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Distribution, Storage, and Dispensing of Hydrogen at Vehicle Refueling Stations

ASME International Pipeline Conference
Calgary, Alberta, Canada
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Gasoline Fueling

100 years of experience

Public Dispensing – 180,000

Safety Maintained

Hydrogen Fueling

Infancy stage

Dispensing – 20 today

20,000 in 10 years

200,000 in 20 years

Goal

50 year experience

as a chemical

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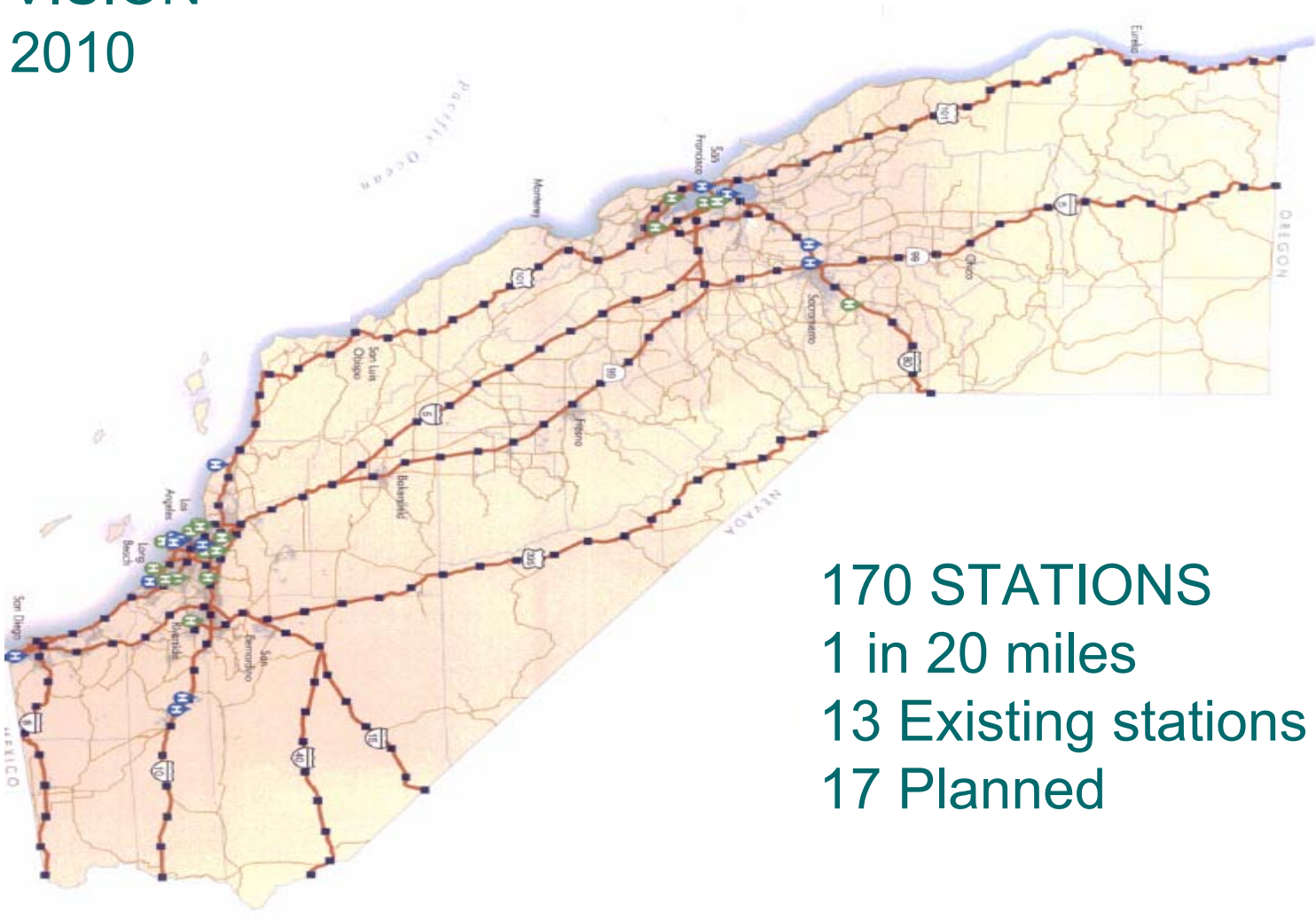
California Hydrogen Highway

VISION
2010



170 STATIONS
1 in 20 miles
13 Existing stations
17 Planned

California Hydrogen Highway
www.HydrogenHighway.ca.gov

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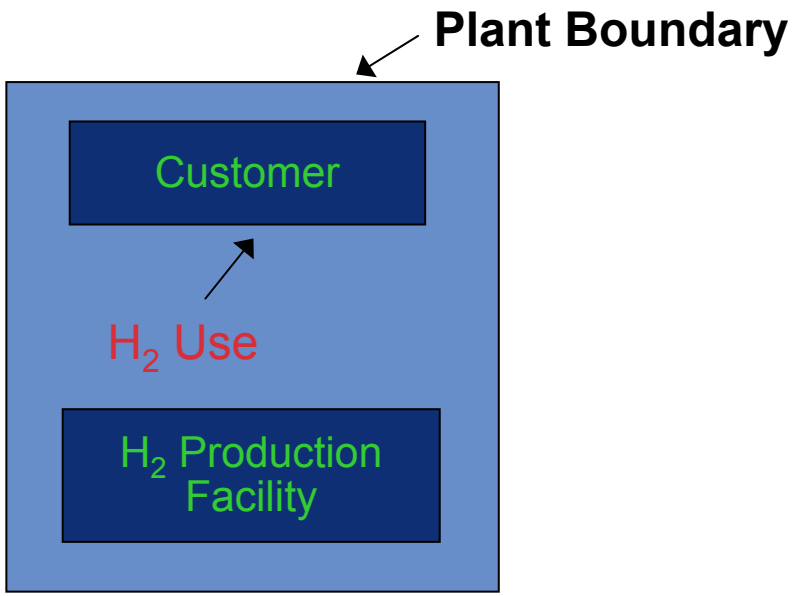
U.S. Hydrogen Production: Approx. 35 Billion SCFD

Hydrogen Consumed Where Produced: ~ 33 billion SCFD



Major Uses

- Ammonia
- Petroleum refining
- Food Industries
- Metals Treatment
- Petrochemicals

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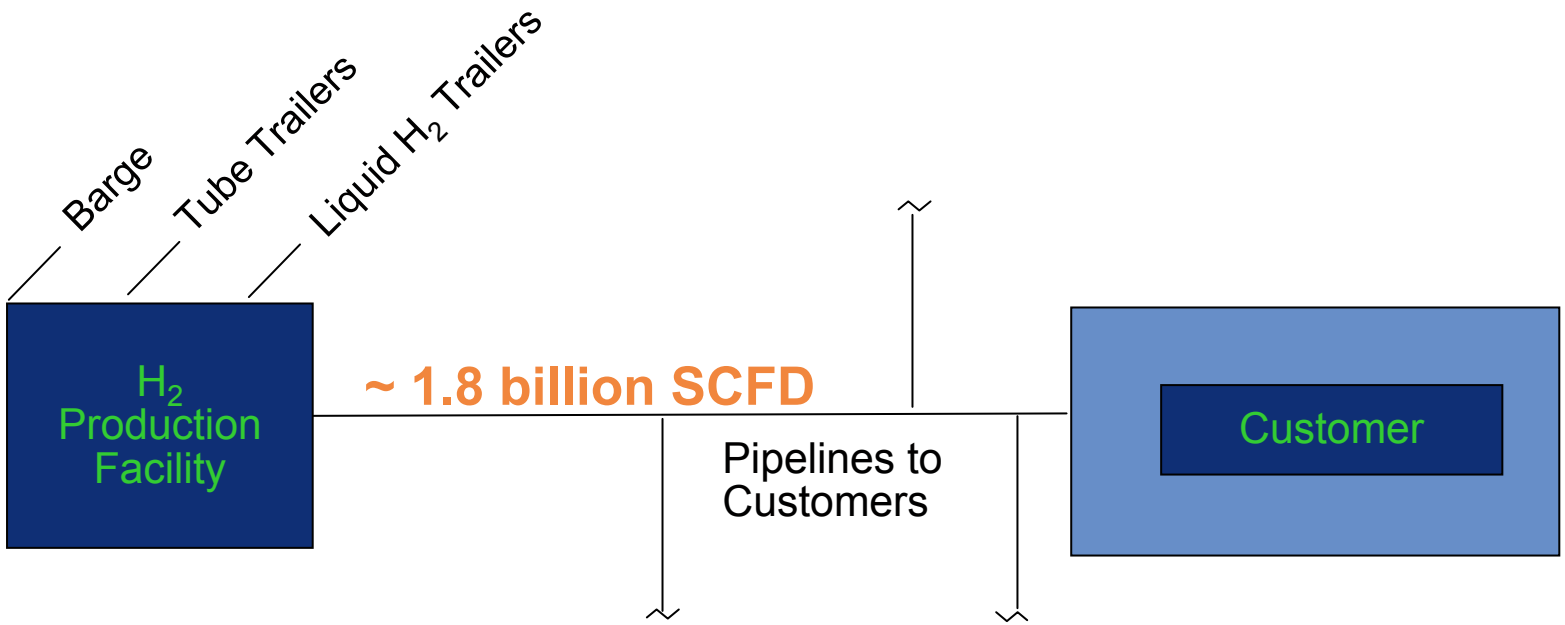
Merchant Hydrogen (Outside Customers)

~ 2 billion SCFD



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Hydrogen Distribution

- **Truck in *liquid* hydrogen**
  - **delivered at about –425°F and 100 psig.**

LH2 Delivery Trailer

75 in U.S

Hydrogen Distribution

- Truck in *gaseous* hydrogen
  - delivered at about 2600 psig
  - 209 in US

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Hydrogen Distribution

- *gaseous* hydrogen pipelines
  - Nominal Size (inches): 2 to 12
    one 18” line
  - Operating Pressure (psig): 60 to 2220
  - Length (miles): 0.002 to 51
  - Age (years): 1 to 45

Hydrogen Storage

- ***liquid*** **hydrogen stored at about –425°F and 150 psig.**

459 sites in US

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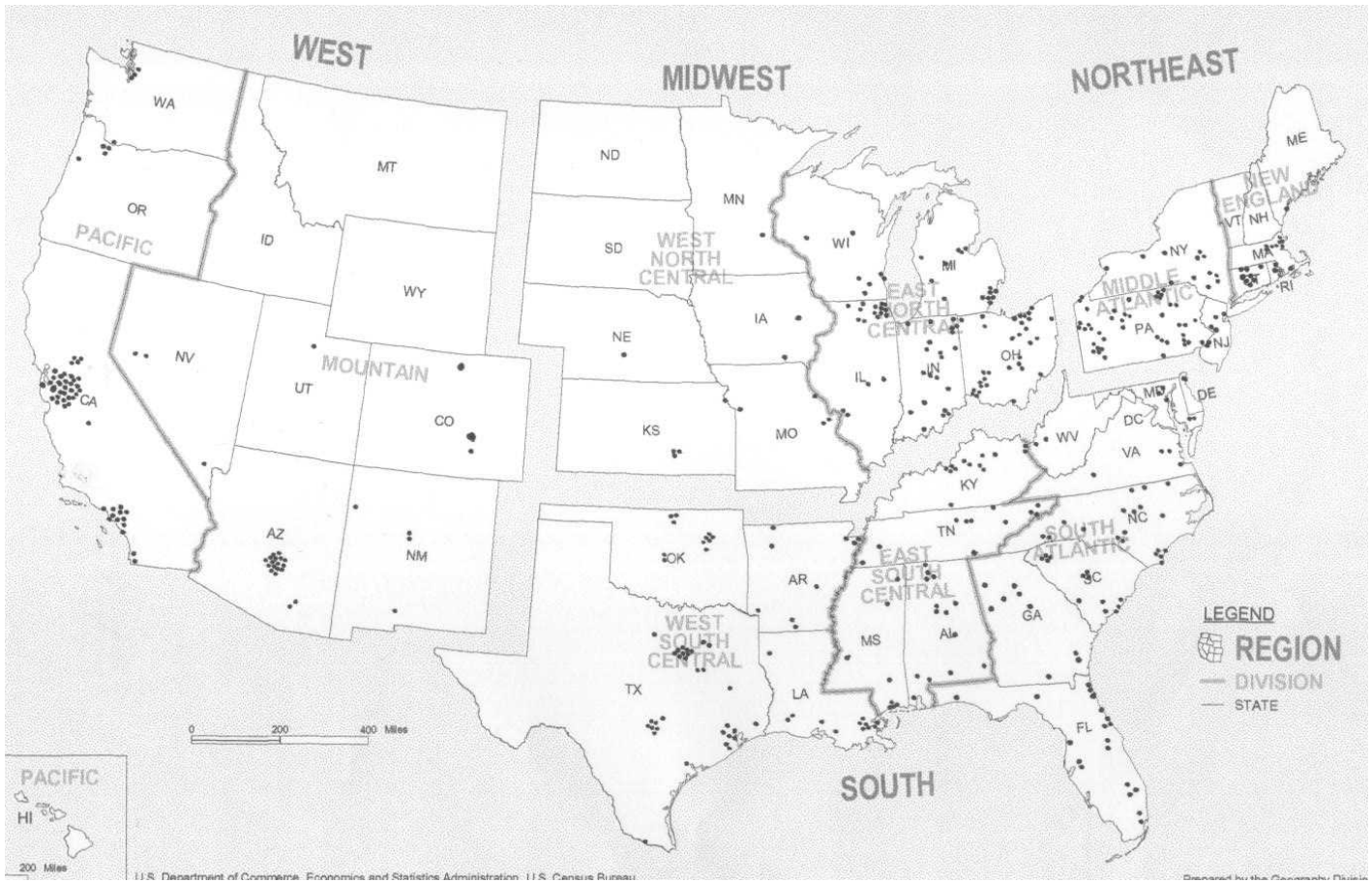
Liquid H2 Storage Sites - US

Some are hydrogen fuel stations



Hydrogen Storage

- *gaseous* hydrogen stored at about 2000 psig

  - 600 in US

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On-site Hydrogen Generation

- Generation of *gaseous* hydrogen at fueling site or station – if large area available

- Challenges
  - B 31.3 adequate?
  - Optional
  - AHJ friendly?
  - Up-to-date?

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Transportation

- Tubes to 2640 psig
  - DOT and TC regulations
  - Demand for 7000 and 14000 psig systems
- Large number of trailers on the highway
  - Movement and parking restrictions
- Did not perform well in recent accidents
  - Complete loss of product
  - Major disruption
  - Mitigation plans

Transportation Challenges

- Over the road shipping of gaseous H2 increases incident probabilities
- Liquid H2 distribution and local pipeline network could minimize the risk.

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Cryogenic H2 trailers
- could perform better in an incident

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Transportation challenges

- Section XII
  - CFR recognition
- High Pressure tubes and associated piping
  - Non-metallic tubes
- Pressure Relief Devices on metallic tubes
  - DOE sponsored tests
- CFR changes
  - Protection in an accident
  - Rear impact protection
  - Recessed vales

LH2 storage at Fuel (Gas) Stations

Chicago (CTA), IL

City of Las Vegas, NV

CaFCP, CA

Ann Arbor, MI

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LH2 Storage at Gas Stations

- Place tanks below grade
  - similar to gasoline tanks
    - Increase safety
    - Reduce security risk
    - Increase available space
    - Reduce environmental effects

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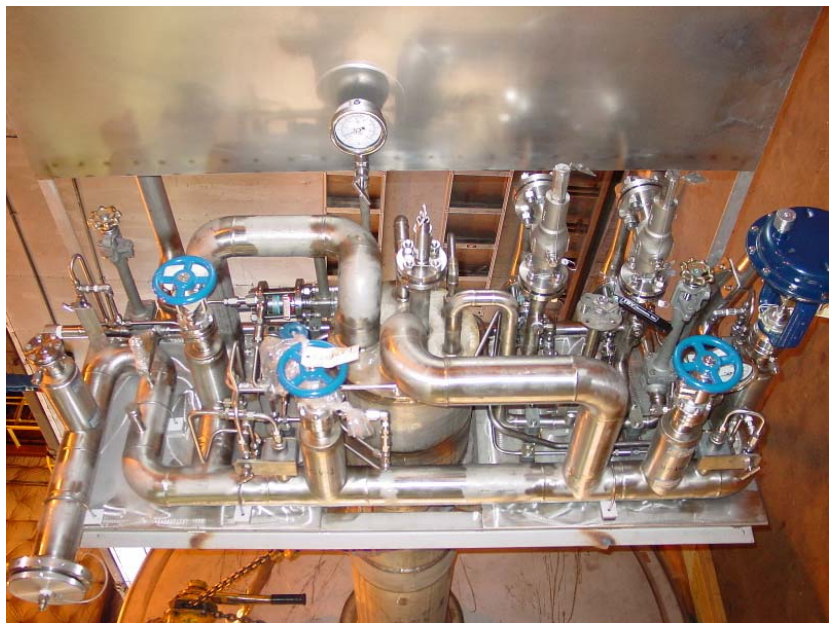
LH2 Storage Challenges

- Below grade cryogenic piping
  - Corrosion protection
  - Welded Construction
  - Inspection
  - Mechanical Integrity



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Other System Components

- Vaporize *liquid* hydrogen, Compress and store gaseous hydrogen ready for dispensing.

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H2 Dispensing Challenges

- Higher pressures
  - **13,500 psig**
- Material compatibility
- User friendly designs
- Mechanical joints
- Zero leak construction

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Other Piping Challenges – near term

- Centralized cryogenic storage
- Vaporization and compression
- High Pressure storage for fast fill
- Clustered stations from single source

Thank you

tell me more

www.airproducts.com