

Hydrogen as a Fuel

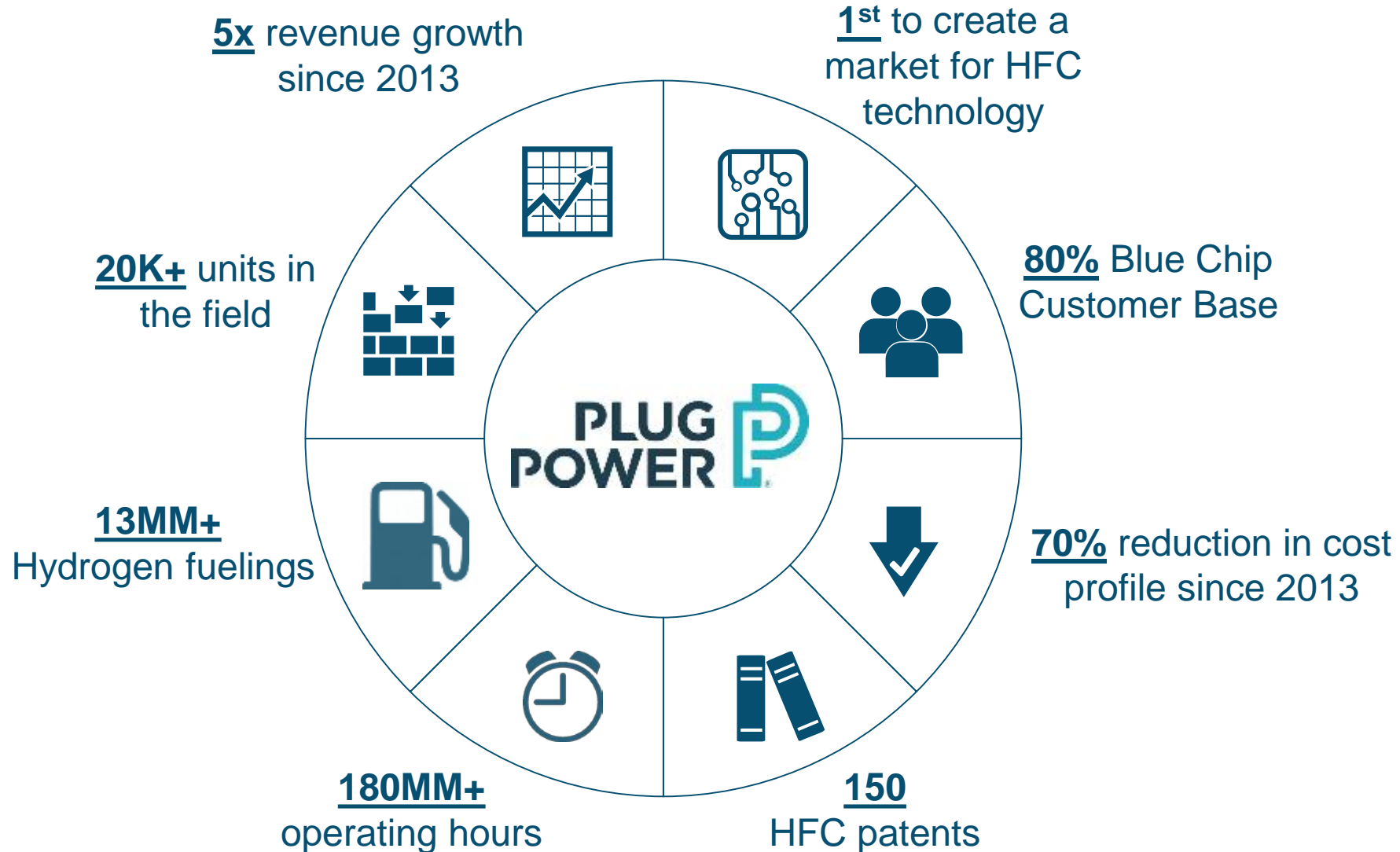
John A. Cococcia
Business Development

August 1, 2018

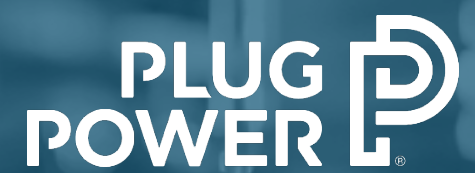


**Changing the way the world moves by developing
industry-leading hydrogen fuel cell energy solutions
for high growth markets around the globe**

Plug Power is the Leader in Hydrogen and Fuel Cell Technology



Full Product Suite Accelerates Customer Adoption



GENKEY

Complete Turnkey Solution

Fuel Cell Technology

Fuel Cell Stacks and Systems

PROGEN

High-power and air-cooled designs
Lower cost / higher performance
35+ years of Plug Power IP



Fuel Cells for Stationary Applications

GENSURE

10,000+ units in the field worldwide
High reliability with 99.6% uptime
Environmentally hardened from -20F to 120F



Hybrid Fuel Cell Solutions for Forklifts

GENDRIVE

20,000+ units in the field
Drop-in replacement
180MM+ operating hours



Fueling Infrastructure and Delivery

GENFUEL

60+ installed sites
300+ hydrogen dispensers
15K+ fuelings / day, 13MM+ total



Complete Service and Maintenance

GENCARE

98+% uptime performance
IoT data collection, monitoring and control
driving efficiency and uptime



Key Value Proposition Elements

-  Maximize work time with Fast Fills
-  Re-purpose and Improve labor deployment
-  Increased Productivity by maximizing picks per hour
-  Re-purpose battery room into productive space
-  Electrical Grid Independence
-  Eliminate toxic and hazardous material
-  Zero tailpipe emissions

Product suite for Class 1 / 2 / 3 =
Complete DC conversion



Plug Power holds more than 90% of the hydrogen battery fuel cell market
in the material handling industry.

Operator Labor: 77%

Vehicle Cost: 11%

Maintenance Labor: 5%

Insurance: 3%

Parts: 3%

**Energy:
1%**



According to accumulated field data presented at MODEX2014* the cost to operate a class 1, 2, or 3 MHV is dominated by **these TWO factors.**

By switching to **hydrogen**, a small change in energy costs pays **huge vehicle and labor dividends.**

Loyal "Blue Chip" Customers Globally

Walmart 


Carrefour

Good things
come from
Sysco

amazon 

colruyt 

P&G

THE
HOME
DEPOT




ASKO

LOWE'S

ACE
Hardware

Wegmans

IKEA



HONDA

Coca-Cola

FM > LOGISTIC

Kroger

gsf
golden state foods

Why We Entered Material Handling



Fuel Cells will Enable the Key Trends in the Motive Industry

Each trend is driven by the value customers place on time, reliability, convenience, predictability, and cost savings



Fuel Cell Vehicles are Electric Vehicles with Significant Enabling Traits

Adaptability

- Wide span of addressable power ranges (50W to >30 kW)
- Performance and cost optimization through hybrid design
- **Enables** a variety of use cases including delivery trucks/vans, busses, cars, industrial vehicles, robots, drones, etc.

High Energy Density

- Energy scales with hydrogen storage
- **Enables** longer range, heavier payloads, increased hotel loads (sensors, communications, active devices)

Fast Refueling

- Quick turn-around of high-value assets
- **Enables** 24/7 operations to address ever-increasing consumer demand

Scalable Infrastructure

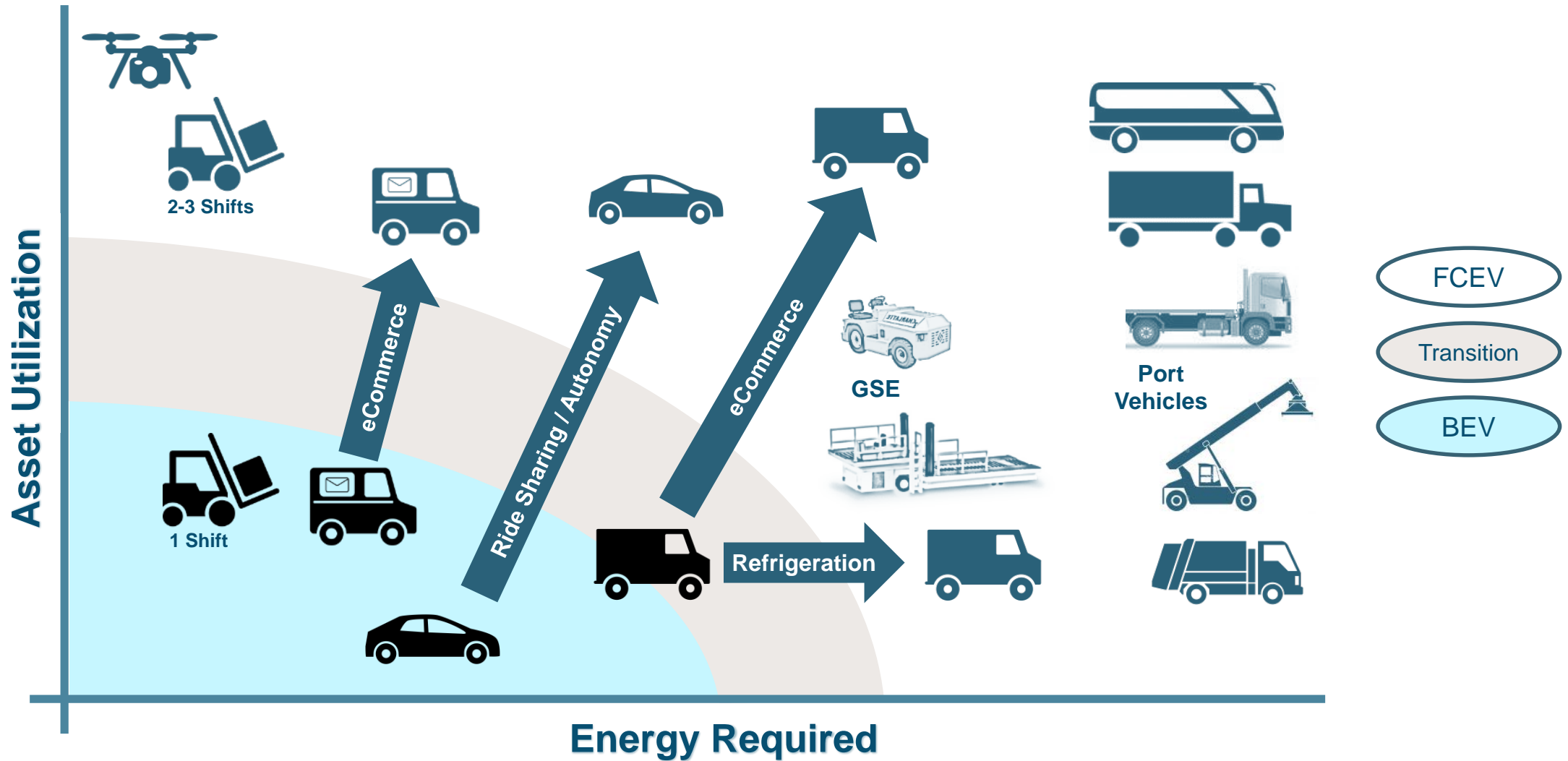
- Scales with increased fleet size and energy needs
- **Enables** rapid deployment and scaling of EV platforms

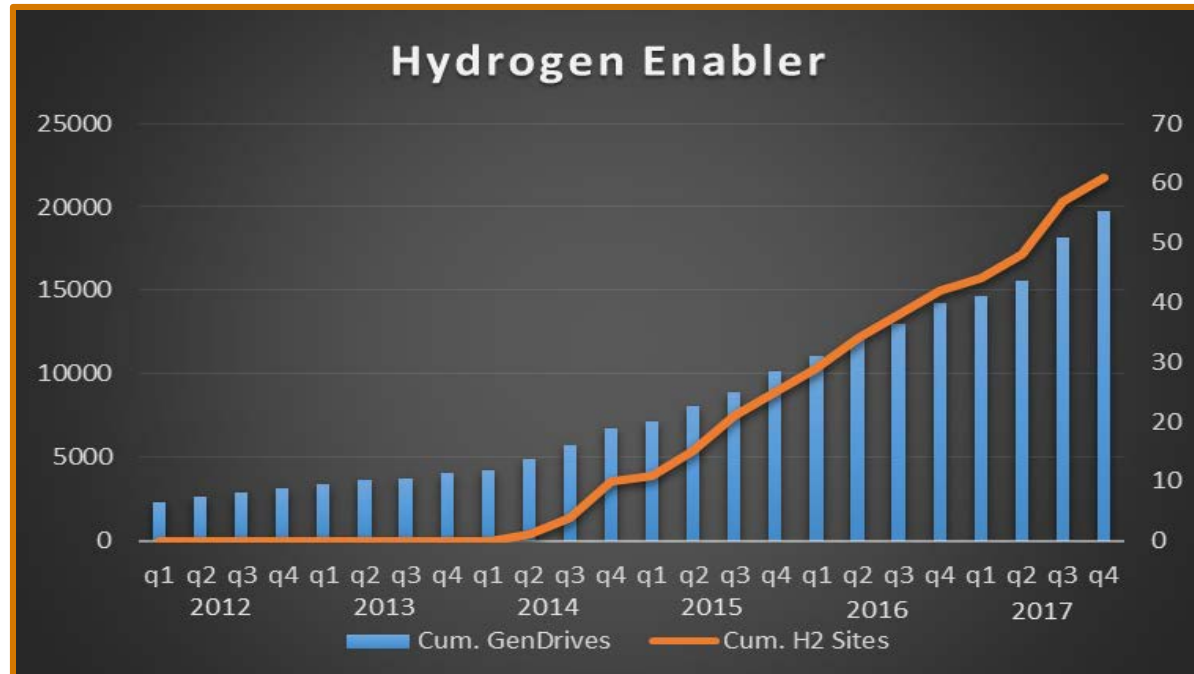
Renewable Fuel Options

- Available today; scaling rapidly with expansion of renewable power and advancements in hydrogen conversion technologies
- **Enables** truly flexible and renewable fuel options for transportation

Fuel Cells Hasten Changing Market Dynamics

Heavy use cases, heavy loads and long ranges are enabled by fuel cell technology.

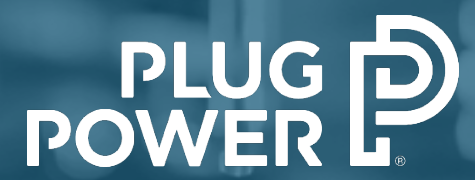




Hydrogen fueling system deployment: **driven growth of fuel cells** within material handling market

Today, Plug Power has **dispensed more hydrogen** into fuel cells than anyone!

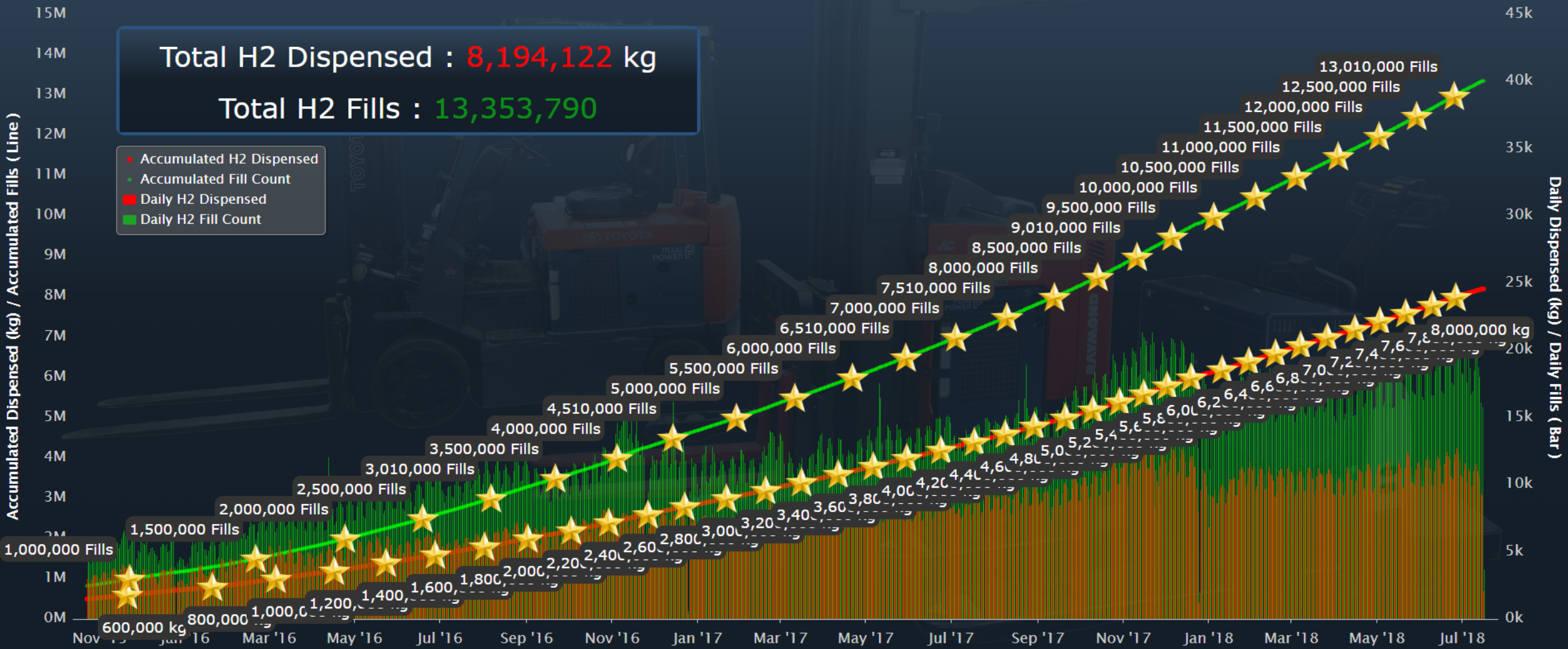
Proven H2 Supply: GenFuel



Total Fleet Hydrogen Dispensed and Fill Count

Total H2 Dispensed : 8,194,122 kg
 Total H2 Fills : 13,353,790

- Accumulated H2 Dispensed
- Accumulated Fill Count
- Daily H2 Dispensed
- Daily H2 Fill Count



- North America is unique in the world with the amount of liquid hydrogen infrastructure:
 - Direct result of the space program
 - All >>20 years old
 - Stressed a model of large central generation and widely distributed customers
 - Capacity being strained due to addition of Plug Power customers and consumer sites in CA
 - First new capacity coming on this year (UHG (TN), Air Liquide/AirGas (KY))
- Other geographies have not made the investment in liquid, generally resulting in higher delivered molecule prices
- Fueling applications (350/700 bar) have added challenges and complexity to the supply chain – capacity, cost, reliability, etc.
- “Green” demands increasing (even outside of CA)

- Fuel is where the growth in the hydrogen market is centered
- Traditional commercial/industrial users **had** to use hydrogen, so molecule costs were less of a focus
- In many cases, fuel applications are driven by pricing, as they are compared to alternates (electricity, gasoline, natural gas, etc.)
- Hurdles as we transition to hydrogen as a fuel include:

- **Capital risk:** Other fueling infrastructure has been built and paid for, but for hydrogen, who pays for the new infrastructure? Who is willing to finance it? Who is willing to take the risk of uncertainties of H2 as a fuel, future technology advances, unknown demand, high fixed costs, etc.?
- **Compression and Storage:** Fuel users need to keep or convert the molecule to high pressures (350 or 700 bar) for storage or use in their applications.
- **CapEx:** As a result, fuel users need to add expensive equipment to convert and manage the gas at high pressures.
- **Efficiency:** The added equipment, in many cases, causes additional handling/conversion losses, reducing system efficiencies and increasing costs.
- **Green:** Users increasingly are looking to new energy carriers to be sustainable, minimizing their impact on the environment.
- **Safety Impressions:** Users and the general public continue to have concerns about safety.
- **Cost Impressions:** Adoption of EV platforms incorrectly drives comparison to grid electricity costs.

Molecule Cost

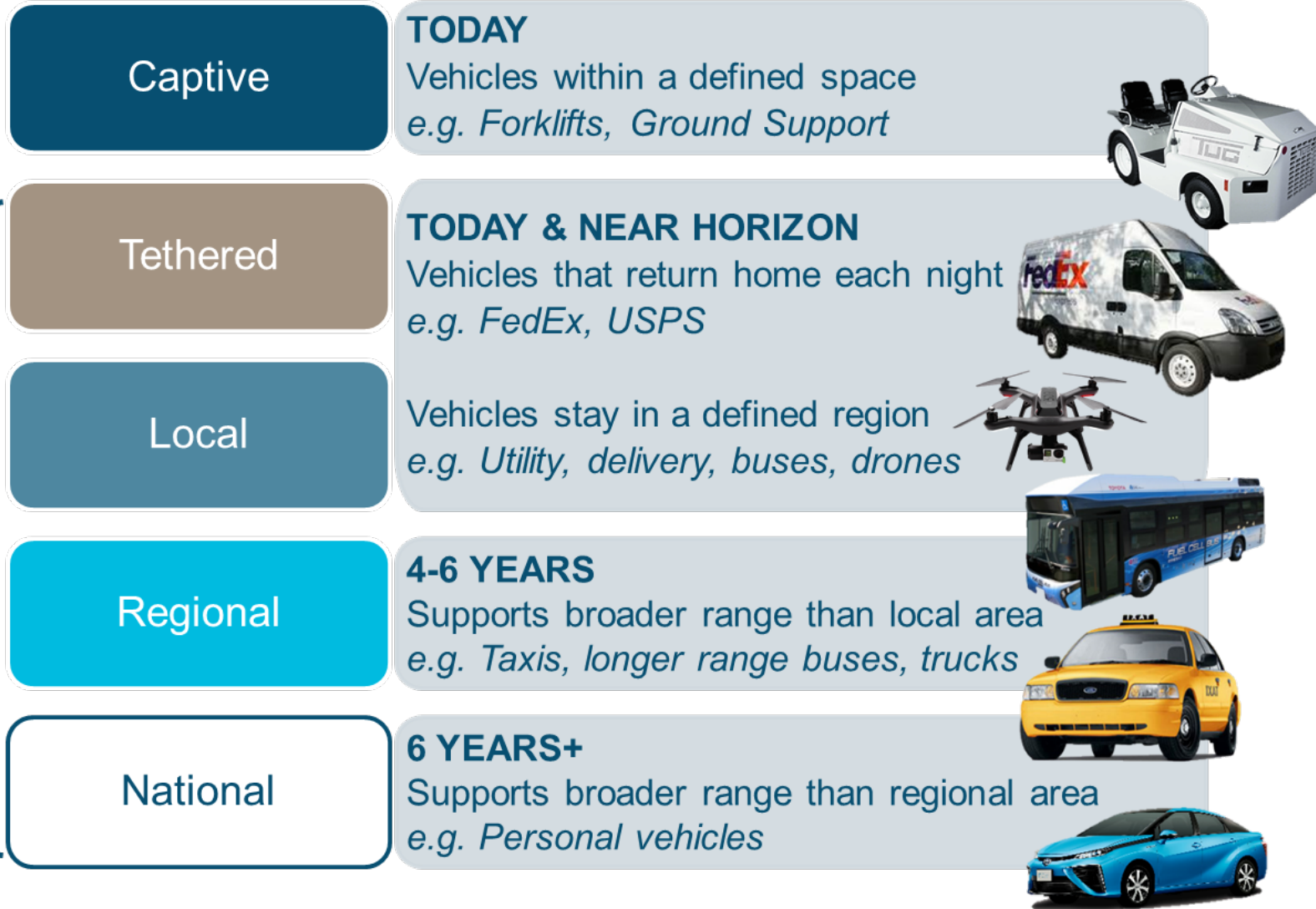
Capital Cost

Capital Risk/
Allocation

Pace of
Adoption

Hydrogen is the Enabler of the Sustained Growth of Fuel Cell Applications

Leveraging existing technology to
Increase range & power



Future hydrogen systems need to be:

- Reliable
- Proven
- Lower Cost (Molecule and CapEx)
- Increasingly Green





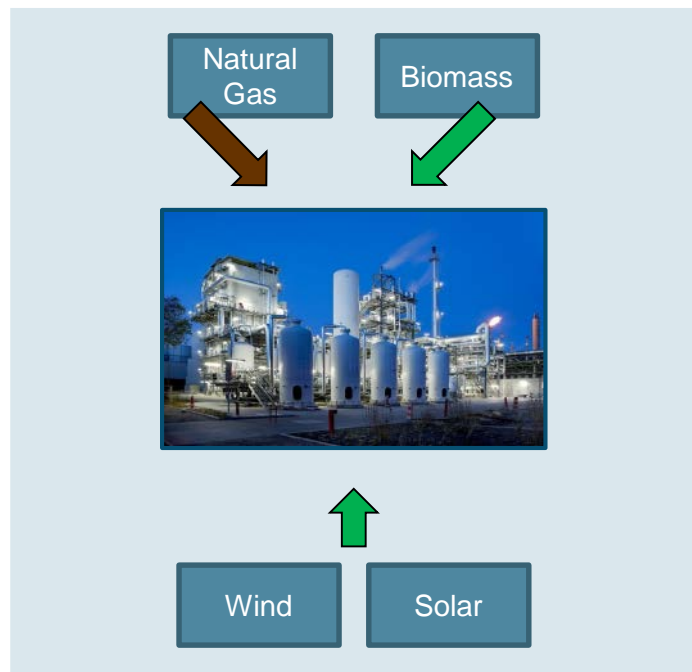
TODAY



H2 as an Industrial Gas

- IGCs do not think of H2 as a fuel
- Pass through cost to customers
- Option on future advances

2-4 YEARS



Distributed Generation

- Technology and demand advances H2 as a fuel
- Local and regional deployments and business models will further drive adoption
- Consumer adoption further accelerates cost/performance curve

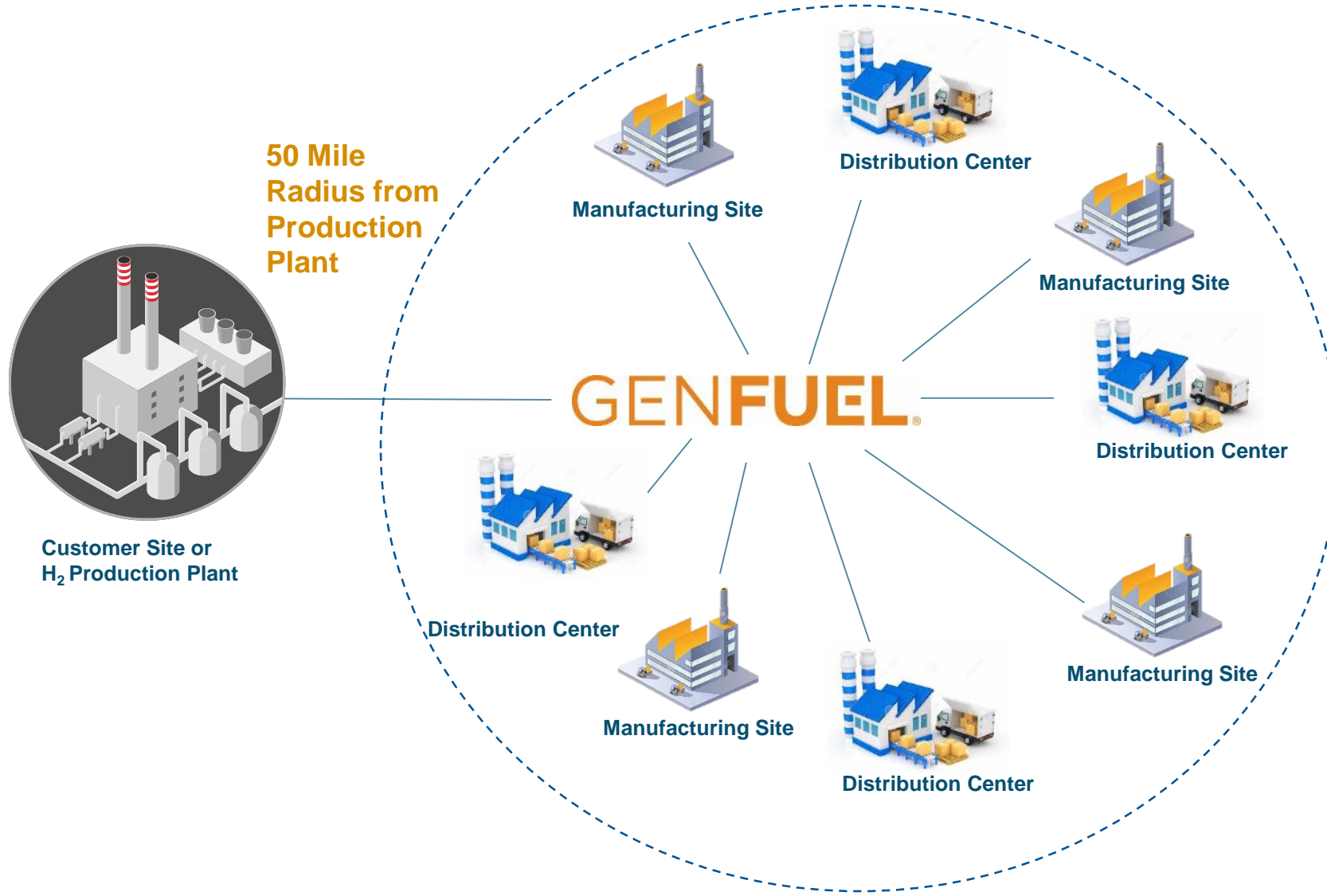
6-10+ YEARS



H2 as a Renewable Fuel

- Leverage low-cost renewable energy
- Additional benefit stranded power opportunities
- Accelerated tech advancement reduces costs and enhances value

Addressable Market Expansion Leveraging GenFuel H2 Infrastructure



Example Assets: Hub & Spoke Delivery



2018

Utilize Existing Liquid Assets/Customer Sites



Complete Sys.
Design



Procure Sys.
Materials



Setup Dist.
Network



2019

Utilize Centralized 1000 -1500 kg/day reformer



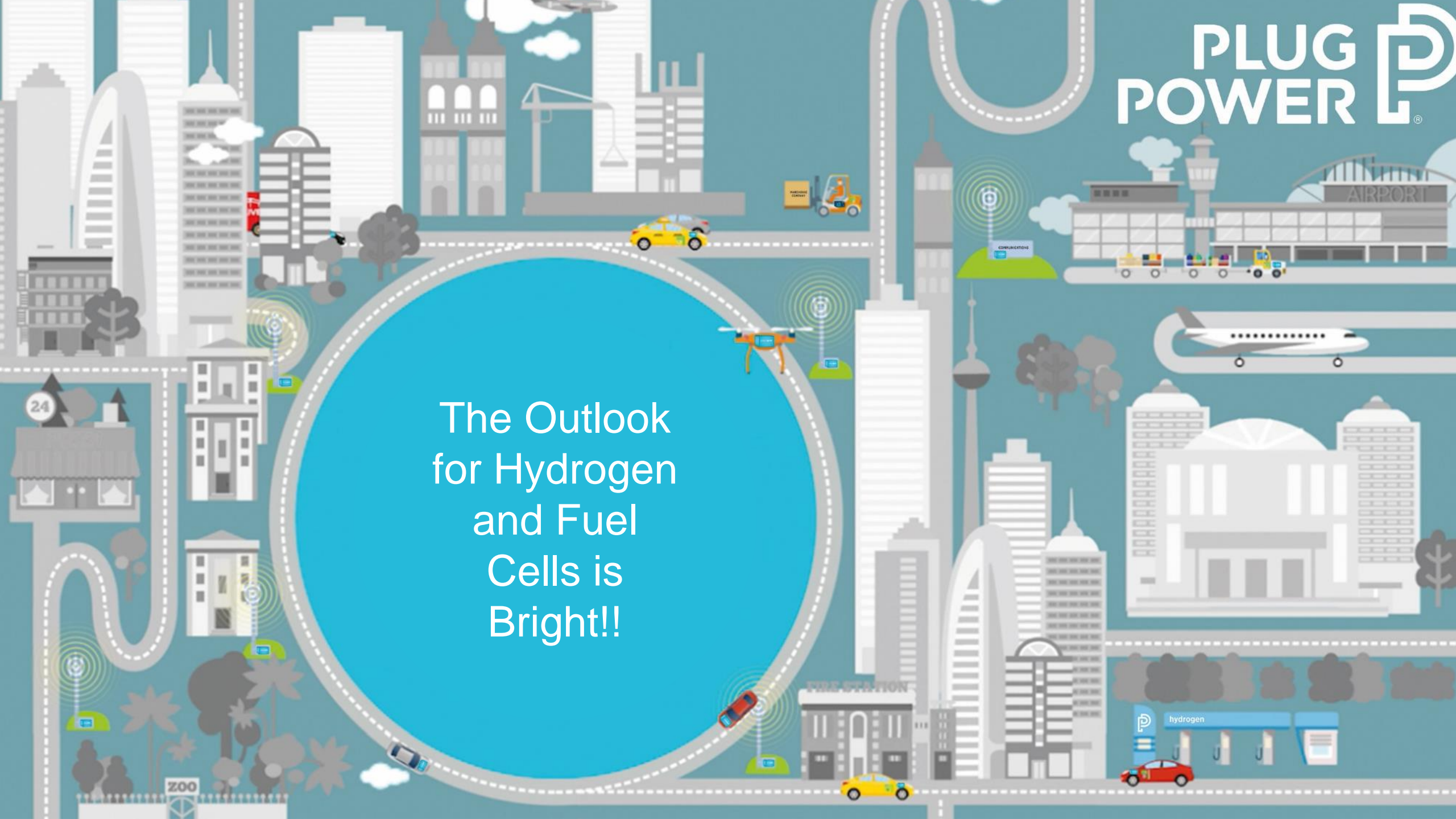
Deploy Central
Generation



Expand Dist.
Model

Low-cost fuel system infrastructure increases addressable market

The Outlook
for Hydrogen
and Fuel
Cells is
Bright!!





Corporate Headquarters

968 Albany Shaker Road, Latham, NY 12110

West Coast

15913 E. Euclid Avenue, Spokane, WA 99216

plugpower.com