


# NREL Alt Fuel Lessons Learned
# -- Hydrogen Infrastructure --

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# Gap Between Existing and Required $H_2$ Fueling Experience

- Very limited access to today's stations
  - Stations not made available or…
  - No-go access contracts/liability clauses or …
  - Assurance of access by customers/drivers
    - "OEM x vehicles/drivers have priority over OEM y"
    - e.g. "Can't fuel on Tuesday and Thursday afternoons 4-7pm"
- Very limited availability of 700bar fueling
  - Every major OEM is developing 700bar capability (GM vehicles since 2004)
  - With only two exceptions, 700bar is the baseline
- Current stations are largely behind-the-fence, demo-like, and lagging in technology availability (note: vehicle technology refreshed every 3-4 years)

➔ Build a new generation of hydrogen stations that inspire confidence in our ability to establish a hydrogen infrastructure

# Additional Observations (I could be wrong)

**Energy Companies:**

- $$$$$
- But, not necessarily from the retail business (and only ~10% stations are company owned/operated)
- Don’t do station/technology development (exceptions are e.g. Chevron’s onsite reformer work)
- They do have land (retail sites)
- Don’t perceive an Early Mover Advantage
- Not in a hurry to shift environmental burden upstream (?)

**Industrial Gas Companies (and other equipment suppliers):**

- Station and fueling technology experts
- $
- Don’t do retail (dealing with general public/liability is new)
- Don’t have land (requires complex/time-consuming effort to establish partnerships)
- Don’t have renewable expertise (yet) – renewable requirement for state funding drives different technology solutions – no in-house expertise/resources – results in a complex/costly/time-consuming effort (or no bid for state funding)

# Hydrogen Refueling Infrastructure:
## Need for Broadened Perspective

Current mindset:

- Provide enough hydrogen for the vehicle miles driven
  (assuming vehicles will travel to a single station or few stations)
- Strive for high station utilization for relevant field experience

Automaker Perspective:

- Consumers move about the coverage region, and therefore, determine their own patterns for where they want to refuel -- efforts to match a station's supply with overall vehicle demand will be inaccurate
- Vehicles are far too costly to leave stranded due to an underbuilt infrastructure
- Early customers are too valuable to hydrogen outreach efforts to risk dissatisfaction

Broadened Perspective:

- Hydrogen stations are a critical element in building market pull for a hydrogen future
  -- which means serving the consumer/driver -- which means focusing on consumer access to fuel rather than fuel availability.

**This is about more than just fueling vehicles – this is about building a market!**

- Can't wait to deploy fueling stations once the market signal is clear – these stations have a key roll in making that market signal emerge

# Critical Infrastructure Next Steps…

- **<u>Compelling, retail-like</u> refueling stations**
  - Geographically targeted regions where automakers want to put vehicles
  - <u>700bar</u> fast-fill refueling
  - Compelling station designs (customer and technology perspectives)
  - Robust hydrogen capacity and throughput – designed for growth
  - Operational with (or before) vehicles
- **<u>Access</u> to all stations**
  - All-OEM access
  - Address liability exposure
    - Straight-forward access agreements w/ consistent principles or
    - Eliminate access agreements altogether
- **<u>Expedient</u> station approval and permitting process**
  - State-wide consistency and local adherence
  - Community support
- **<u>Funding</u> Support and Incentives/Enablers**
  - Stations, station technology and capacity upgrades, operating costs
  - Liability coverage/solution (funded liability pool, liability cap)
  - Assurance stations will be there on time - supply base

**Germany**


**U.S.**


**This is about more than just fueling vehicles – this is about building a market!**

- Can’t wait to deploy fueling stations once the market signal is clear – these stations have a key roll in making that market signal emerge

# Fuel Cell Commercialization Overview (Conceptual)

New Calif ZEV Ruling: 2012-2014 → 7,500 FCEV

| Yr 1 | Yr 2 | Yr 3 | Yr 4 | Yr 5 | Yr 6 | Yr 7 | Yr 8 | Yr 9 | Yr 10 |
|---|---|---|---|---|---|---|---|---|---|
| **Technology Development** | | | | **Pilot Commercialization** | | | **Early Commercialization** | | |
| Technology development and validation under real world conditions | | | | Technology refinement and early market preparation | | | Commercial deployment into mass market | | |

## OEM/Vehicles

- So. California
- U.S. Northeast

- So. California
- No. California
- U.S. Northeast

Region 1 Region 2

100 veh / OEM

1,000+ veh / OEM (**ZEV 7500**)

Launch Build-up:
to 10,000 veh / yr / OEM

## Energy/Infrastructure

First "retail-like" Stations in U.S.

10 18 40

Region 1 Region 2

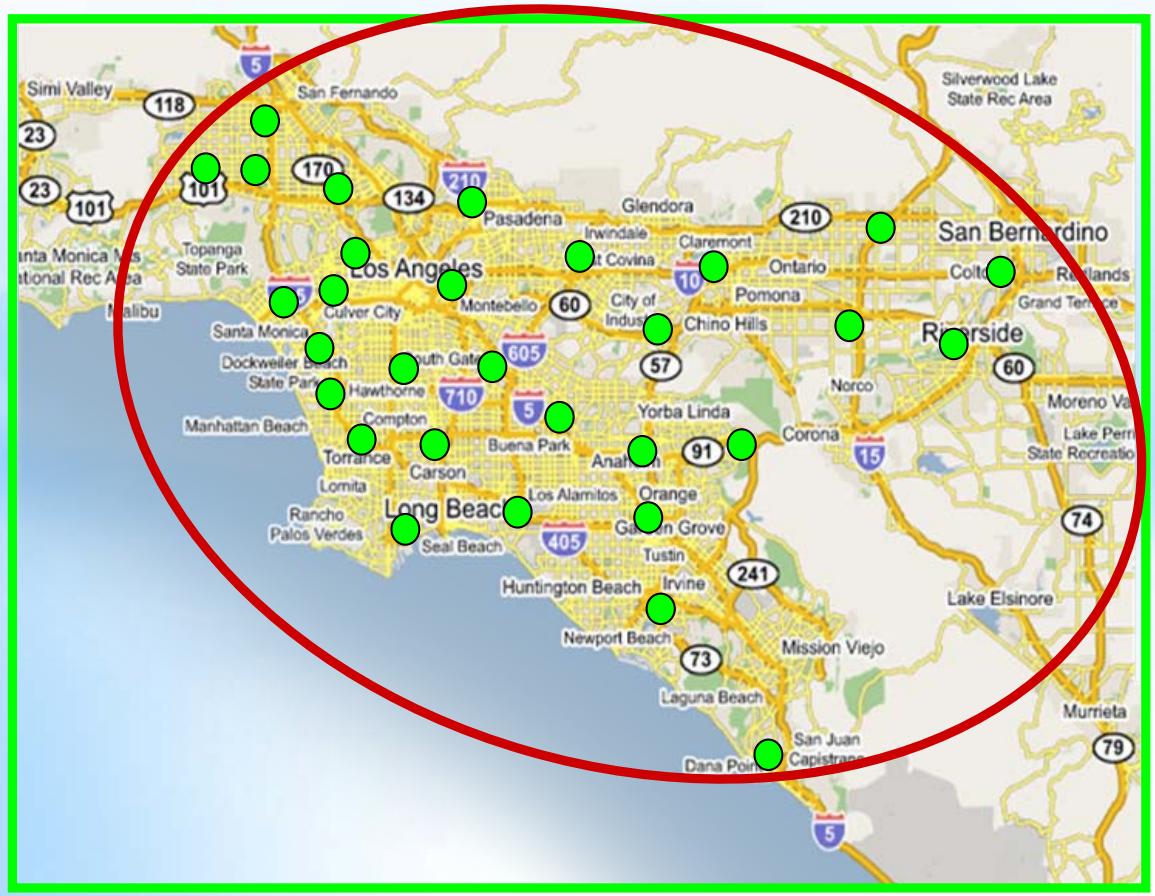
Leadtime → 10 stations

Leadtime → 40 stations (per metro area):

Leadtime → 250 Stations

- Planning and execution of next phase infrastructure must begin now
- Early deployment of fueling infrastructure will influence vehicle deployments

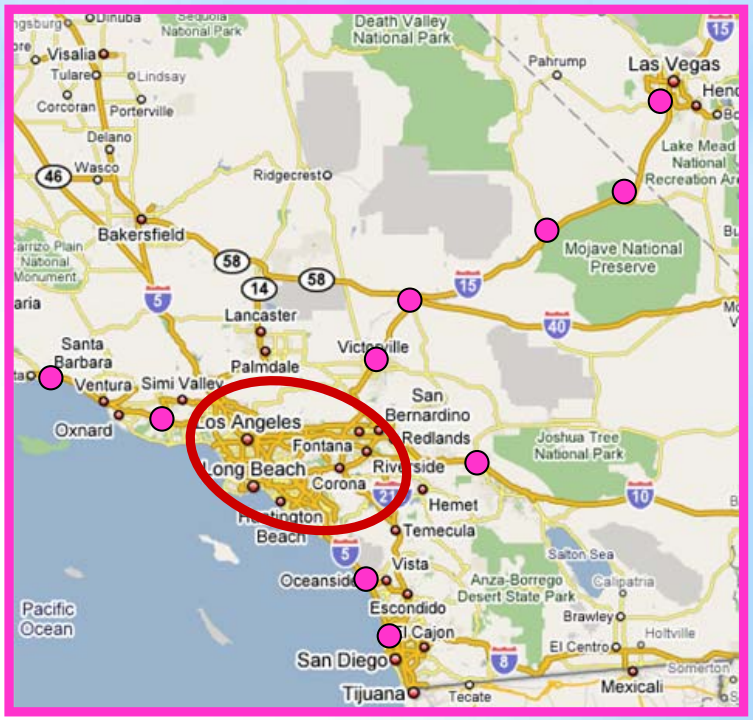
# LA Metro Area 2010+
# Hydrogen Infrastructure (Conceptual)




30 stations in LA Metro Area
(illustrative placement)

Average distance to metro station = 3.6 miles

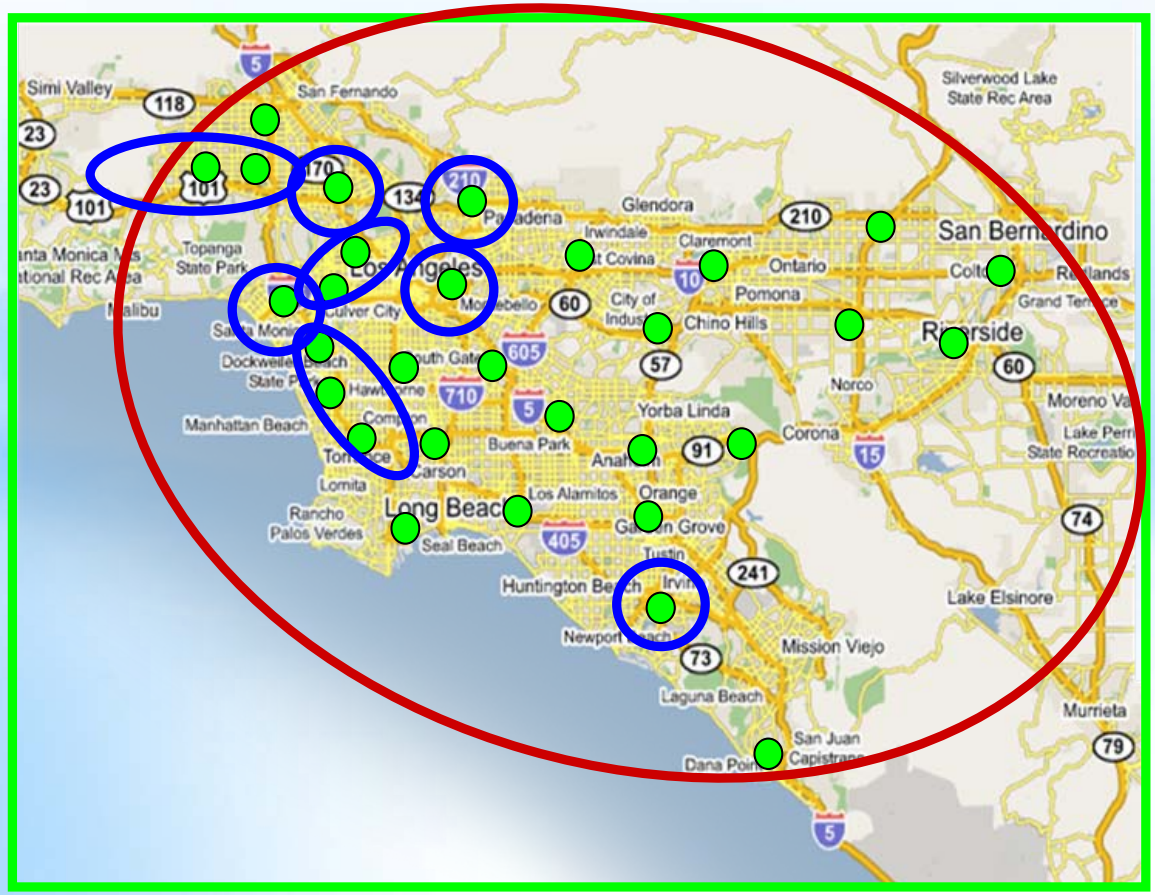
10 stations for
Destination Corridors




**To: San Diego, Santa Barbara, Palm Springs & Las Vegas**

# LA Metro Area 2010+
# Hydrogen Infrastructure (Conceptual)

## ➡ High-profile market areas and 700bar Refueling Priorities

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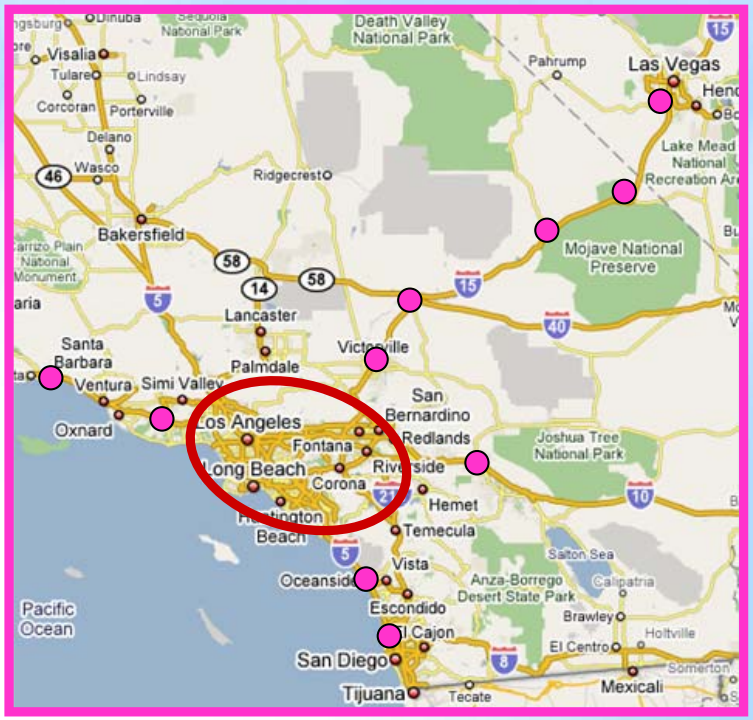


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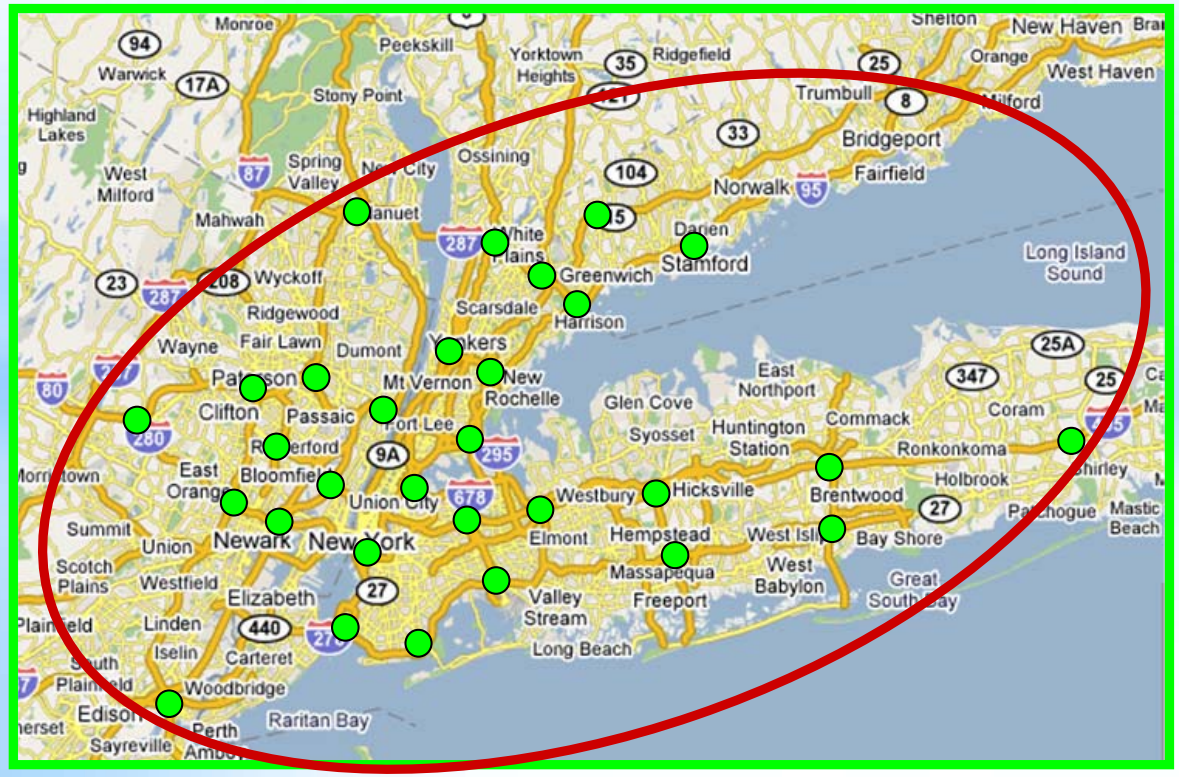
# Hydrogen Infrastructure (Conceptual)

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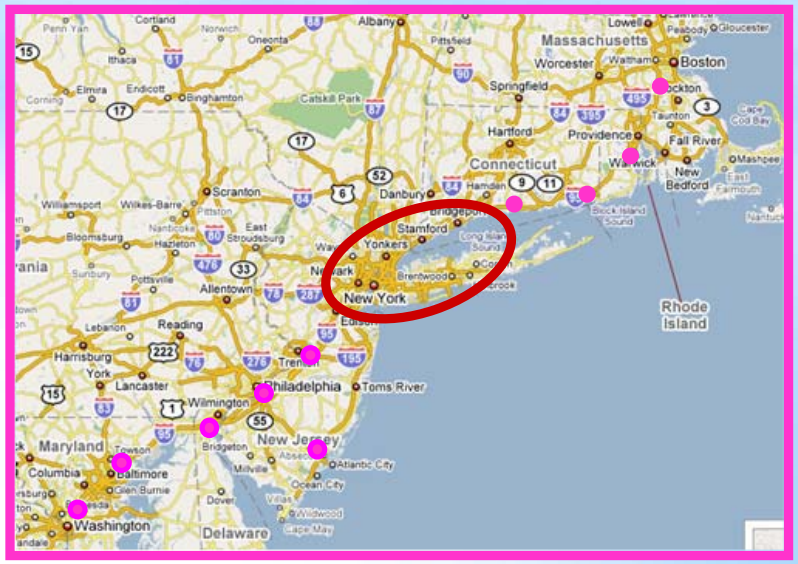


**To: Boston, Philadelphia, Baltimore, WDC, Atlantic City**

# Gas-Friendly to Gas-Free

FUEL EFFICIENCY

E85 ETHANOL

HYBRID

ELECTRIC

FUEL CELL