

AIR
PRODUCTS 

A group of diverse people, including children and adults, are shown from a high angle, holding a globe of the Earth. They are all smiling and looking towards the camera. The background is a solid blue color. The text is overlaid on the image in white.

Hydrogen Infrastructure Fueling a Cleaner Future

Karen Campbell
Air Products and Chemicals, Inc.
H2 Production and Northwest Transportation
Conference, 16 June 2003

Air Products' future energy solutions

Air Products is a \$6 billion global company that supplies 50% of the merchant hydrogen market

- **Demonstration leader – 20 fueling stations**
- **Developing solutions for the H₂ economy – sourcing, on-site generation, storage**
- **Global safety leader**
 - Codes & standards team
 - KnowH₂owSM safety training
- **Founding member of the National H₂ Association**



Infrastructure overview

Today

Hydrocarbon sourced infrastructure exists

- Global production: 45 billion kg/yr
- Industrial applications: chemicals, metals, electronics, space
- 95% of H₂ used captively



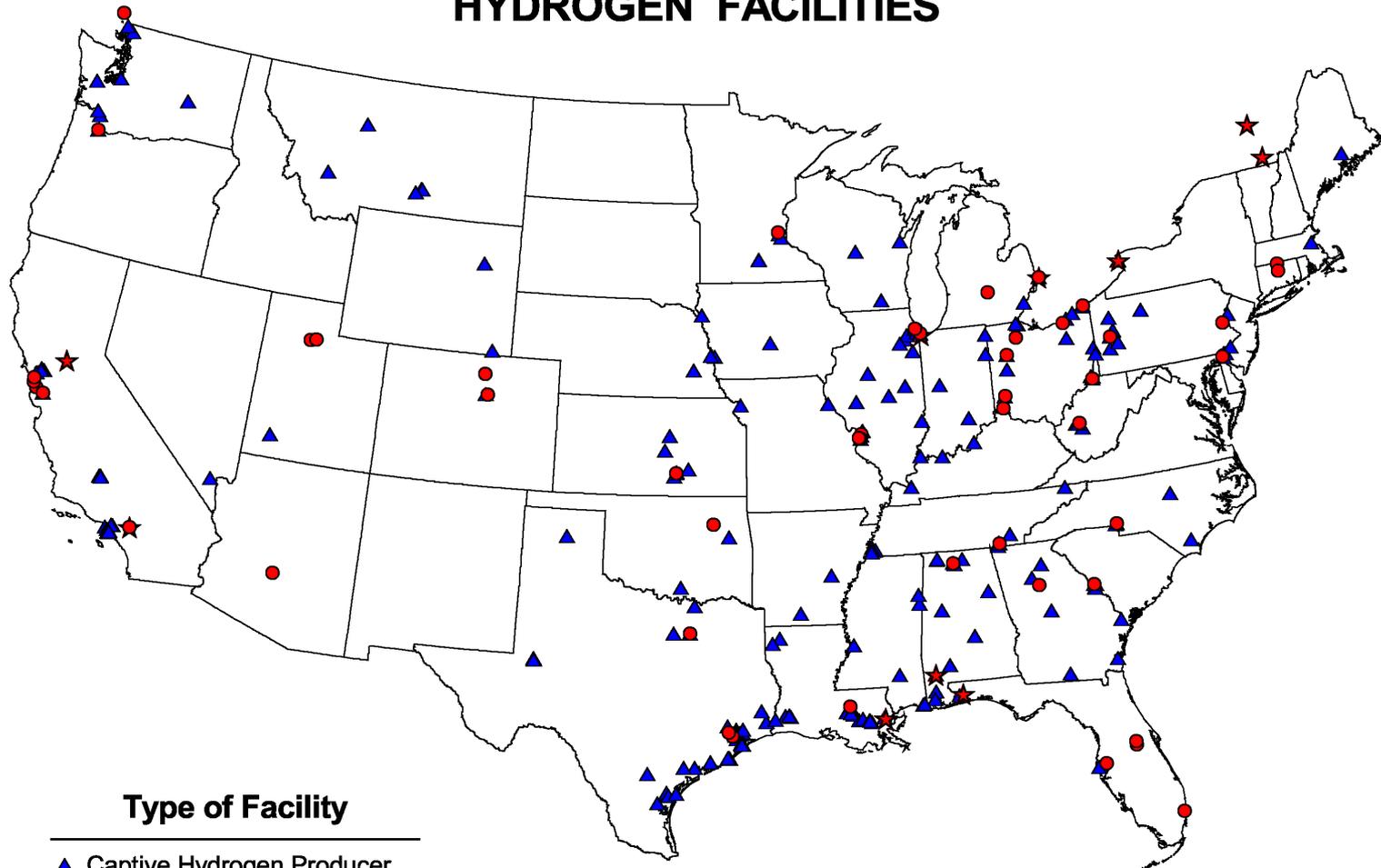
PATHWAY?

Tomorrow

Renewable sourced H₂ for transportation and energy storage for power generation



HYDROGEN FACILITIES



Type of Facility

- ▲ Captive Hydrogen Producer
- ★ Liquid Hydrogen Producer
- Gaseous Distribution Terminal

U.S. Department of Energy
National Renewable Energy Laboratory



Supporting the hydrogen economy . . .

- **Today's petroleum fuel infrastructure wasn't built in a day . . .**
. . . and doesn't need to be replaced in a day!
- **Current world hydrogen production (45 billion kg/year)**
 - **Massive growth in hydrogen production, distribution, storage and delivery will be required**
- **Investments in hydrogen can be done gradually with growth in demand**

Hydrogen Infrastructure

Factors

- Regional dynamics and geographic constraints
- Distance from production to point of use
- Capital utilization

Infrastructure Solutions will include

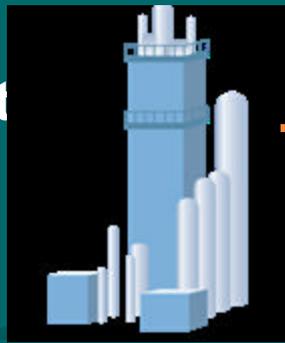
- Leveraging existing production and delivery infrastructure
- Point of use generation
- Combined fueling and energy
- Hydrogen feedstock flexibility
- Pipeline installation and conversion

Hydrogen sourcing transportation

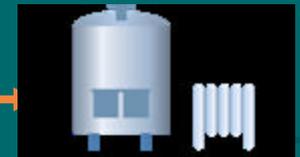
Distribution

Fuel Station

- Central Product

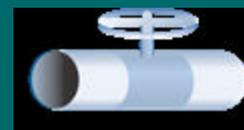


Hydrogen



- On-site Production

Natural Gas,
Propane,
Methanol,
Feedstocks



Hydrogen fuel station experience



Hydrogen fueler

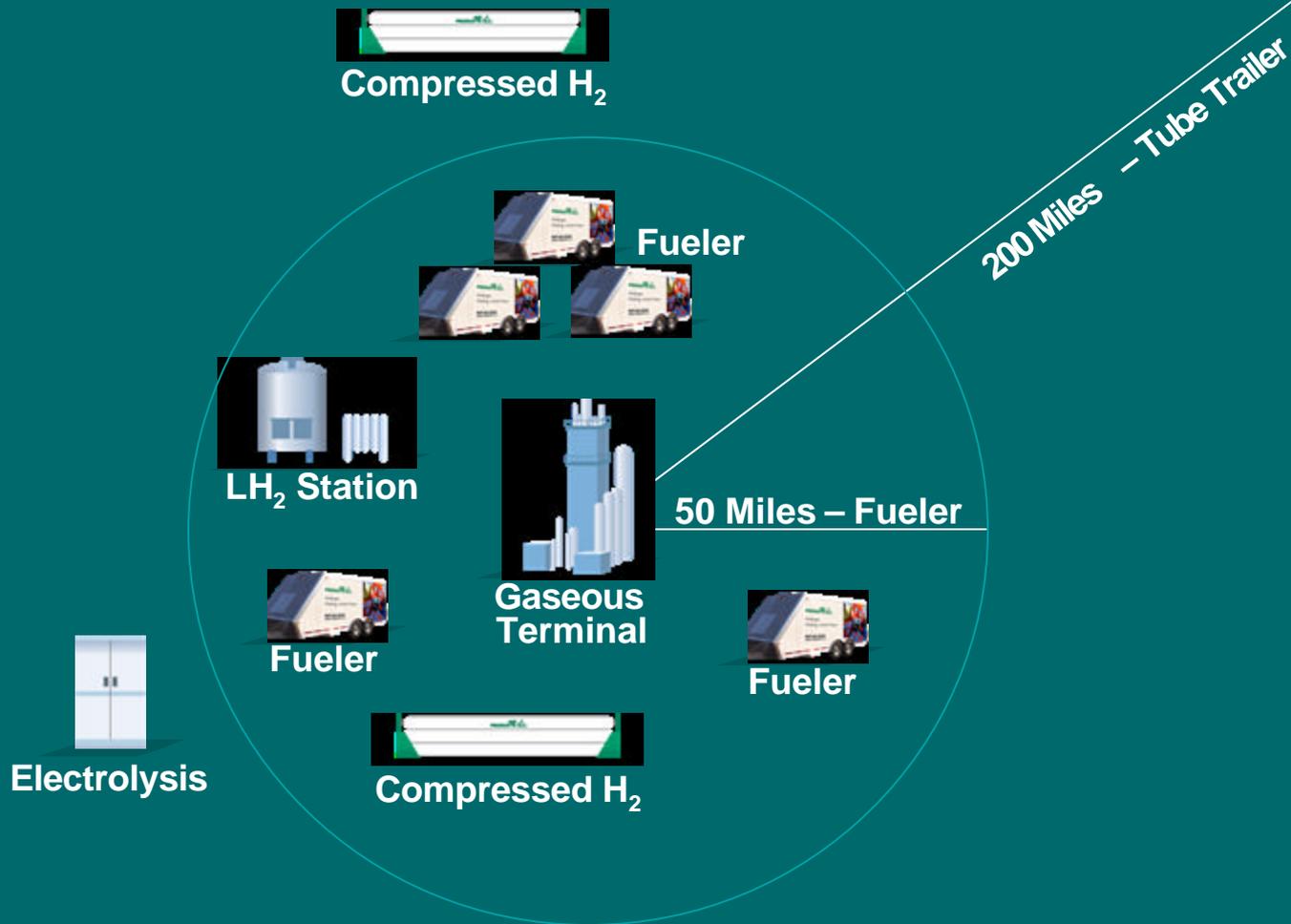
- Totally self-contained
- No site installation
- High reliability
- Zero emissions



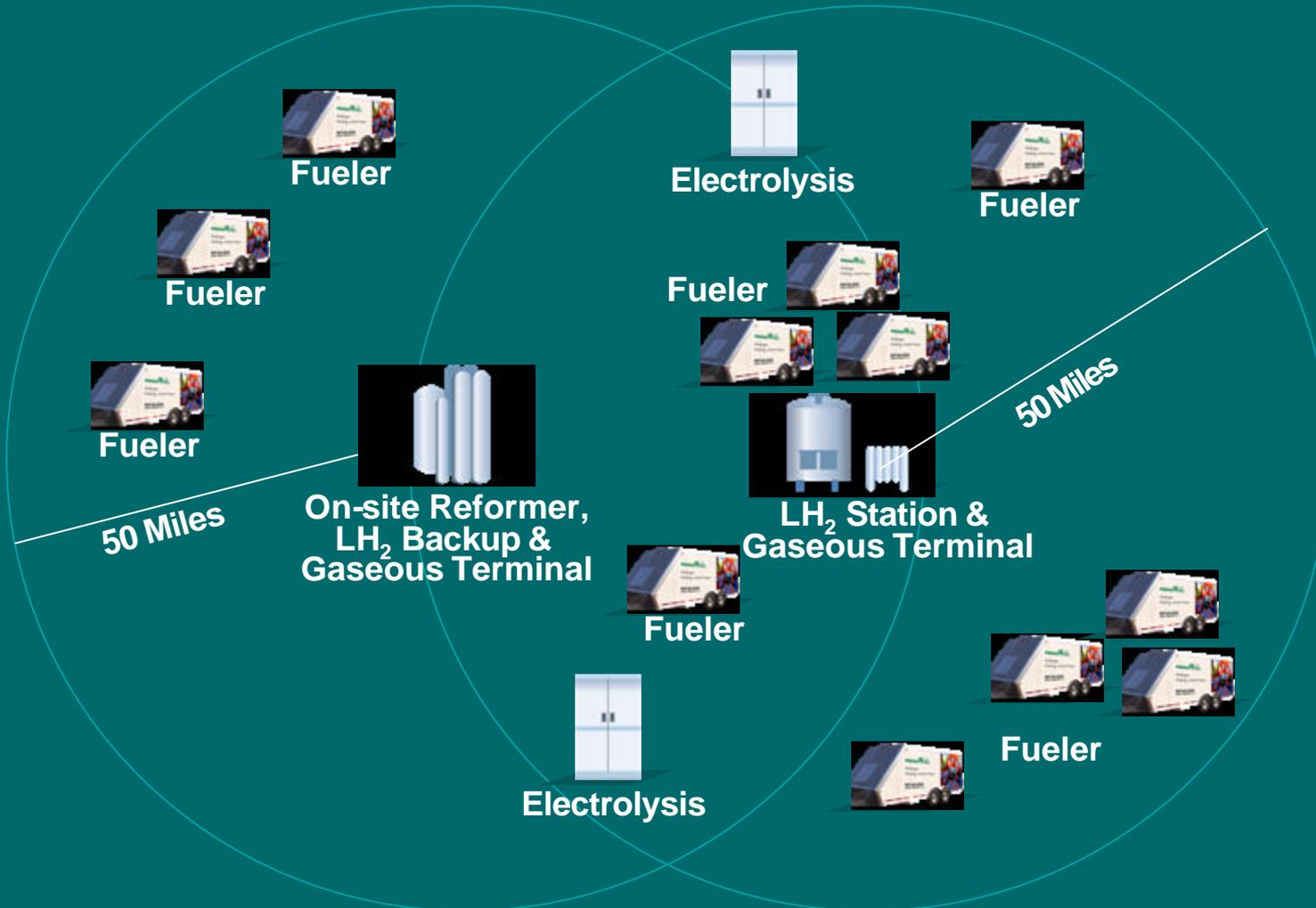
Low Cost Fueling Options



Deployment near existing hydrogen infrastructure



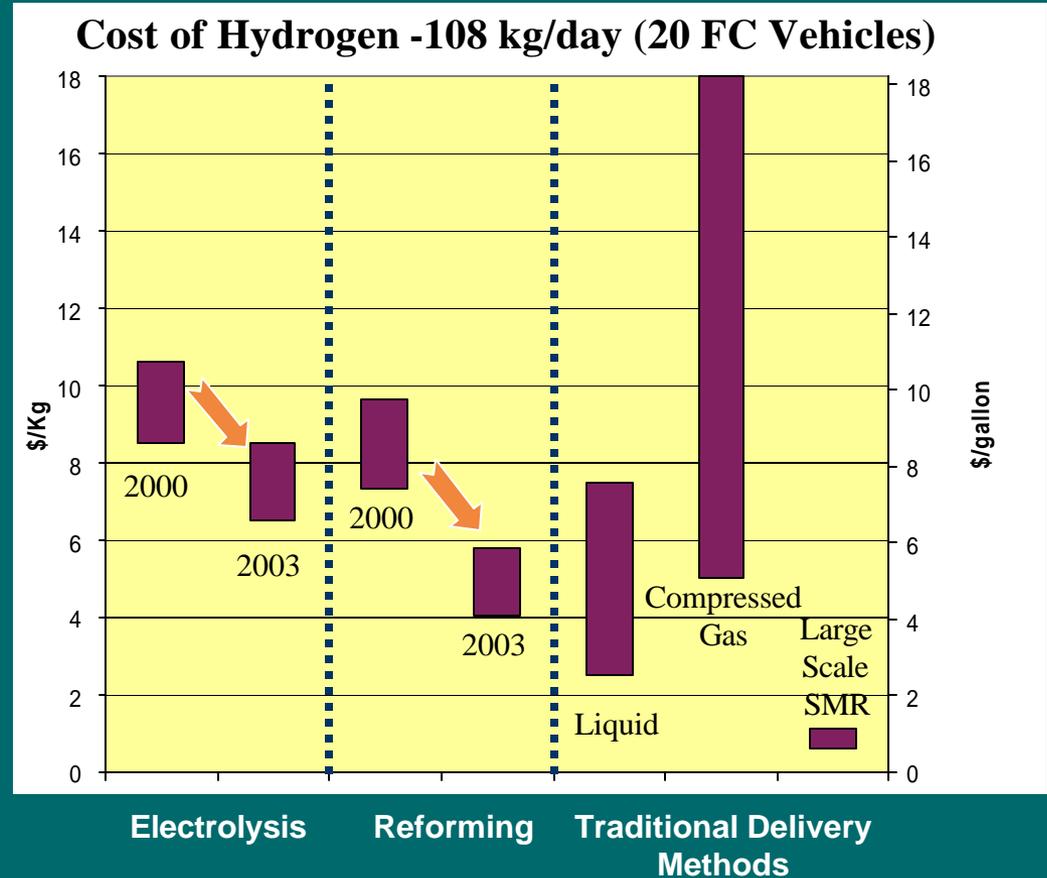
Deployment outside of existing hydrogen infrastructure



Production

Small Generators

- ~ 30 - 40% Reduction in Hydrogen Cost since 2000 based on market projections.
 - Innovation
 - Competition, > 20 companies with small generator products
- Future cost reductions
 - Innovation will continue to play a role
 - Highly dependent on unit production volume



Requirements for infrastructure success

- **Vehicles and fuel need to develop together**
 - **Capital utilization critical for payback**
- **Competitive system cost (fuel and fuel cell)**
- **High reliability fueling critical for fleets and backup/critical power generation**
- **On-site fueling with off-site/fast fill capability**
 - **Off-site availability for market penetration of fleet vehicles and to build start of retail infrastructure**
- **Easy, low-cost expansion beyond demonstration**

Summary

- **Hydrogen is available now**
- **There will not be a single pathway solution**
 - **Based on application needs and locations**
- **Long-term, lowest-cost solution still being developed**
 - **Depends on the ultimate fuel cell, vehicle and device needs**

Thank you