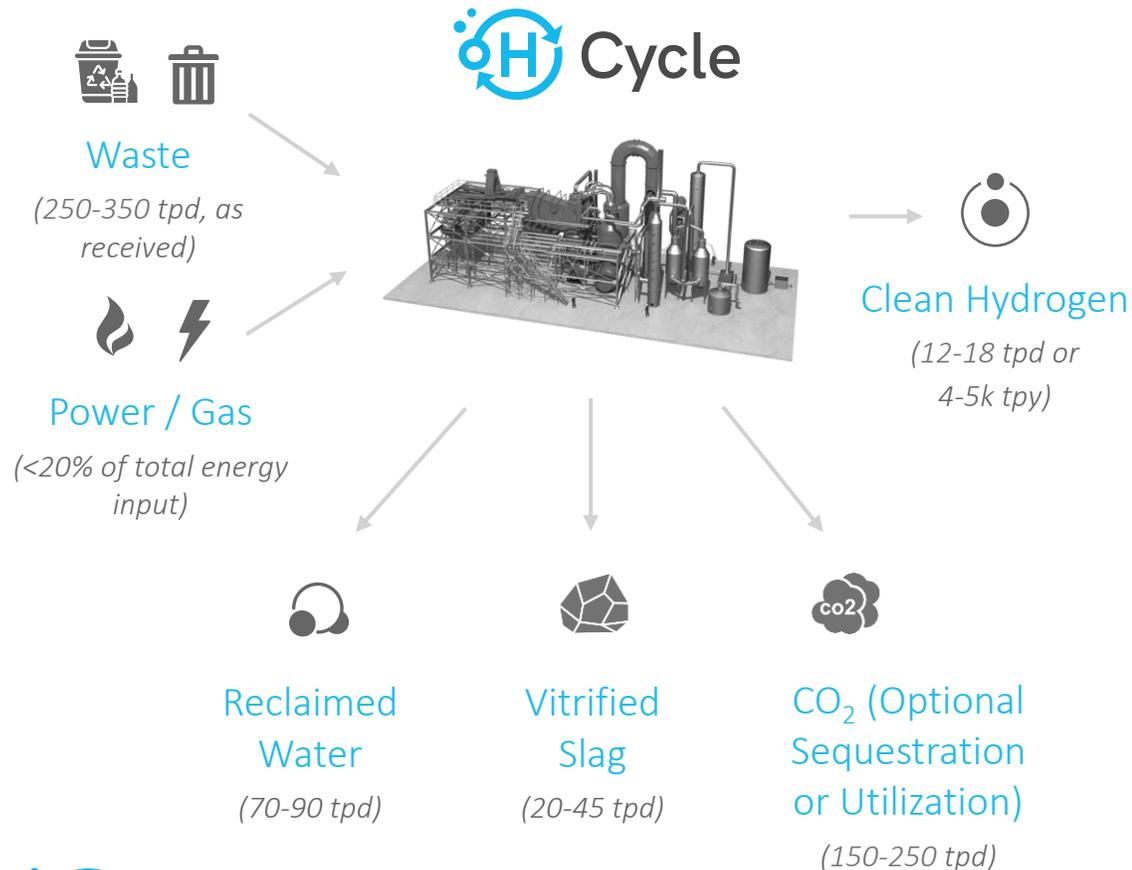
Advisor

Previous roles as Engineering Manager with Ausra, Director of Engineering at Areva, and multiple roles at Monolith Materials including President, Chief Technology Officer. Currently Monolith Board Director and Venture Partner with Azimuth Capital.

The team combines diverse skills in engineering, technology, finance/investing, contracts and public engagement.

# H Cycle's Waste-to-Hydrogen Process is Best-in-Class

## Process Overview



## Advanced Gasification Technology

### Robust, Flexible Solution

At the heart of H Cycle's process is a multi-step, non-combustion thermal processing technology that converts energy-rich waste into high-purity hydrogen and CO<sub>2</sub>. The facility has a small land footprint of approximately 6 acres.

### Omnivorous Advantage

The process handles a large variety of streams and contaminants, suitable for co-mingled residues across seasonal variations.

### Ultra Low Emissions Process

Volatile contaminants, such as nitrogen and sulfur, are eliminated through water-washes followed by water treatment. Metals and other inert materials are converted into a non-leachable, non-hazardous vitrified slag.

### Product Purity

H Cycle's hydrogen product achieves up to 99.97% hydrogen purity for use in precise customer production processes or as zero-emission transportation fuel.

# H Cycle will deploy Omni CT's Proven Technology

## The Demonstration Facility

- Omni Conversion Technologies' (Omni CT's) technology development started in 2001 with a pilot in Castellgali, Spain at a waste management company's premises.
- Commercial-scale demonstration in operation from 2007 to 2015 in Ottawa, Canada with a throughput of 70-100 tpd (black-bag waste).
- \$300M+ was invested in the core technology development.



Plasco Trail Road Facility, shown on the left, was operated in campaign mode showcasing availability of 85%+ over 30-day runs.

## Technology Due Diligence

- H Cycle's team reviewed 40+ waste-to-value technologies, determining that Omni CT's technology was commercially-ready.
- The review of the technology prioritized:
  1. Proven demonstration at scale
  2. Omnivorous capabilities
  3. Integration with gas clean-up
  4. Efficiency of energy extraction
- Omni CT's technology received a TRL 8<sup>(1)</sup> by two credible independent engineering groups.
- New Energy Risk (a subdivision of AXA) has reviewed the technology and identified an insurance solution for underwriting to support commercialization.

The core of the process is a non-combustion thermal processing technology licensed from Omni CT, an industry leader in alternative waste processing.

# H Cycle is a Superior Solution to Waste Management Challenges

H Cycle's Solution to Waste Management has Emissions Benefits over Traditional Practices

Emissions Profile of Waste Solutions

(Kilograms of CO<sub>2,e</sub> per metric tonne of wet waste)

■ Gross CO<sub>2</sub> ■ CO<sub>2</sub> Displaced ■ Net CO<sub>2</sub>

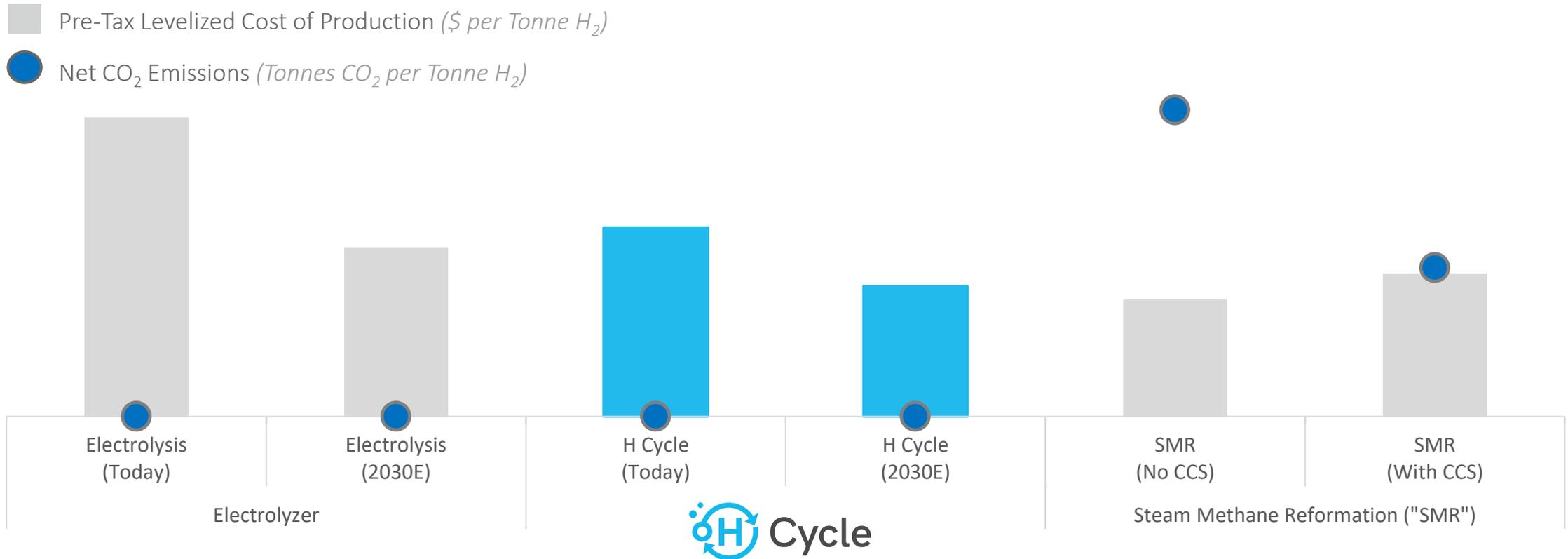
	Landfill	Incinerator	H Cycle	Compost	Anaerobic Digestion
Product Value	None	Electric Power Generates \$30-40 per tonne of waste	Hydrogen Generates \$100-150 per tonne of waste	Compost Fertilizer Generates \$50-120 per tonne of waste	Renewable Natural Gas Generates \$100-200 per tonne of waste
Net GHG Emissions	200 kg CO <sub>2,e</sub> per tonne of waste	38 kg CO <sub>2,e</sub> per tonne of waste	-506 kg CO <sub>2,e</sub> per tonne of waste	-204 kg CO <sub>2,e</sub> per tonne of waste	-432 kg CO <sub>2,e</sub> per tonne of waste
Feedstock Flexibility	Very High	High	High	Very Low	Low

- 1) Thermal processing operates in reducing conditions and involves no combustion, therefore does not produce NOx and SOx in significant quantities. Dioxins are below quantification levels.
- 2) All inorganics are melted out as vitrified non-hazardous slag (a glass like solid).

# H Cycle has Advantageous Economics for Hydrogen Production

H Cycle's Hydrogen Production Method has a Cost Benefit Relative to Low-carbon SMR and Electrolysis

Relative Economic and Environmental Performance by Method for Hydrogen Production<sup>(1)</sup>



1) Ultimate Cost Depends on Project Scale and Waste Tipping Fees.

# Project Development Overview

## Western Locations in Consideration

- ① East Bay Area, CA
- ② Los Angeles Area, CA
- ③ South Central Valley, CA
- ④ Mid Central Valley, CA
- ⑤ North Central Valley, CA
- ⑥ Salt Lake City, UT
- ⑦ Honolulu, HI
- ⑧ Seattle, WA



## Future Project Development Considerations

### 2.5 to 3.5 years typical development schedule from inception to COD:

- Development: 12-18 months, including site control, permitting, commercial agreements, engineering design, and construction agreements
- Construction: 18-24 months: depending upon long-lead equipment timing

### Key permits:

- CEQA / Conditional Use Permit
- Minor Source Air Permit
- CalRecycle Solid Waste Permit and 1383 Diversion Confirmation
- Hydrogen storage and safety approvals

### H Cycle Advantages:

- Development budgets fully funded
- Shortened time to market: First unit already funded and in detailed engineering and long-lead equipment procurement

H Cycle looks forward to working with you to advance low-carbon waste to hydrogen solutions.

# The Bottom Line



## Low-Carbon Hydrogen

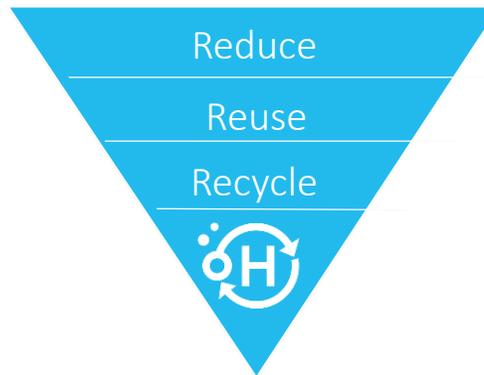
Providing low-cost clean hydrogen to transportation and industrial consumers, while enhancing landfill diversion and reducing methane emissions.

75%+ reduction in GHG emissions vs. base case of 1) landfilling waste, and 2) producing hydrogen from conventional fossil fuel processes.



## Post-Recycling Waste Solution

Regulators recognize the nature of the solution and are moving to include hydrogen production from waste as part of the solution:

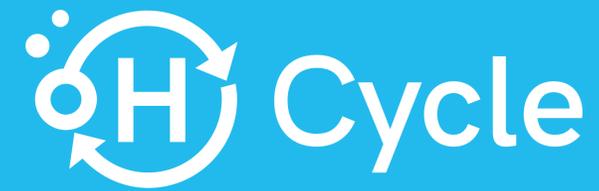


## Competitive Market Price

H Cycle's waste handling fees are competitive with existing tipping & transport fees in the market today.

H Cycle projects generate additional value for municipalities and waste authorities by generating diversion credits from avoided landfilling.

H Cycle is best positioned to enable the circular economy and lead the low-carbon hydrogen market.



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