

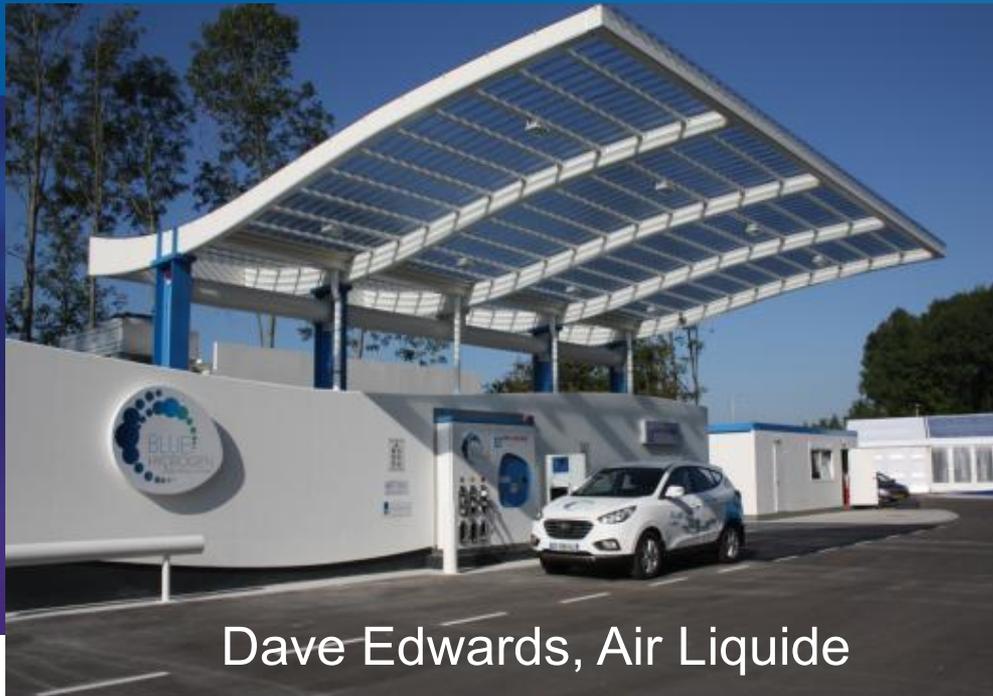


Hydrogen Infrastructure

Accelerating Electric Drives: The Next Generation of Hydrogen Fuel Cells

2016 Ohio Fuel Cell Symposium

September 27, 2016



Dave Edwards, Air Liquide





Who is Air Liquide?

Key figures



2015

More than
50,000
employees

Présent in
80
countries

Revenue
16.4
€ billion

More than
2 million
customers
and patients

Following the acquisition of Airgas *

More than
68,000
employees

Present in
80
countries

Revenue
>20
€ billion

More than
3 million
customers
and patients

* on May 23, 2016

Air Liquide - Hydrogen



Hydrogen: 40 years in industry

- \$2.5B Revenue (refinery and chemicals)
- 1850 km of pipelines
- 1000 trucks
- 18 Billion Nm³/year from 46 large plants (enough for 15M vehicle refills)
- 75 filling stations
- 300+ fuel cell installations



Large H₂ Plants and Pipelines



Air Liquide Hydrogen Mobility:

Light vehicle refueling

- GM/Shell demo stations- NY and CA
- Germany - H₂ mobility
- California - 4 stations in development
- NE Fueling network

Mass transit stations

- BC Transit - Whistler Station
- Oslo, Norway
- Birmingham, AL -Demo

Materials handling applications

- Walmart
- Coca Cola
- Procter & Gamble





Where are we going?

Air Liquide's 2020 Hydrogen Energy Strategy

Our ambition: leadership in H₂ Mobility



- Lead **activation of H₂ Energy Markets** in particular H₂ Mobility
- **Be Major Mobility player**
Maintain leadership across the full value chain from H₂ production to delivery at the pump

TECHNOLOGY

INVESTMENT

**CUSTOMER
EXPERIENCE**

Investment: Everything we do leads to CO₂- free H₂ mobility

**50% of H₂ energy
from carbon-free processes by 2020**

A commitment to meet
both **environmental requirements**
and **economic constraints**

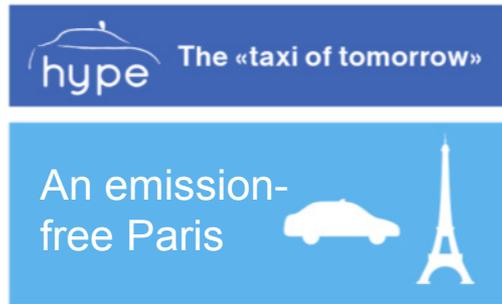
Achieving “Blue H₂”

1. Natural gas reforming + CCUS
2. Water electrolysis (renewable, nuclear)
3. Biomass gasification
4. Biogas reforming



Innovative business models to accompany new usages...

Captive fleets are catalysts for take-off



**Targeting
70 taxis**

by the end of 2016

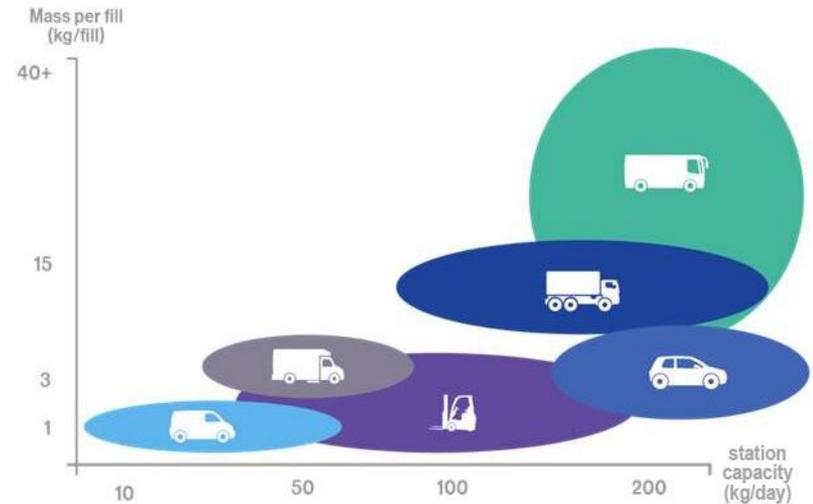
and 600

within 3 years

Speeding-up energy
transition for taxis



Captive fleet niches: buses, light commercial vehicles, taxis



Value is created by mutualising Hydrogen Stations infrastructure with private users



Where are we today?



H₂ mobility projects worldwide



Active Air Liquide Hydrogen Stations Globally – mobility applications

75

delivered
end 2015

Retail filling station projects underway

12

invested and operated
by Air Liquide in *2015*

26

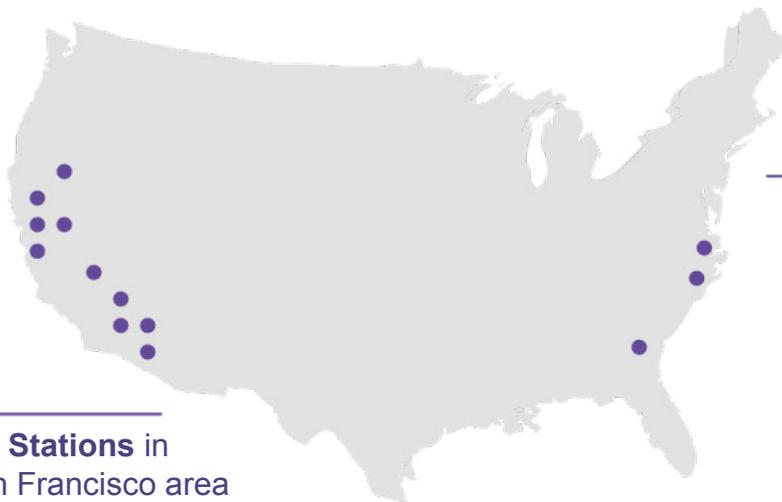
in *2016*

40

in *2017*



U.S. – California & ‘Zero Emission Vehicles’ States



4 Hydrogen Stations in
L.A. and San Francisco area
More under development, with
**active support from
California State**



Collaboration with  **TOYOTA**

12 Hydrogen Stations in
New York City, Boston, New
Jersey, Connecticut and
Rhode Island



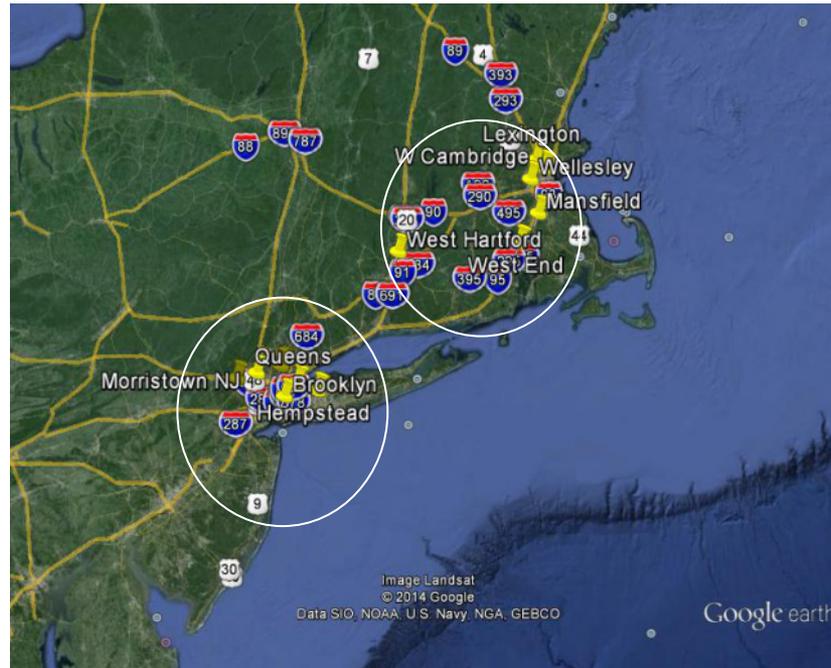
1st Hydrogen Station
start-up Q1 2017



**Dedicated H₂ supply
chain** implemented by Air
Liquide for Toyota's roll-out
of the Mirai



East Coast Planned Fueling network- Stations

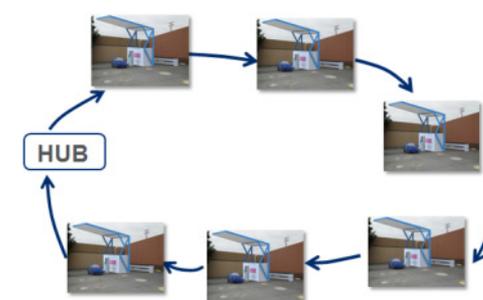
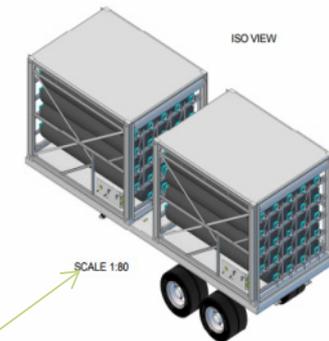
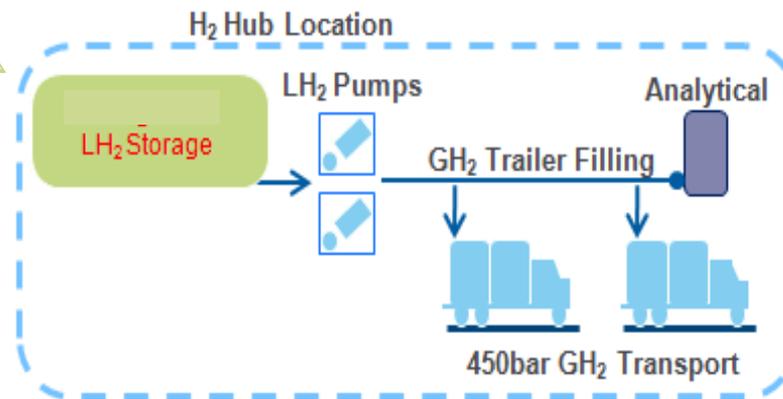


12 Stations for the North East

- NYC and Long Island- (4)
- Boston Area – (4)
- Connector Stations – (1) Hartford, CT & (1) Providence, RI
- Northern New Jersey- (2)

Distribution Model- Hub & Spoke

LH₂ Source



East Coast Planned Fueling network- Hubs



- 2 Hubs to supply the NYC and Boston clusters
 - Delivered liquid from Canada with (5) back-up sources
 - Capacity - 2,100 kg/d (each hub) or 4,200 kg/d total
 - Allows for flexible demand growth
 - Uses proven technology used in forklift applications
- Boston Hub
 - Lease signed, approved by planning, and construction permitting underway
 - Room for expansion
- NYC Hub
 - Using existing Air Liquide fill facility
 - Other sites being evaluated for planned expansion

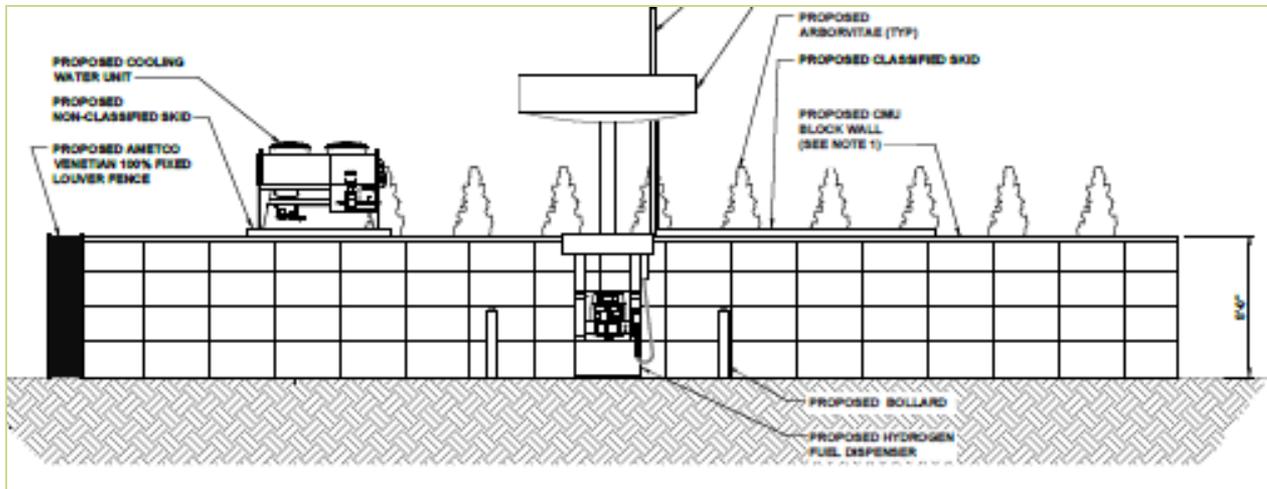
Current Station Schedule



2015					2016												2017											
Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



Concept for NE Stations





Station Example





Retrofit of an existing station



Design standards

- NFPA, CGA and local fire codes
- Use permits typically not necessary at existing stations
- SAE standards compliance



Station Example – Anaheim 19Mar16



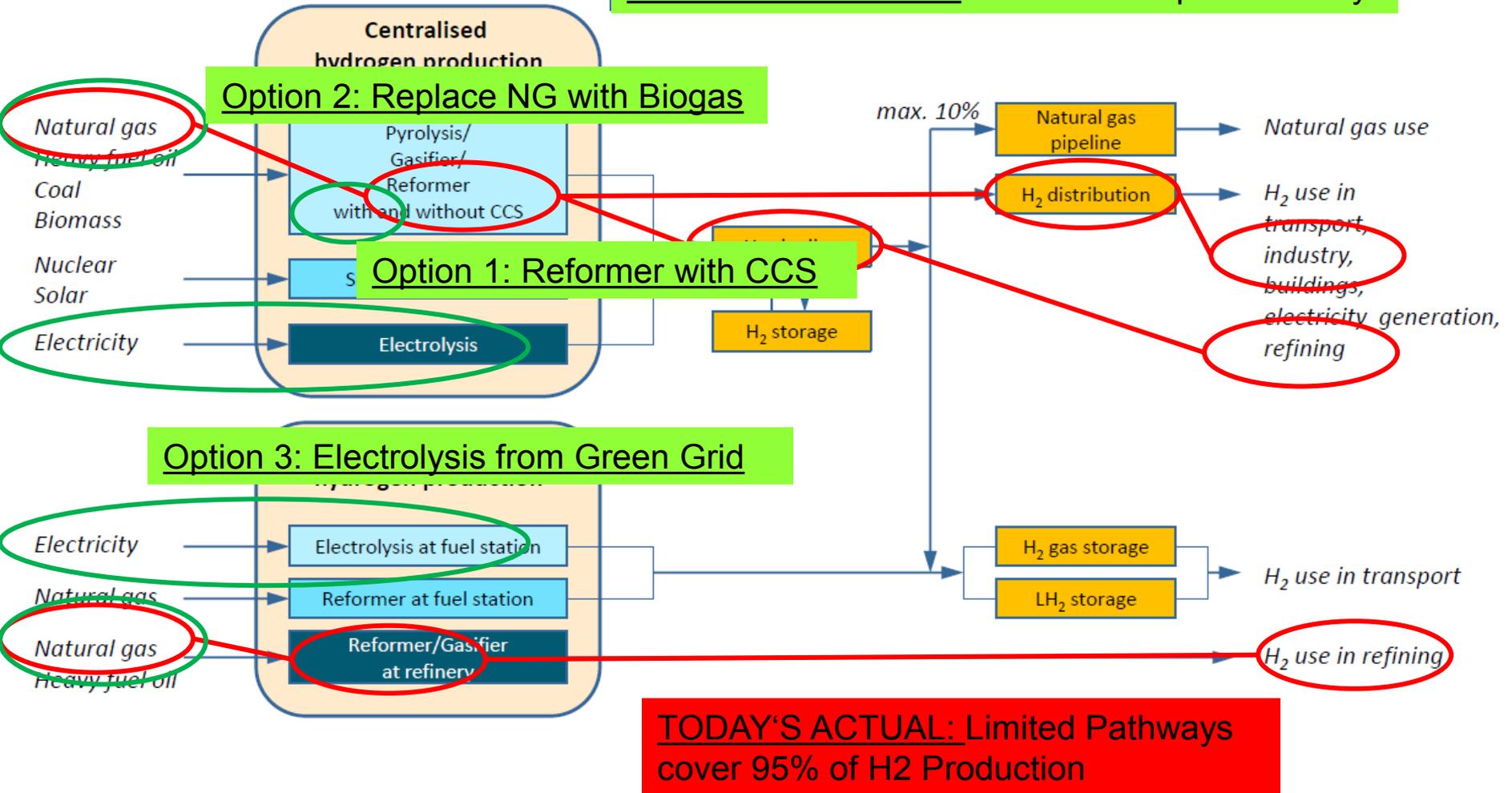


Hydrogen Production

Hydrogen Supply and Distribution



GREEN PATHWAYS: Most Viable Options Today



* IEA North American Hydrogen Workshop, 2012

Hydrogen Supply and Distribution



Large Scale Production

H₂ Source:

- Steam Methane Reforming
- Waste gas purification
- Electrolysis

Gaseous (200-450 bar)



Liquid



Onsite Production

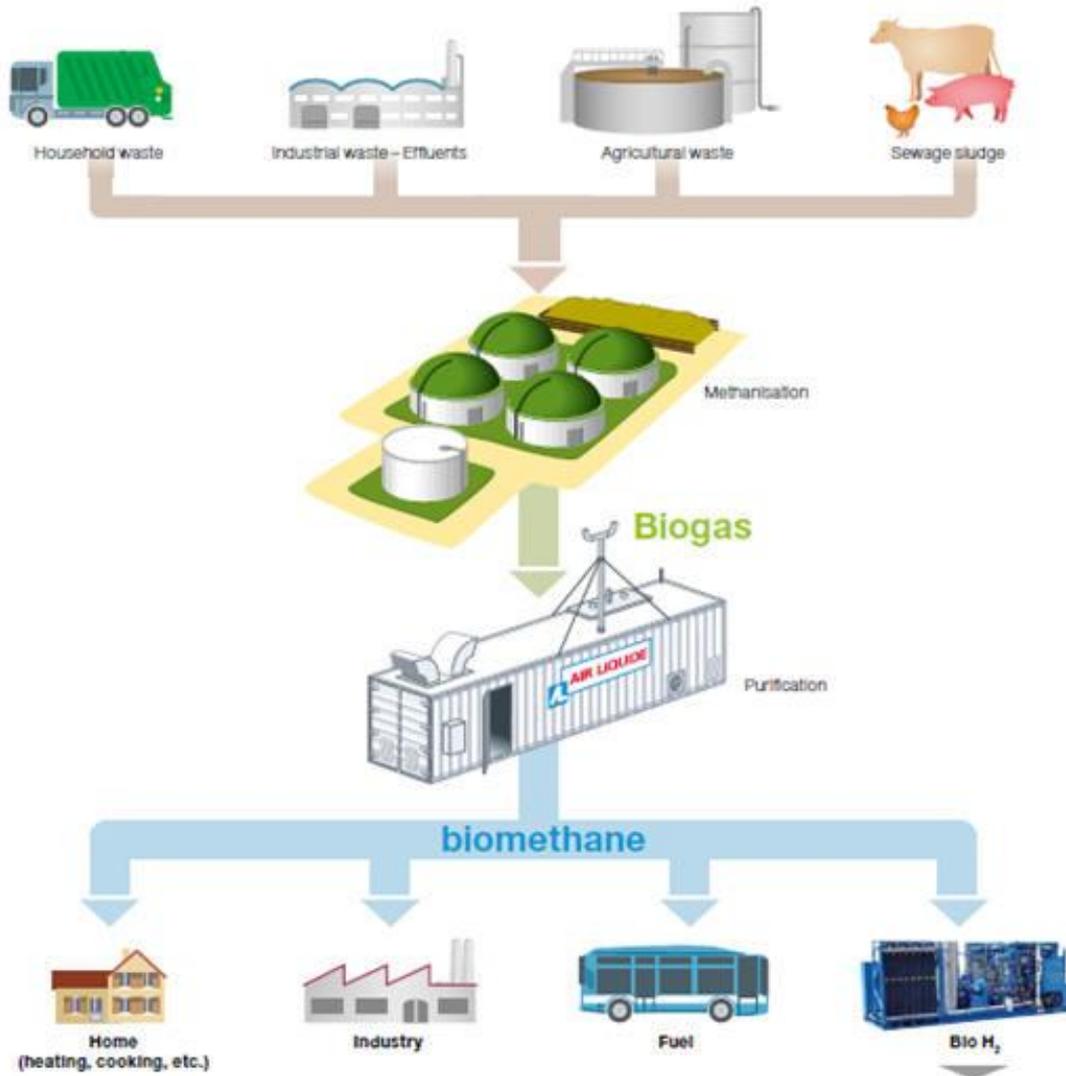
Reforming NG



Electrolysis



Hydrogen Supply and Distribution



Summary and Key Points



- The cars are coming
- The infrastructure will be ready
- California and Northeast states lead the way
- Targeting existing retail sites with enough space
- Hydrogen stations and fueling equipment are commercially available
- Blue hydrogen enables sustainable supply







Thank You