HYDROGENICS

SHIFT **POWER** | **ENERGIZE** YOUR WORLD

Hydrogen Buses 氢能源公交车
ADB Low Carbon Cities 亚行低碳城市
Seoul, South Korea 韩国首尔

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HYDROGEN EVOLUTION IS…
氢能源的发展

- Evolving the Electric Vehicle to a more advanced, easier to use and environmentally friendly transportation using Fuel Cells
  通过燃料电池将电动汽车发展为更先进、更易于使用和环保的交通工具
- Evolving Renewable energy to capture any excess energy via Electrolysis to create Hydrogen and balance grids with Power to Gas
  发展可再生能源，通过电解捕获任何多余的能量，生成氢气并平衡电网
- The HYDROGEN EVOLUTION IS….氢能源的发展是.....

HYDROGENICS

氢能公司

HYDROGENICS

SHIFT **POWER** | **ENERGIZE** YOUR WORLD

70 years of experience in delivering top-tier hydrogen solutions 在提供顶级氢能解决方案方面拥有**70年**的经验

Leading **PEM stack** and system technology, including unmatched **power density** in a single stack (3MW) 领先的基于水电解和质子交换膜(PEM)技术的电堆和系统技术，包括单个电堆**强大的功率密度**（3兆瓦）

Only global company with leading technology in both **electrolyzers** and **fuel cells** 全球唯一一家在**电解槽和燃料电池**方面具有领先技术的公司

Over **2,000 fuel cell** and **500 electrolyzer** installations around the world 在全球安装**2,000多个燃料电池和500个电解槽**

Supplied equipment for **60+ fueling stations**为**60**多个**加氢站**提供设备

Serving customers in **100+ countries** around the world 服务全球**100多个国家**的客户

Publicly traded: **NASDAQ** (HYGS) and **TSX** (HYG)
在**纳斯达克**和**多伦多证券交易所**上市

Zero-emission technology **零排放**技术

Over **145 patents**超过**145项专利**

Our Principal Product Lines 我们主要的产品线

HyPM
Fuel Cell Power Modules
燃料电池功率模块

- Robust and flexible platform for zero-emission **Mobility/Transportation** applications
  稳定灵活的零排放出行/交通应用平台
- Track record of superior performance and durability
  跟踪记录卓越的性能和耐用性
- Fully customizable
  完全可定制

HyPM and HyPM-R
Fuel Cell Power Modules and Rack Systems
燃料电池功率模块和机架系统

- Suitable for **Critical and Back-Up Power** applications
  适用于主要及备用电源应用
- Unlimited scalability to meet runtime needs
  无限的可扩展性以满足运行时需求

HySTAT™
Alkaline Electrolyzers
碱性电解槽

- Suitable for industrial hydrogen **Generation**, energy **Storage** and **Fueling**
  适用于生成工业氢气、储能和加氢
- World leading market share 世界领先的市场份额
- Industrial standard
  工业标准

HyLYZER™
PEM Electrolyzers
PEM电解槽

- Suitable for industrial hydrogen **Generation**, energy **Storage** and **Fueling**
  适用于生成工业氢气、储能和加氢
- Worlds most power dense stack with the smallest footprint
  世界上功率最大、占地面积最小的电堆
  Scalable to 50MW, 100MW+ 可扩展至50兆瓦，甚至超过100兆瓦

Helping Our Customers Achieve New Milestones
帮助我们的客户实现新的里程碑

Our products and solutions are helping customers and industries achieve new milestones

TRANSPORTATION

First hydrogen powered public service train
First multi-passenger, hydrogen powered all-electric airplane
First hydrogen fuel cell powered medium-duty delivery trucks
Largest hydrogen powered bus fleet in China

FUELING

First hydrogen fueling station in Scotland
First hydrogen fueling station in Sweden
First hydrogen fueling station in Norway
First hydrogen fueling station in Canada

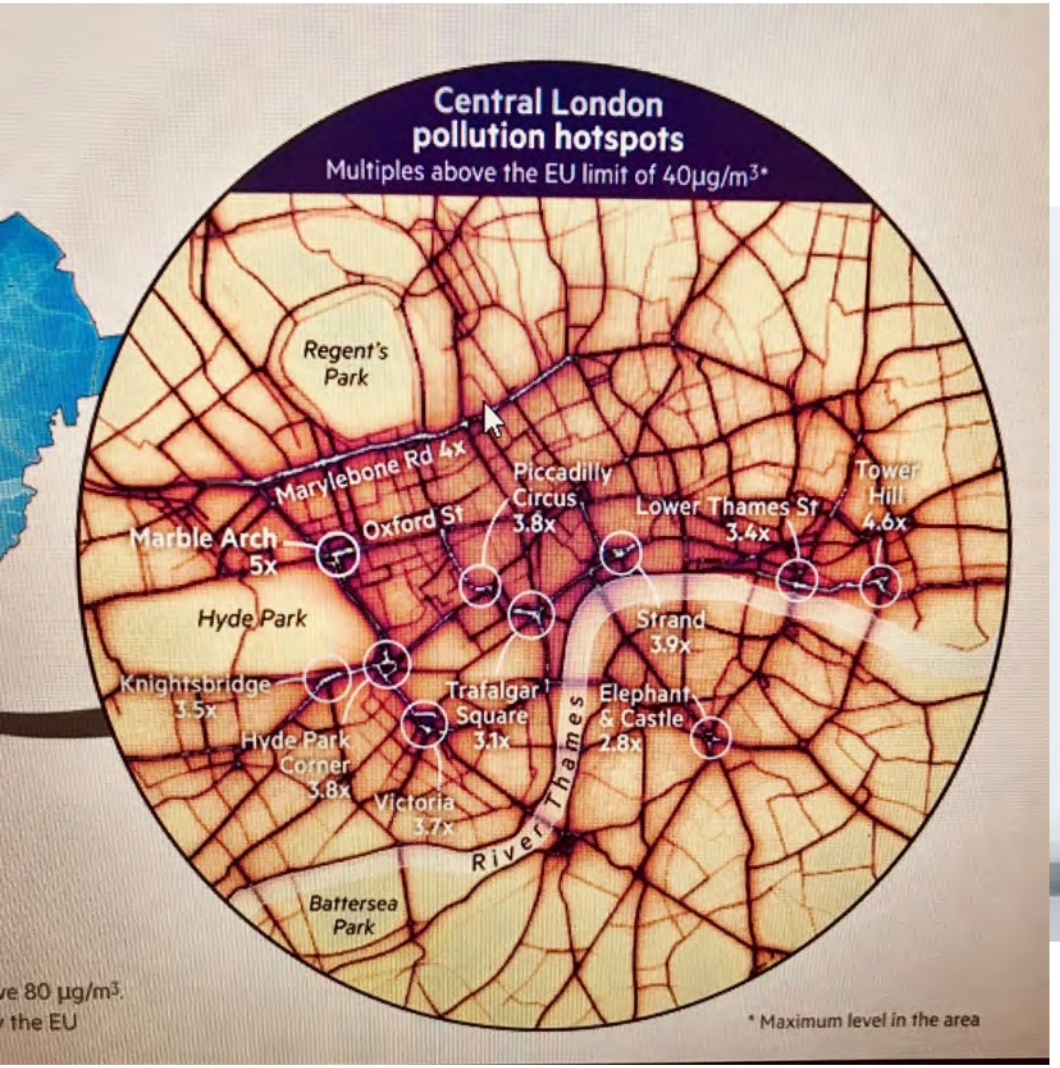
ENERGY GENERATION, STORAGE, CRITICAL AND BACK-UP POWER

First and largest Power-to-Gas facility in the world
First Hydrogen-to-Power project at a MW-scale
First hydrogen injection into pressurized natural gas infrastructure
First telecom UPS with electrolyser

IN DEVELOPMENT

Largest PEM electrolysis plant in the world
First hydrogen fueling station in South East Asia
First hydrogen powered high-speed ferry in the USA

Urban Air Pollution in Cities is Mainly Transport
交通是城市空气污染的主要来源



Hyundai Nexo Cleans over 900kg of clean air in a month
现代Nexo能在一个月内净化超过900千克的空气

HYDROGEN HEAVY DUTY APPLICATIONS
氢能源在重型领域的应用

Nyagan, Russia

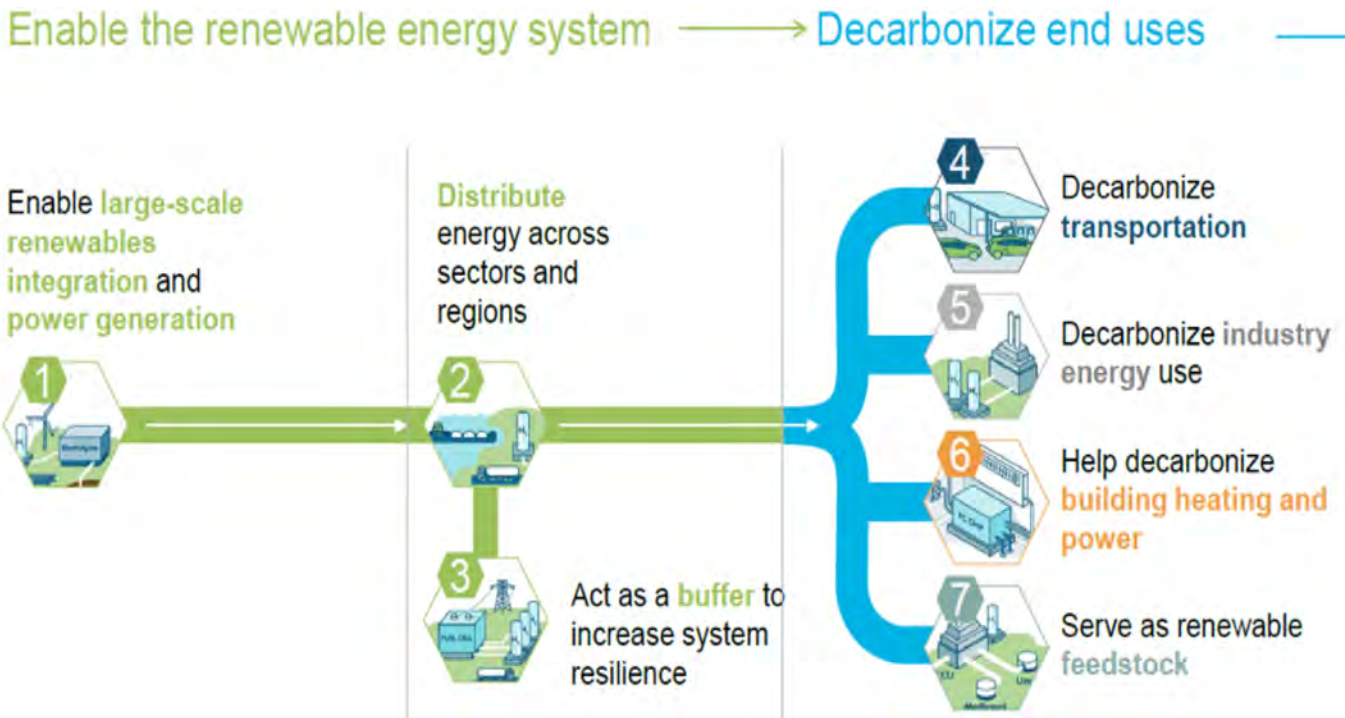
Fuel Cell Advantages 燃料电池的优点

- Extend Range of Vehicle: 30kw FC module 增加车辆行驶里程：30kw燃料电池
  - Bus from 120-220km to 330 to 450km range
    公交车从120-220公里到330-450公里不等
  - Logistic Vehicle from 200km to over 450km
    物流车辆从200km到450km以上
  - Passenger Car from 250km to over 600km
    小客车从250km到600km以上
- Fast recharging of 3 to 7 minutes 3至7分钟即可充满
- Better temperature tolerant with heat and cold 耐温性更好
- Hydrogen Trains: 1/3 the cost of Electric train ? 氢能源火车：电动火车成本的1/3？
- More environmental： 更环保：
  - Easier and Better recycling Capability 更容易和更好的回收能力
  - Green H2 has lowest carbon emissions of any vehicle
    氢能源汽车具有最低的碳排放
- Less Charging stations and infrastructure 减少充电站和基础设施
- Greater cost reductions over time 随着时间的推移极大降低成本
- Supported by all major companies globally with the Hydrogen Council
  得到国际氢能委员会全球所有主要公司的支持
- Allows for usages of wasted energy in the grid and renewables
  能够利用电网和可再生能源中浪费的能源

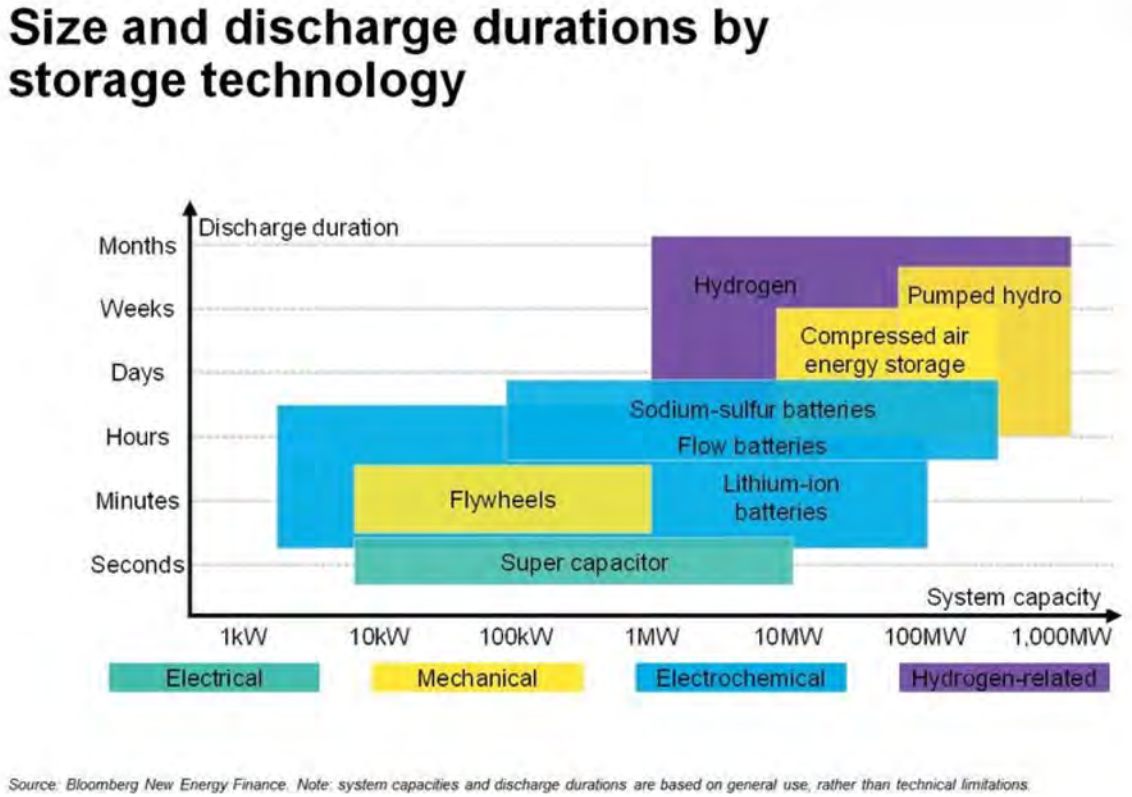
Fuel Cell Vs Battery and Combustion
燃料电池、纯电与燃油车的对比

Attribute 性能	Electric 纯电	Combustion Engine 内燃机	Fuel Cells 燃料电池
Zero Emissions 零排放	☐		☐
Extended Runtime 延长运营时间		☐	☐
Fast Fueling 快速充满		☐	☐
Quiet Drive 驾驶安静	☐		☐
High Efficiency 高效	☐		☐
Route Flexibility 路线灵活性		☐	☐
Renewable Capable 可再生能力	☐		☐
Maintenance 维护	☐		☐

Hydrogen Energy Density and Hydrogen Council Goals
氢气的能源密度和国际氢能委员会目标

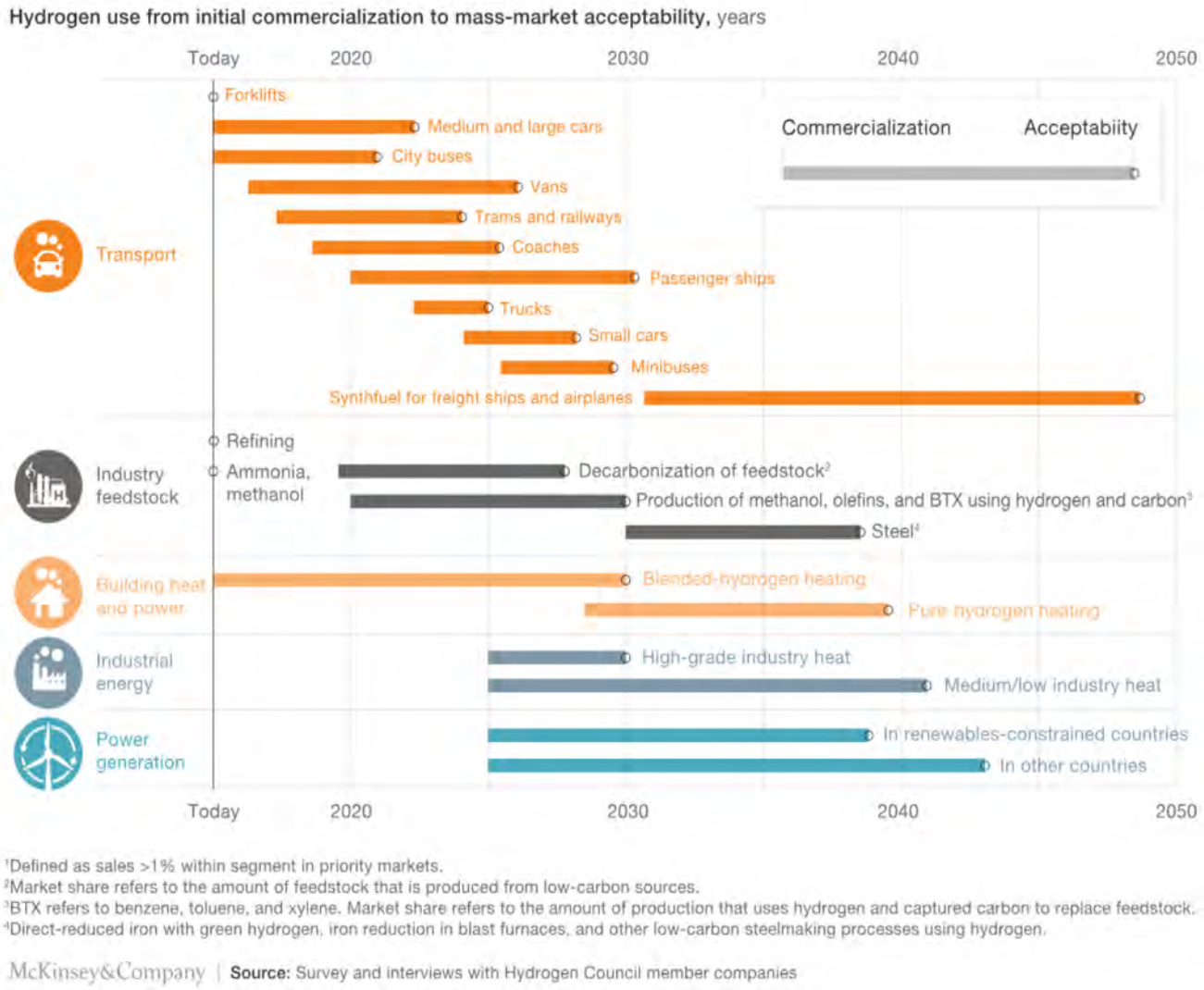


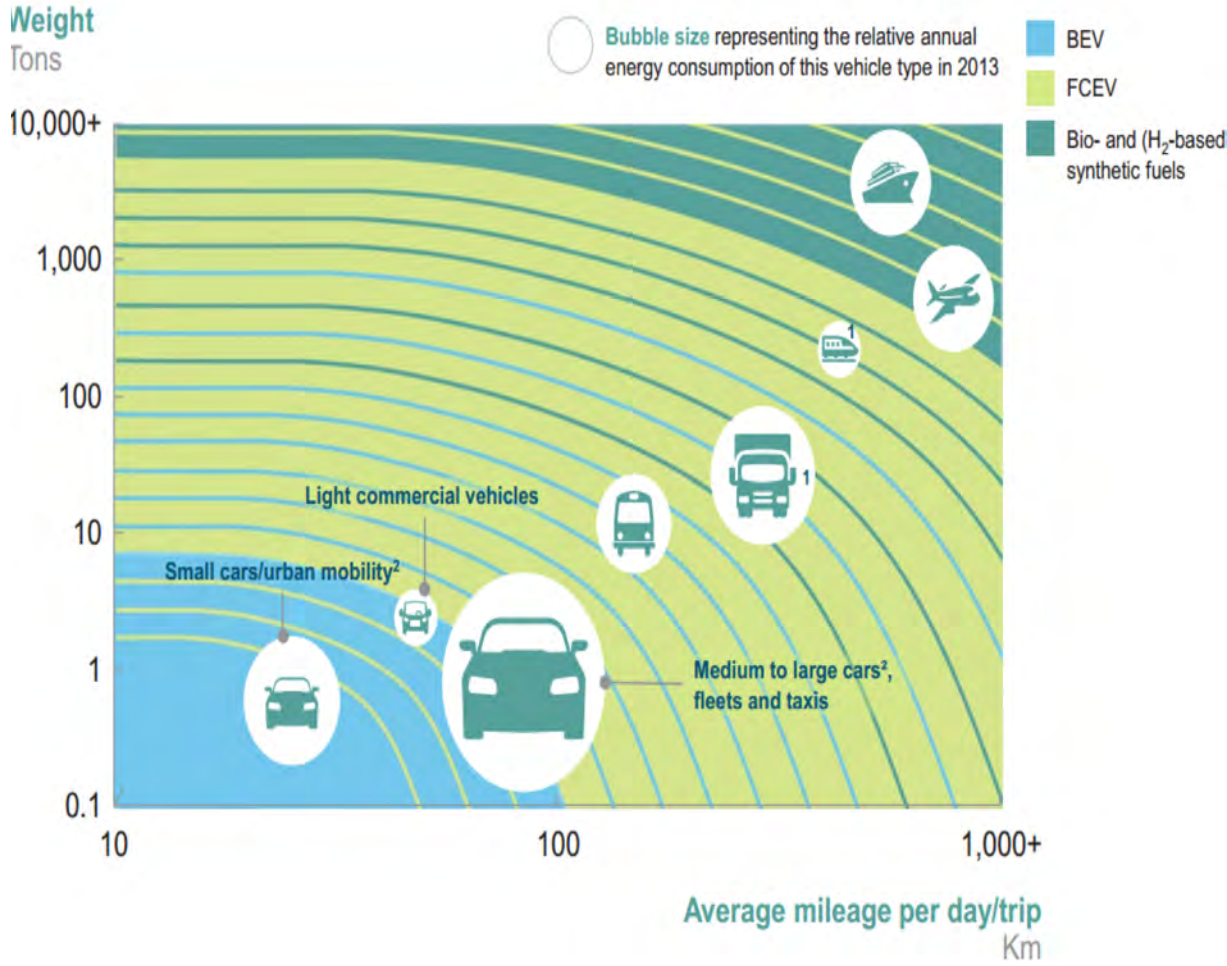
Hydrogen Council 2050 Goals 国际氢能委员会2050目标



Source: Bloomberg New Energy Finance. Note: system capacities and discharge durations are based on general use, rather than technical limitations.

Hydrogen Commercialization Trends
氢能的商业化趋势



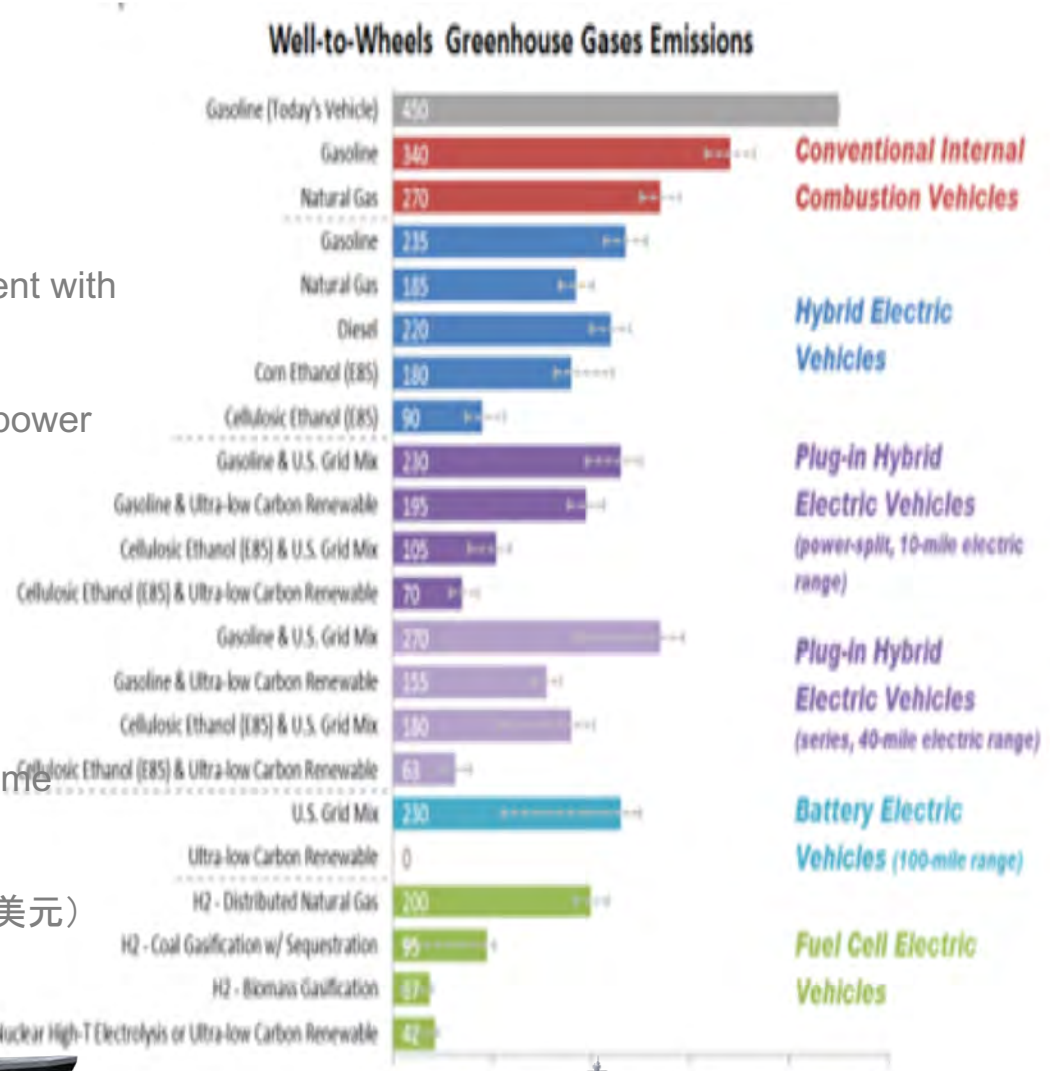


Why HYDROGEN and PEM Fuel Cells 为何选择氢能和PEM燃料电池

- Current battery technology cannot support Heavy Duty Transport
  目前的电池技术不能支持重型交通工具
- Batteries have major precious metals concerns and recycling which are not present with Fuel cells
  电池具有贵金属和回收利用问题，燃料电池不存在这些问题
- Renewables have excess power in most markets, also coal, nuclear have excess power which can be utilized
  - Ex: 5GWH in Germany alone in excess

  可再生能源、煤炭和核电在大多数市场都拥有多余的、可被利用的电力
  例如：仅德国就有5千兆小时的电力过剩
- Transporting H2 is getting better and better and cheaper
  ex. LOHC, Ammonia
  氢气输送会越来越容易和便宜 例如：液态有机氢载体技术、氨
- Auto industry supports Hydrogen Fuel cells as the lowest cost powertrain with volume ($40 USD target per Kw)
  - Toyota, Hyundai, Honda, Daimler, Audi, Mecedes, etc…

  汽车行业支持氢燃料电池，因为它拥有最低的动力系统成本和体积（每千瓦目标40美元）
  如丰田，现代，本田，戴姆勒，奥迪，梅赛德斯等.....



Fleet Vehicles: first step to maximize investments in Fueling
车队：最大化加氢投资的第一步

- Fleet vehicles are the most logical step to maximize investment in hydrogen fueling 车队是最大化氢燃料投资的最合理的步骤
- Why Fleets ?为何是车队？
    - China: approx. 15 stations with 1500 FCEV

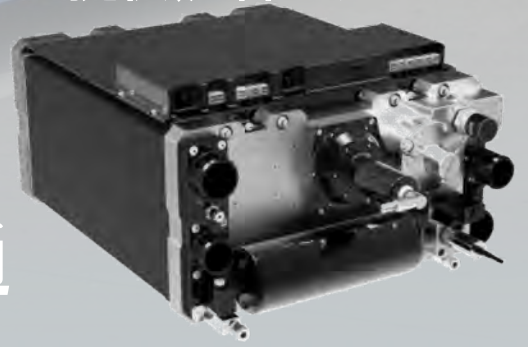
      中国：约有15个加氢站，1500辆氢燃料电池汽车
    - Japan: approx. 120 stations with 2000 FCEV

      日本：约有120个加氢站，2000辆氢燃料电池汽车
- Fueling Stations are approx. $500k to 3 million USD per station
  加氢站的建设成本大约是每个50万-300万美元
  Allows centralization with large excess power
  允许集中大量过剩电力

HYDROGEN URBAN TRANSITBUSES
城市氢能源公交车

Fuel cell provider for Yutong and Foton, China's Largest Bus Manufacturers 是中国最大的客车制造商宇通和福田的燃料电池供应商

Hydrogenics fuel cells in worlds Largest bus fleet of 75 buses in Zhangjiakou since May 2018 operations began 为全球氢能源公交车数量最多的城市张家口提供燃料电池



Zero-Emission Public Transit零排放公共交通

Urban Transit Buses 城市公交车


Cardiff, Wales 威尔士加的夫


Winnipeg, Canada & Scottsdale, AZ
加拿大温尼伯和亚利桑那州斯科茨代尔


Aachen, Germany 德国亚琛


Barth, Germany德国巴特


Munich, Germany德国慕尼黑


Volcano National Park, Hawaii 夏威夷火山国家公园


San Francisco, USA美国旧金山


SinoHytec, China
亿华通，中国


Blue-G, ChinaBlue-G，中国

Perugia IT 意大利佩鲁贾

Los Angeles, CA 美国洛杉矶


Coming soon to Palm Springs, USA
即将来到美国棕榈泉


London, UK
英国伦敦


SinoHytec, China
亿华通，中国

FCEV Fleet Projects for Bus and Trucks : USA
燃料电池公交和货车车队项目：美国

CEC and DOE Heavy Duty Fuel Cell Vehicle Projects, California
加利福尼亚州能源委员会能源部重型燃料电池汽车项目

- New Flyer fuel cell bus
- Hydrogenics' Celerity bundled with Siemens ELFA drive

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California References
加州案例

- Various projects at the ports including heavy duty references
- Class 6 and Class 8 trucks projects

CEC and DOE Heavy Duty Fuel Cell Vehicle Projects, California
加利福尼亚州能源委员会能源部重型燃料电池汽车项目

- Freightliner fuel cell truck
- Hydrogenics' Celerity bundled with Siemens ELFA drive

DOE, United Parcel Service Project, California
美国能源部加州联合包裹服务项目

- 17 UPS fuel cell delivery vans powered by Hydrogenics
- BEV + FC Range extender configuration

China FC Buses 中国燃料电池公交

Leadership In China
在中国的领导力

- Hydrogenics leading all FC suppliers with over 130 confirmed buses running and approved in Chinese government our leading HD30 platform in OEM's Foton and Yutong

FOTON

Bus Fleets
公交车队

- Bus fleets currently running using partnership with SinoHytec in Beijing in Zhangjikou
- **Currently 75 buses running in one fleet, largest globally**

SinoHytec, China
中国亿华通

- Cooperation with SinoHytec with hundreds of HD30 delivered
- Systems co-development and supply of FC power systems

亿华通 SinoHytec

Blue-G New Energy Science and Technology Corporation, China
中国Blue-G新能源科技有限公司

- Contract for 1000 units Fuel Cell Bus Power Modules and License agreement
- Delivery over next 2-3 years

Blue-G 北京蓝吉新能源科技有限公司 Blue-G New Energy Sci & Tech. Corp

沂星电动汽车 YIXING ELECTRIC AUTO

Rail, Truck and Plane Projects – Europe 欧洲铁路、货车和飞机项目

Alstom, Germany
德国阿尔斯通
- World's first commercial contract for hydrogen fuel cell trains
- 10-year agreement, contract value > €50M

E-Trucks Europe
欧洲电动货车
- Integrating garbage trucks with HyPM™HD30s
- Three different DAF platform truck variants

trucks europe

ASKO, Trondheim
ASKO，特隆赫姆
- Norway's largest grocery wholesaler
- 4 Trucks of 27 tons
- Supplying four (4) complete 90kW fuel cell power systems
- Including H2 storage, power electronics and controls

DLR German Aerospace
德国航天航空中心
- Project GO4H2
- 11 HyPM™ HD10 units delivered for next aircraft project

DLR H nip Nationales Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie

Alstom: Zero-Emission Regional Trains 阿尔斯通：零排放的区域火车

Primary energy from fuel cells 800k range

主要动能来自800kw的燃料电池

Intermediate storage from Li-ion batteries

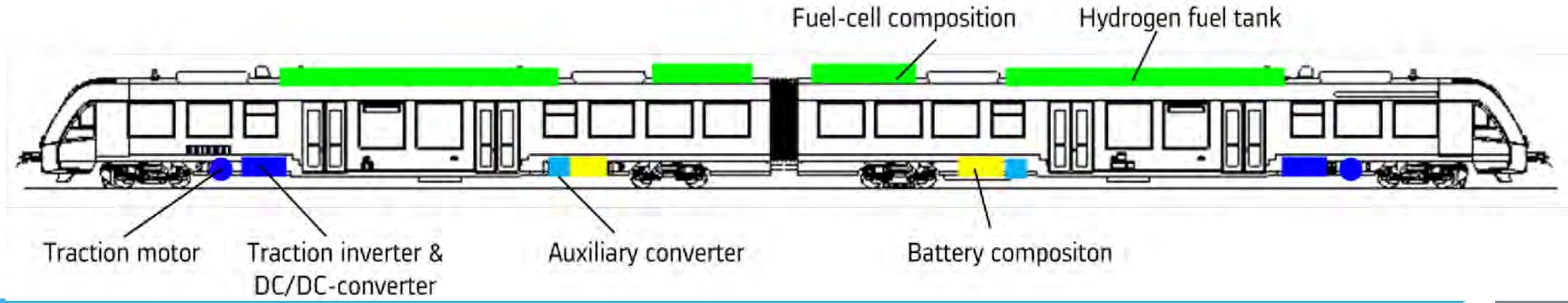
锂离子电池作为中间存储容器

For additional acceleration 用于额外加速

For recuperative breaking energy 用于能量中断的恢复

Combined drive and energy storage system

组合驱动和储能系统



Heavy Commercial & Municipal Fleets – Public Sanitation Vehicles
重型商业和市政车队 - 公共卫生车辆

HyMUVE	
Location	Basel, CH
Vehicle	Bucher-Schoerling City-Cat
Fuel Cell	2 Projects: (1) HD16, (1) HD20
Project	HyMUVE
Integrator	EMPA

Rotopress APU	
Location	Berlin, Germany
Vehicle	FAUN / Mercedes-Benz
Fuel Cell	HD16 G1
Project	BSR / Rotopress APU
Integrator	Heliocentris

FC Garbage Truck	
Location	Kanagawa, Japan
Vehicle	Flatfield
Fuel Cell	(1) HD30
Project	FC Garbage Truck
Integrator	Flatfield

LIFE´nGrabHy	
Location	Eindhoven NL, Veldhoven BE
Vehicle	(2) DAF
Fuel Cell	HD30
Project	EC Life’nGrabHy
Integrator	E-Trucks

Groeningen	
Location	Groeningen, NL
Vehicle	DAF
Fuel Cell	HD30
Project	Groeningen
Integrator	E-Trucks

Heavy Commercial & Municipal Fleets – Freight Trucks
重型商业和市政车队 - 货运卡车





NAC FC APU	
Location	Palm Springs California, USA
Vehicle	Peterbuilt Class 8
Fuel Cell	(2) HD12
Project	DOD FC APU
Integrator	Hydrogenics, SWI

LINDE TRAILH2	
Location	Germany
Vehicle	Mercedes-Benz
Fuel Cell	HD12
Project	LH2 HRS FC APU
Integrator	Hydrogenics, Linde Gas

LA/LONG BEACH PORT TRUCKS	
Location	Los Angeles, California, USA
Vehicle	Class 8
Fuel Cell	(2) HD16
Project	TTSA, Port of LA and Long Beach
Integrator	Vision Industries

LA/LONG BEACH PORT TRUCKS	
Location	Los Angeles, California, USA
Vehicle	Freightliner
Fuel Cell	HD30
Project	TTSA, Port of LA and Long Beach
Integrator	Hydrogenics, Siemens

ASKO/SCANIA TRUCKS	
Location	Trondheim, Norway
Vehicle	(4) SCANIA 27-ton
Fuel Cell	90 kW
Project	ASKO
Integrator	H2: Hydrogenics FC: Hydrogenics BEV: SCANIA

Next Generation Heavy Duty 下一代重型交通

- Hydrogenics has announced the Worlds First Passenger Hydrogen powered plane with Alakai called Skai　氢能公司宣布和Alakai公司共同推出世界首款氢动力乘用飞机Skai

- Alaka'i Technologies, this week unveiled a liquid-hydrogen-powered, five-passenger electric aircraft will be more efficient and powerful than the battery-powered aircraft　本周，Alaka'i Technologies公司推出了一款液氢动力五座电动飞机，该飞机将比电池动力飞机更高效和强大

- Led by veterans of NASA, Raytheon, Airbus, Boeing, and the Department of Defense, unveiled a mock-up of the six-rotor aircraft, called Skai, in Los Angeles at the offices of BMW Designworks 在美国国家航空航天局、雷神公司、空中客车公司、波音公司和国防部的专家带领下，在洛杉矶宝马集团创意咨询公司办公室推出了一款名为Skai的六旋翼飞机

- Able to fly for up to four hours and cover 400 miles on a single load of fuel, which can be replenished in 10 minutes at a hydrogen fueling station. 可在加氢站10分钟内完成补给，一次加氢后能够飞行长达四个小时，飞行距离400英里。

HYDROGEN FUELING
加氢站

Nyagan, Russia

Hydrogen Fueling Solutions 氢能解决方案

Hydrogenics has supplied zero-emission solutions to over 60 fueling stations –Hydrogenics
氢能公司为60多个加氢站提供零排放解决方案 –氢能公司

Production capabilities from 20kg to over 1,000 kg per day
加氢能力从每天20千克至超过1,000千克不等

350 and 700 bar stations 35兆帕和70兆帕加氢站

Fully interconnected systems for easy installations 完全互连的系统，易于安装

Designed for clean, onsite hydrogen production or delivered hydrogen 专为清洁地现场制氢或输送氢气而设计

Built to the highest safety standards 按照最高安全标准制造

Zero-emission fueling for clean mobility solutions
零排放加氢—清洁出行解决方案

350bar Fueling Station Setup 35兆帕加氢站的设置

Module 1: Electrolyser
(21,32, 65, 97 or 130kg/day)
第1块：电解槽
（21,32,65,97或130千克/天）

Module 2: Compression (cooling), (storage) and Storage management system
第2块：压缩（冷却）、（存储）和存储管理系统

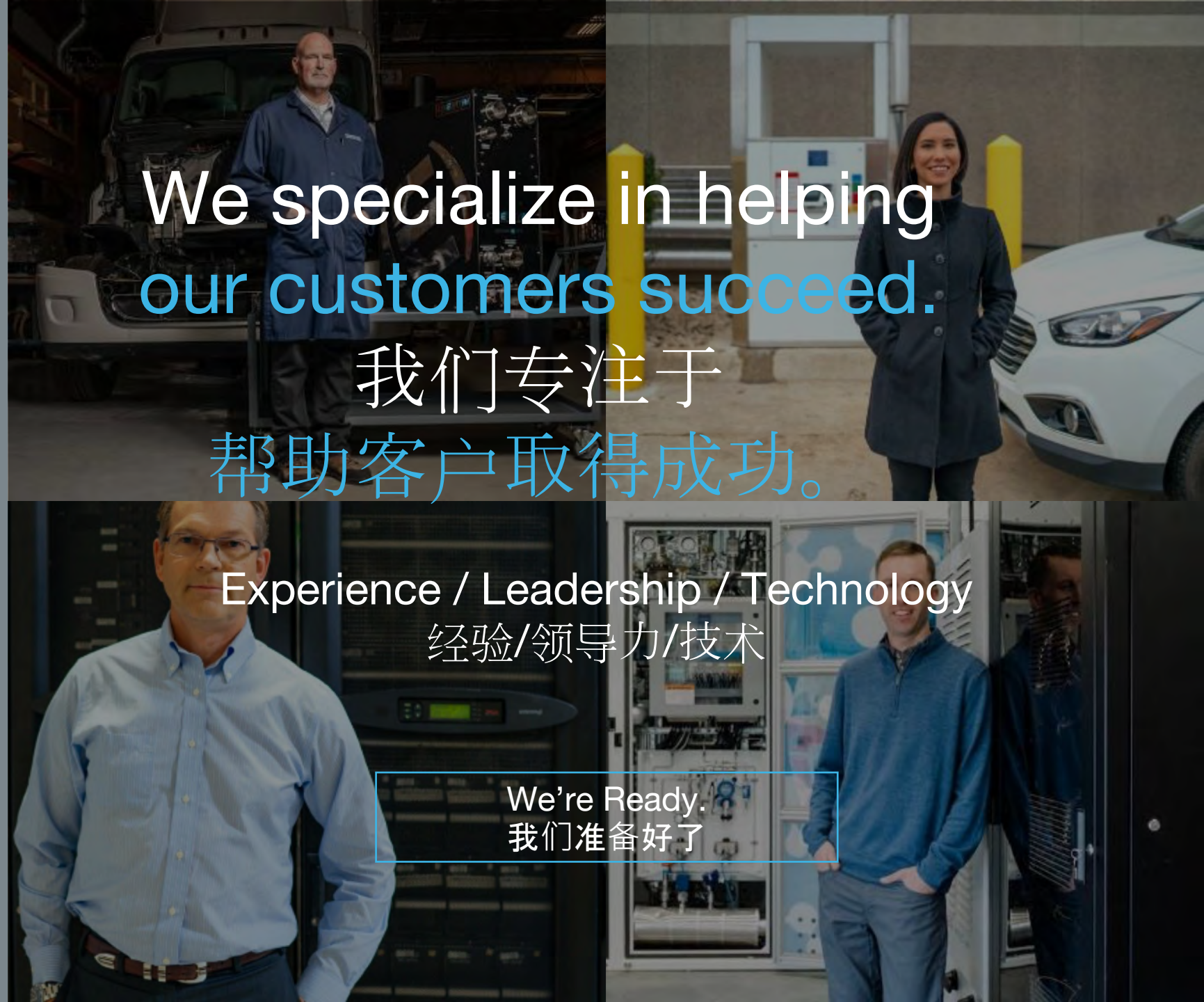
350 bar Dispenser
35兆帕分配器

- Hydrogen quality: **Fuel Cell Grade (99,998%)**
- Fill type: **According to SAEJ 2601 requirements**
- Consumption: **65 kWh/kg H2 produced**
- **Fully interconnected and centrally controlled**

The human factor

HYDROGENICS

SHIFT **POWER** | **ENERGIZE** YOUR WORLD



We specialize in helping our customers succeed.

我们专注于帮助客户取得成功。

Experience / Leadership / Technology

经验/领导力/技术

We're Ready.

我们准备好了