Fuel cell bus and truck power trends

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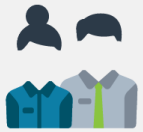
Ballard Power Systems

May 2020

BALLARD BY THE NUMBERS

40
YEARS


900
employees

1,400
patents & applications

25 years Nasdaq
27 years TSX
publicly listed Company

WEICHAI
AngloAmerican
NISSHINBO
大洋电机 BROAD-OCEAN
4
strategic shareholders

760+
transit buses

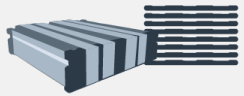
2,200+
trucks


4 TRAIN
projects on track

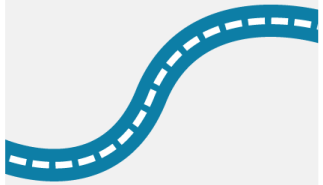
5 SHIPS
in development


12,000
forklifts in operation


$80 million
automobile stack development program


670 MW
fuel cell products delivered


>5.5 million MEAs
produced


>30 million
kilometers in operation


>30,000 hours
operation of fuel cell stack in London buses

Heavy duty vehicles have a higher impact on emissions

Fuel cell technology is needed to achieve decarbonization of heavy duty transport sector

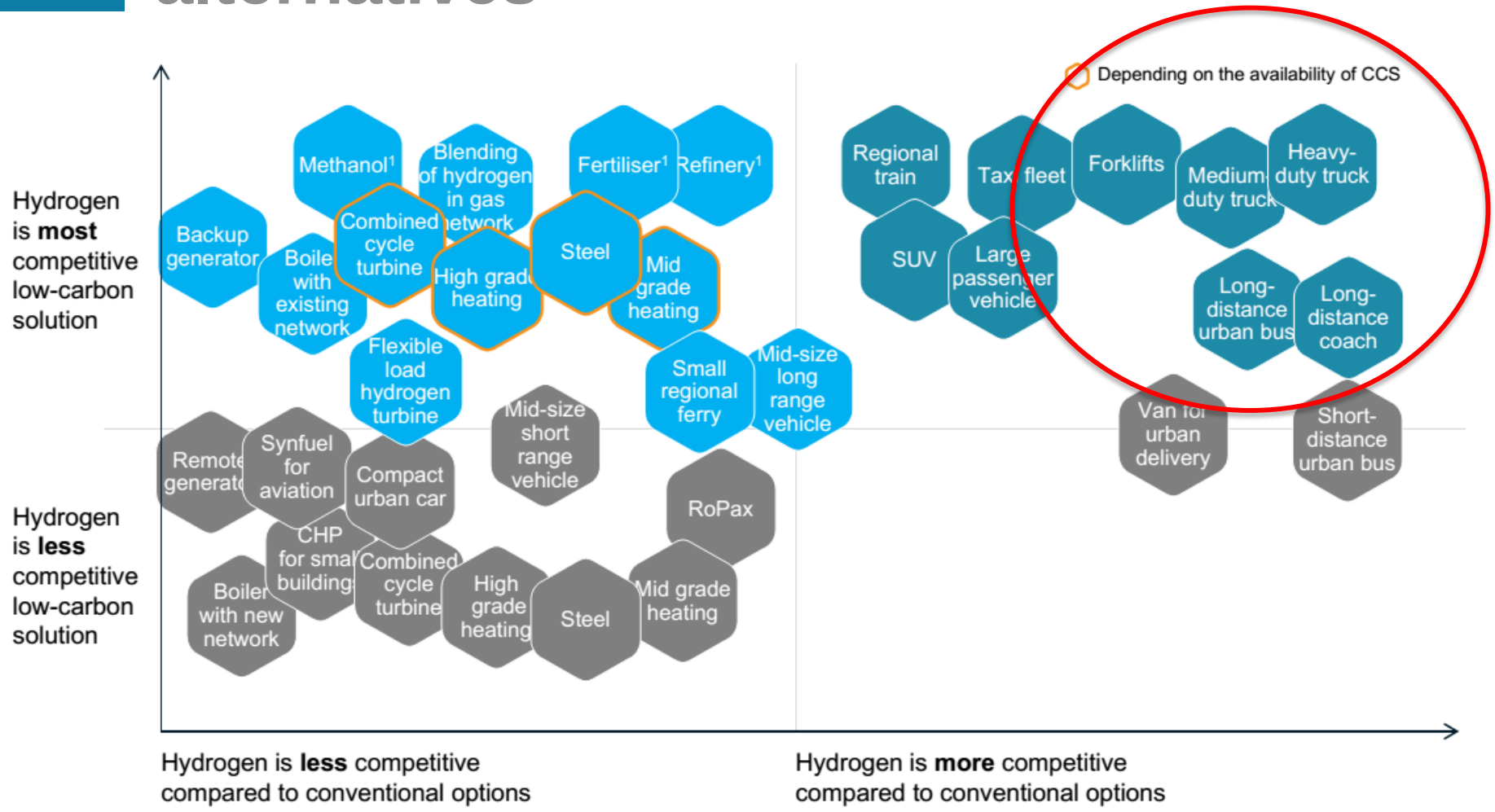
Power

Range

Payload

Fast refueling

Competitiveness of hydrogen applications versus low-carbon and conventional alternatives



Source – Hydrogen Council Report – "Path to Hydrogen Competitiveness: A Cost Perspective", January 2020

Major Investments and Partnerships Now Accelerating

There are over 5,000 fuel cell buses and truck in operation worldwide













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Hydrogen Council

2020

- 25,000+ fuel cell forklifts in daily operation
- 15,000 fuel cell cars on the road
- 5,000 + fuel cell buses and trucks in service

2025

- 5,000 FC vehicles on the road in China by 2020
- 200 fuel stations in California by 2025
- 40,000 vehicles on the road in Japan by 2021
  Japan roadmap
- 50,000 FCVs in service, in China, among which 10,000 units are FC commercial vehicles, and 40,000 units FC passenger cars by 2025
  China road map 2018
- >350 FCEBs on the road in Europe (JIVE)
- 100 FCEBs at Tokyo 2020 Olympics
- +600 FCEBs on the road in Europe
  H2Bus Project
- 2,000 fuel cell buses in Shandong Province
  Weichai
- 1,600 FC trucks in Switzerland
- 800 FC trucks for Anheuser Bush by Nikola

20,000 Fuel Cell Vehicles

2030

10 million Fuel Cell Vehicles

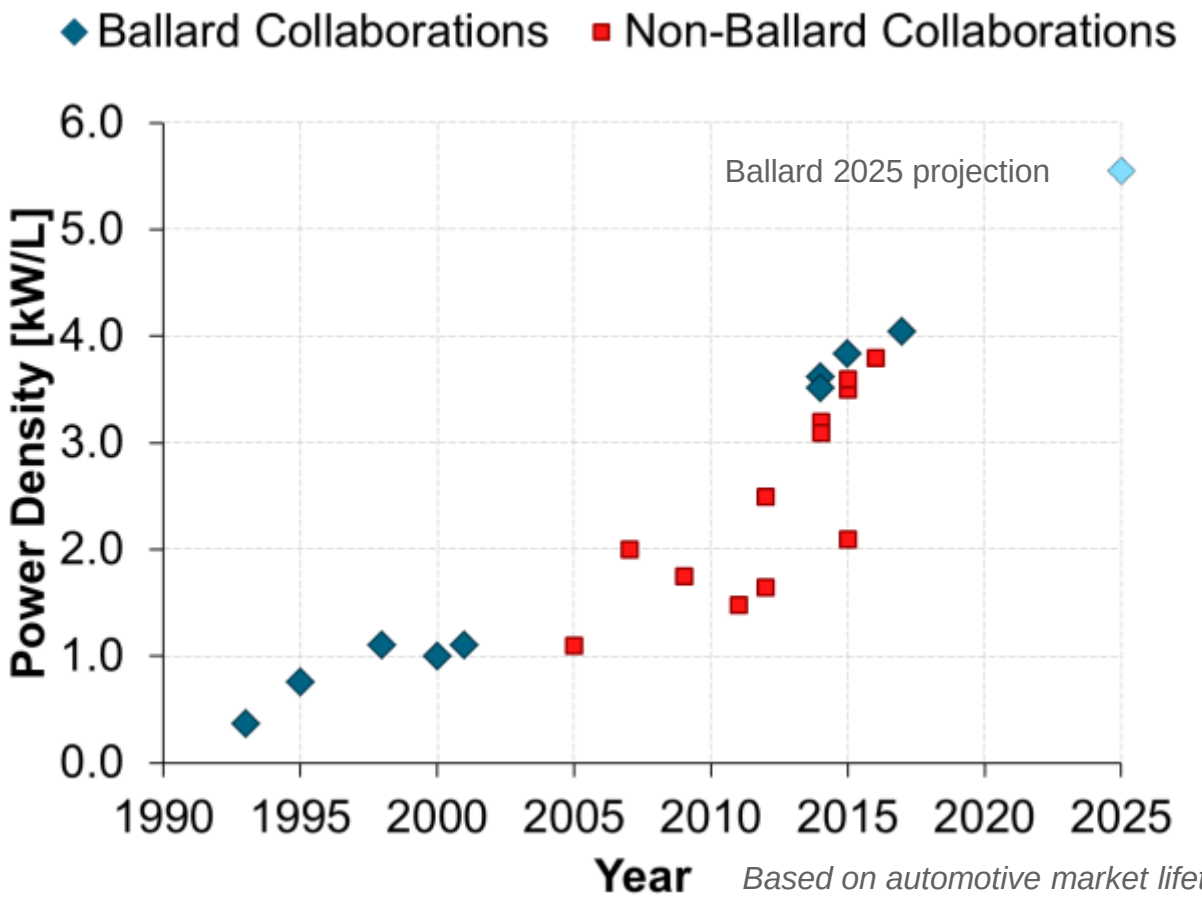
- 6 million FC car produced by 2040
  Korea road map 2019
- 1 million FC vehicles on the road in China by 2030
  China road map 2018
- 10 million fuel cell cars
  500,000 trucks on the road
  1 in 10 trains on non-electrified tracks
  Hydrogen Council vision

How do we get there ?

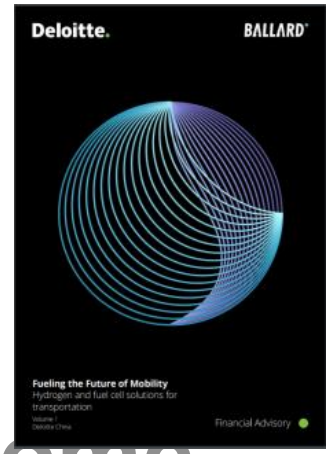
1. 

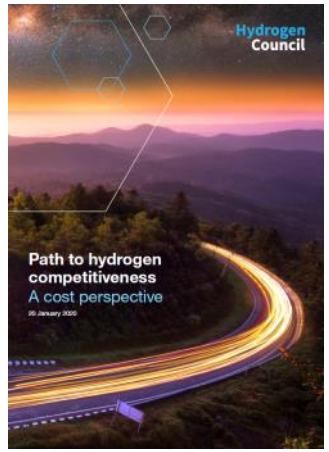
2. 

Continue to improve fuel cell performance



Based on automotive market lifetime of 5,000 hours





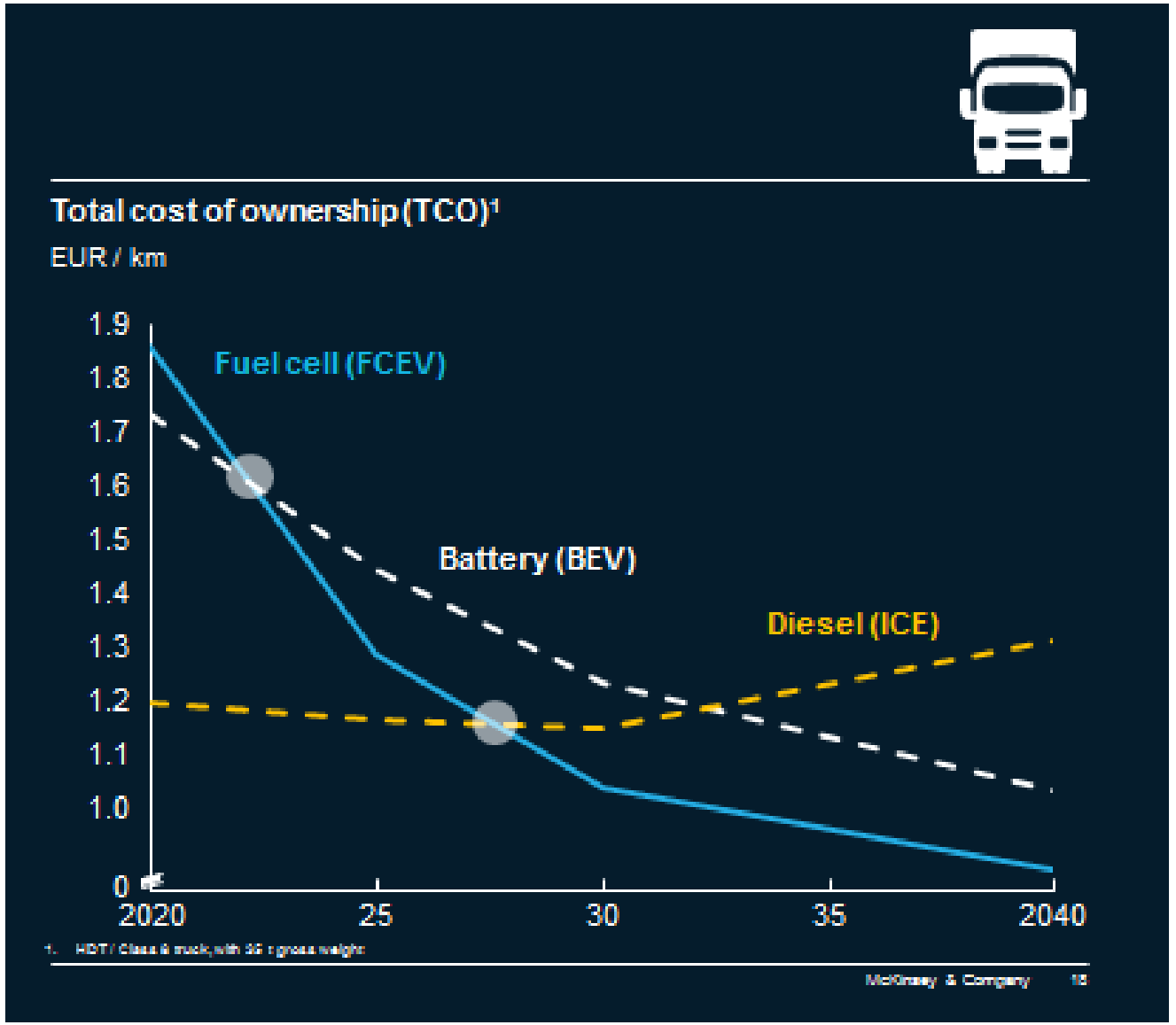
“In less than 10 years, it will become cheaper to run a fuel cell electric vehicle (FCEV) than it is to run a battery electric vehicle (BEV) or an internal combustion engine (ICE) vehicle for certain commercial applications.”

Deloitte-Ballard Report 2020
McKinsey - Path to Hydrogen Competitiveness report 2020

HDT: Commercial heavy duty transport can become cost competitive by 2030

-70%
Fuel cell system

-40%
Distribution and refueling infrastructure



McKinsey - Path to Hydrogen Competitiveness report 2020

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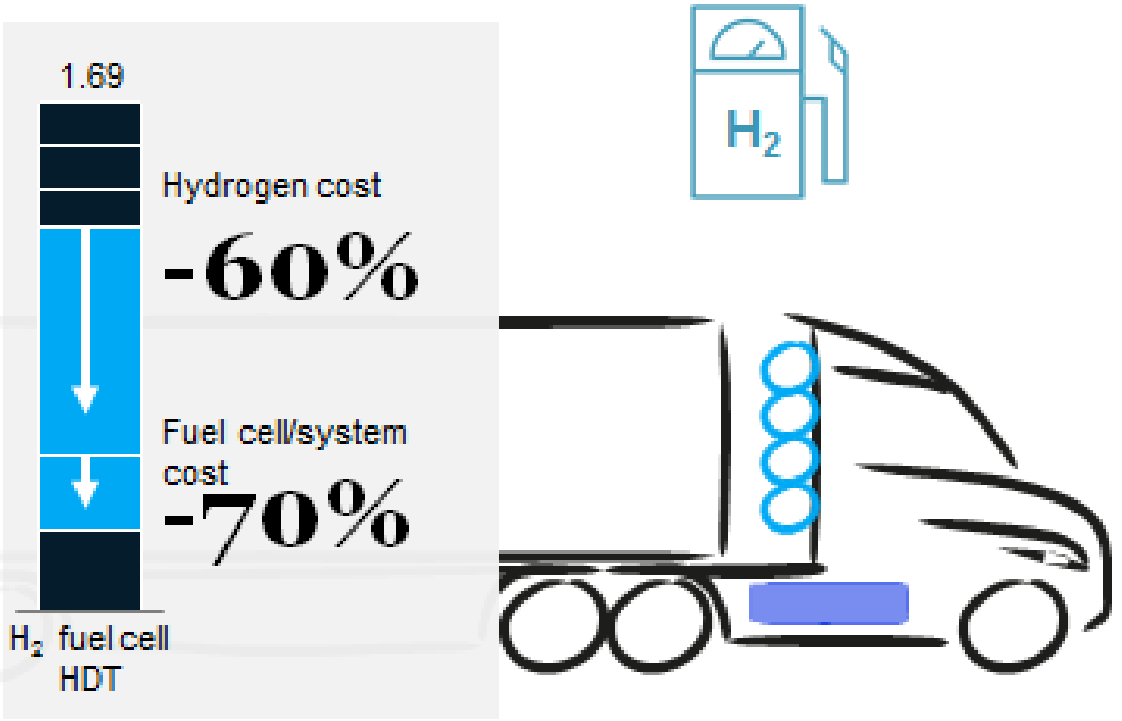
Major cost reduction levers are H2 cost, fuel cell stack and system/tank cost

HDT long haul, TCO in EUR/km, Europe



Hydrogen

- 4.5 EUR/kg (at the pump) due to scale, utilization and lower energy cost **-60%**

Tank and System

- Volume scale up to 150k
- technological improvements **-66%**

Fuelcell stack

- Volume scale up from 1k to 150k **-75%**

McKinsey & Company 18

McKinsey - Path to Hydrogen Competitiveness report 2020

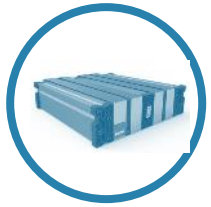
Ballard strategy to achieve 70% cost reduction

Fuel cell system cost reduction drivers

Strategic partnerships to accelerate industrial-scale fuel cell production & adoption (e.g. Weichai Power)

Leverage China joint ventures to advance fuel cell supply chain
Access of new BoP components from automotive supply chain

Reduced BoP cost



Fuel cell stack cost reduction project

- Process & design yield improvement
- Technology innovation → reduced platinum loading; improved power density; etc.
- Choice of lower cost material (eg. carbon plates) for maximum cost reduction at scale
- Higher production yields with reduced labor costs

Recycling & refurbishment processes for minimum lifecycle cost and maximum FCEV residual value

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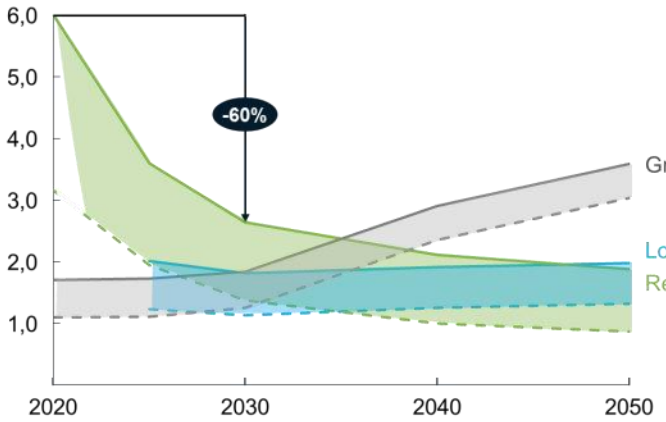
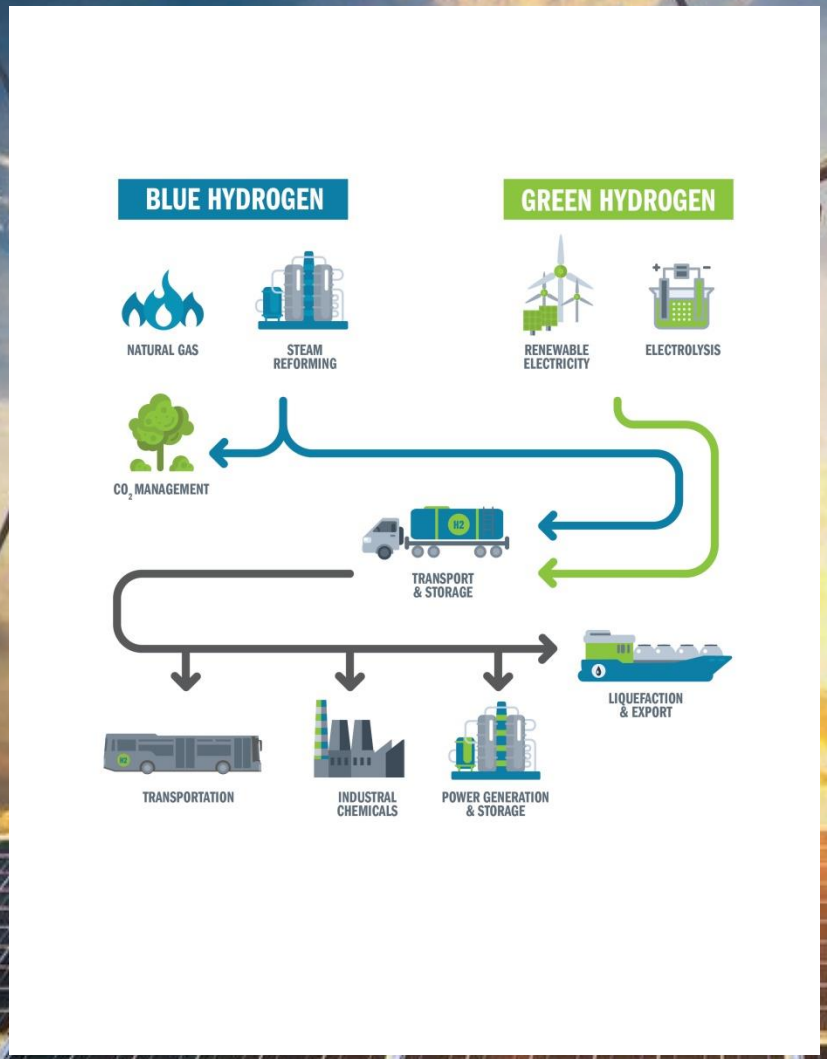
Renewable energy will unlock the hydrogen economy

Renewable hydrogen production costs drop by 60% until 2030

Production cost of hydrogen
USD / kg



$1 to 2/kg



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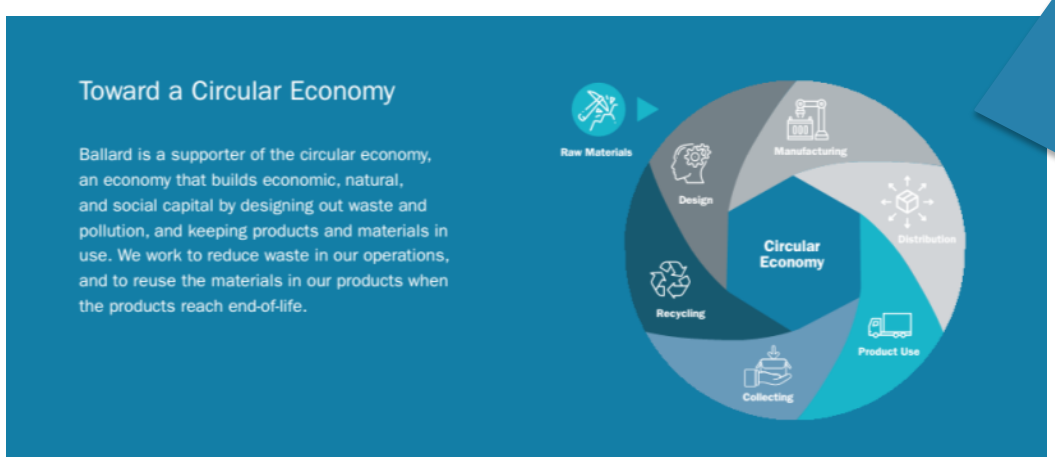
zero emission vehicles must also be sustainable



Toward a Circular Economy

Ballard is a supporter of the circular economy, an economy that builds economic, natural, and social capital by designing out waste and pollution, and keeping products and materials in use. We work to reduce waste in our operations, and to reuse the materials in our products when the products reach end-of-life.

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We deliver fuel cell power for a sustainable planet

Thank you

www.ballard.com