

# Opportunities & Barriers: Port H<sub>2</sub> Infrastructure

*CHBC Ports & Shipping Workshop*

*Banning Landing (POLA/POLB)*

October 2018

Dwight Zuck: Air Liquide H<sub>2</sub> Energy  
Business Development Western U.S.

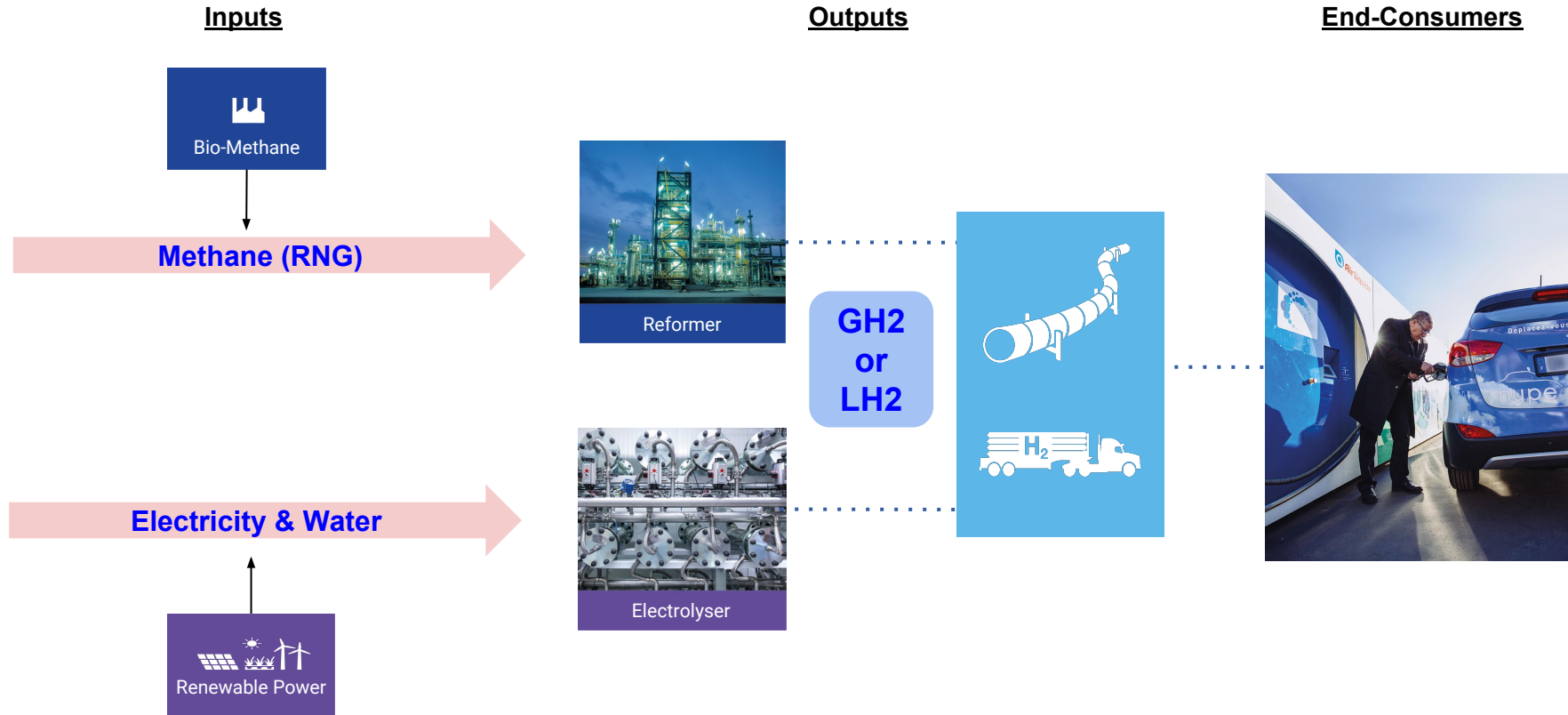


## H2 Energy Barriers/Opportunities in Ports/Shipping

*Moderator: Dwight Zuck, H2 Energy Business Development – Air Liquide*

**Objective:** Review several methods that hydrogen can be provided to the Ports for refueling multiple -- existing real-world industrial operations/projects -- with a discussion on the various limitations (“*barriers*”) that can be -- and are -- being solved (“*opportunities*”).

# Hydrogen Production - An Overview



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# Air Liquide Group Overview

- Present in >80 countries
- ~67,000 employees
- Serve >3MM customers & patients WW
- Revenue: \$19B w/ net profit of \$1.9B (2016)  
*(40% of Revenue linked to Protecting Life & the Environment)*



- 433 Production Facilities WW  
*(ASUs, SMRs, Cogeneration)*
- IG Pipeline networks traversing >6,000 miles
- 12K Trucks (Delivery & Service)
- 24MM cylinders
- \$336MM dedicated to Innovation ('16)  
*(~60% to Protect Life & Environment)*

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# H2 Energy at Air Liquide Worldwide



**Mobility  
for Professionals**  
US+EUROPE  
9 HRS



**Mobility  
for Consumers**  
US North-East  
12 HRS  
+ Supply chain



**Mobility  
for Consumers**  
California  
4 HRS



**Mobility  
for Consumers**  
Japan  
6 HRS



**Mobility  
for Consumers**  
Dubai HRS  
1 HRS



**Mobility  
for Consumers**  
Korea  
1 HRS



**Power to Gas**  
Denmark  
5 HRS  
+ 1 Electrolyzer



**Mobility  
for Consumers**  
Germany  
12 HRS



**Mobility  
for Consumers**  
Paris, Brussels  
& Rotterdam  
5 HRS

3, 500 mTPD H<sub>2</sub> Production  
1,150 miles H<sub>2</sub> Pipelines  
46 large H<sub>2</sub>/CO plants  
40 Electrolyzers  
\$2.3B in sales

100+ Hydrogen refueling  
stations (HRS) installed  
by Air Liquide WW  
w/ 40 directly invested  
and operated  
by Air Liquide

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# H2 Energy in California



## Anaheim H<sub>2</sub> Refueling Station “HRS”

- > Milestones
  - 10,000 fills March 2018
  - Single Day Fills
    - > 275 Kg Dispensed
    - > 92 FCEVs



## Port of Long Beach

- Project Portal (2017)
- > In partnership with Toyota
- > Designed for Toyota Class-8 FCETruck.
- > AL-built, operated & GH2 supplied

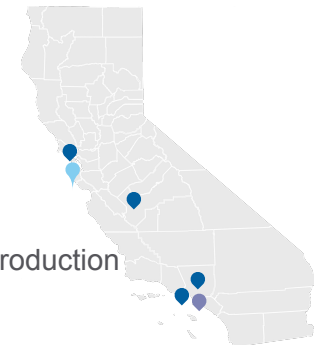


## Three other HRS

- > LAX (50 Kg/Day SMR)
- > Palo Alto
- > Santa Nella

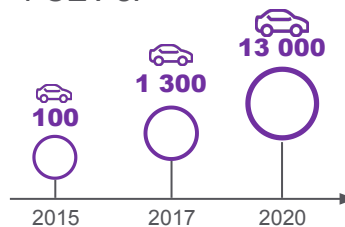
## Steam Methane Reformers (2)

- AL Built & Operated
- @ Petroleum Refiners
  - Sulfur Removal & Gasoline Production
  - El Segundo & Rodeo
- 15-20 Year Agreement Terms
- Large Scale
  - >100,000,000 SCF/Day
  - > 260 TPD
  - > 235,000 KG/Day
  - .... thats >~70,000 FCEVs//Day/SMR

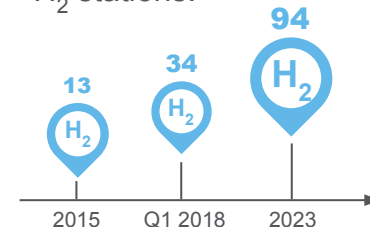


## Overall California FCEV & HRS Deployment

FCEV's:



H<sub>2</sub> stations:



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# H2 Energy Northeast US



New York



Connecticut



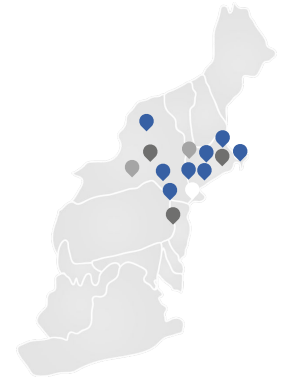
Massachusetts



New Jersey



Rhode Island



Network of 12 HRS

First openings in 2018

Start-up in 2018

Dedicated H2 supply chain by  Air Liquide  
creative oxygen

In collaboration with  TOYOTA

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# AL H2 Energy Infrastructure Products ...

## Permanent Hydrogen Refueling Stations



- “H70-T40” fills (700 bar, -40C)
- 9 US installations by EOY 2018
- Next Gen under development
- Proprietary design
- **H2 feed: GH2 storage, onsite SMR, onsite electrolysis**

## Movable Hydrogen Refueling Stations



- “H70-T40” fills (700 bar, -40C)
  - ◆ First ‘Movable’ in US
- **Rapid Deployment**
- **Paris** and coming US installation
- Air Liquide proprietary design
- **H2 feed: GH2 Tube Trailer**

## High Pressure Distribution ‘Pods’



- High pressure GH2 Distribution
  - ◆ **H2E: 450 bar**
  - ◆ (traditional ‘Industrial’: 165 bar)
- Increases GH2 Distribution Efficiencies & reduces delivery frequency
- Deployed in CA & NorthEast
- AL Proprietary Design

... others under Development!!!

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# H2 Energy ... Established Global Momentum

## Hydrogen Council

Home News Studies Resources Events Videos FAQ

**OUR GOAL: 100% DECARBONISED HYDROGEN FUEL IN TRANSPORT BY 2030**

GCA5 Press Release

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- Founded Davos Switzerland 2017
- By 14 Founding Global Firms
- As of Sept 2018:
  - 53(!) Leading Firms WW
  - Accounts for 3.8MM Jobs
  - €1.8 trillion in revenue across 11 different countries.
  - 33 Multi-Nationals

BOSCH 国家能源集团 CHN ENERGY DAIMLER GM

**GLOBAL HYDROGEN COALITION QUADRUPLES SIZE IN 18 MONTHS**

HONDA HYUNDAI Iwaki Kawasaki

KOGAS PLASTIC PARTS SINOPEC THE LINDE GROUP TOYOTA WEICHAI

## Hydrogen Council's 2050 Global Vision



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# Opportunities for *Perceived* H2 Barriers... in Ports & Shipping

## 1 Education ... Education ... Education !!!

Copious existing Tools & Resources Internet  
ie.; H2Tools (PNNL), NREL, DOE,  
Start Young All Ages

## 2 Ever-expanding Global Support Organizations

NGOs, National Labs, Multinationals, Hydrogen Council, CHBC, ...

## 3 Government Support ... Federal, State, Local ... even International!

## 4 R&D Investment for Sustained Innovations

## 5 Increased Collaboration (*per DOE's Pete Devlin*)

## 6 *How we communicate what we know (per Sandia's Jay Keller)*

## 7 *In the end, it's for our childrens' childrens', children ... start now! (per LOOP's Andreas Truckenbrodt).*

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*Remember:  
We are all “H2 Energy-zers” !!*

*So, without Further Ado ...*

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## ...your Esteemed, H2 Energy Port-Solutions Panel !!

- **Paul Fukumoto:** Director Business Development @ **FuelCell Energy, Inc.**
- **Jonathan Palacios-Avila:** CEO @ **Stratos Fuel**
- **Rob Del Core:** Managing Director @ **Hydrogenics USA**
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*Note: Clarifying Questions just after each presentation...*

*...concluded by Open Discussion at conclusion (depending on Del Core ;)*