# Geographically Based Hydrogen Demand & Infrastructure Rollout Scenario Analysis

January 31, 2007

Margo Melendez

# Objective/Overview

Lay out several scenarios for infrastructure deployment in the 2012-2025 timeframe

2012-2015: Initial introduction

2016-2019: Targeted regional growth

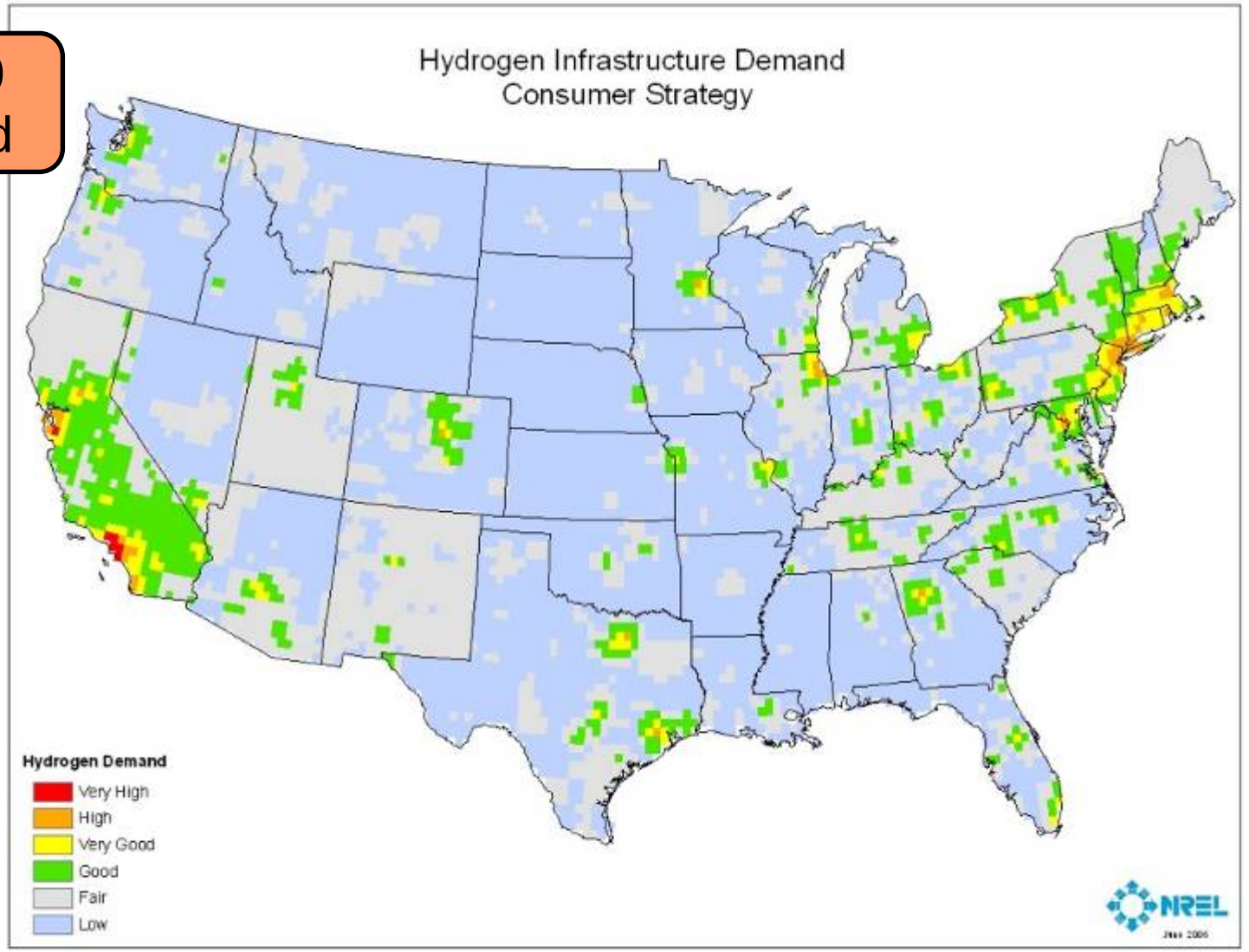
2020-2025: Inter-regional expansion

# Approach

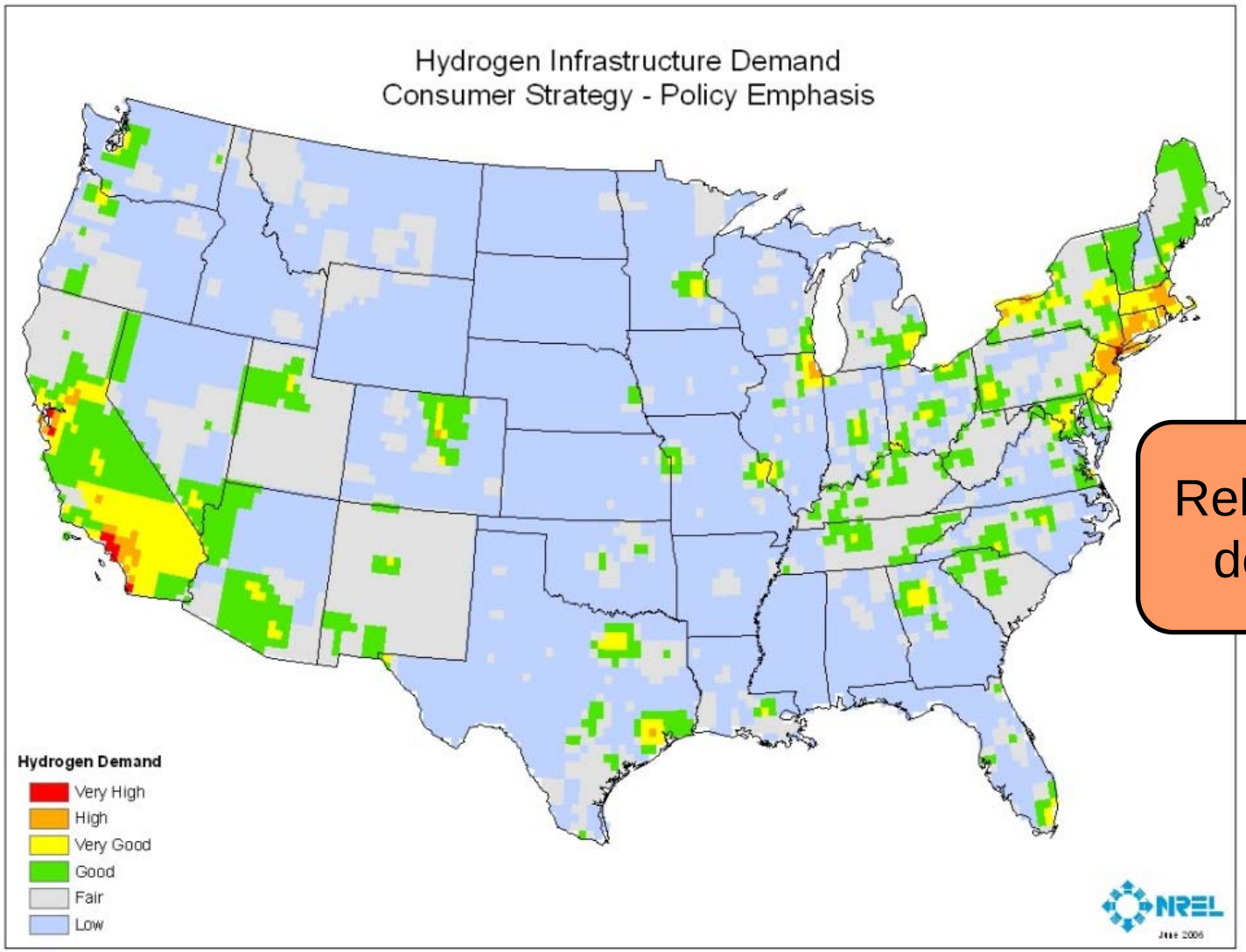
- Identify infrastructure to support deployment scenarios in the 2015-2025 timeframe
  - Based upon HyTrans estimates for station needs in a given time period (Scenarios 2 & 3)
  - Emphasis on urban deployment to best match anticipated hydrogen demand

# Baseline H2 Demand Results

20 X 20 mile grid



# Baseline Demand with Policy Emphasis



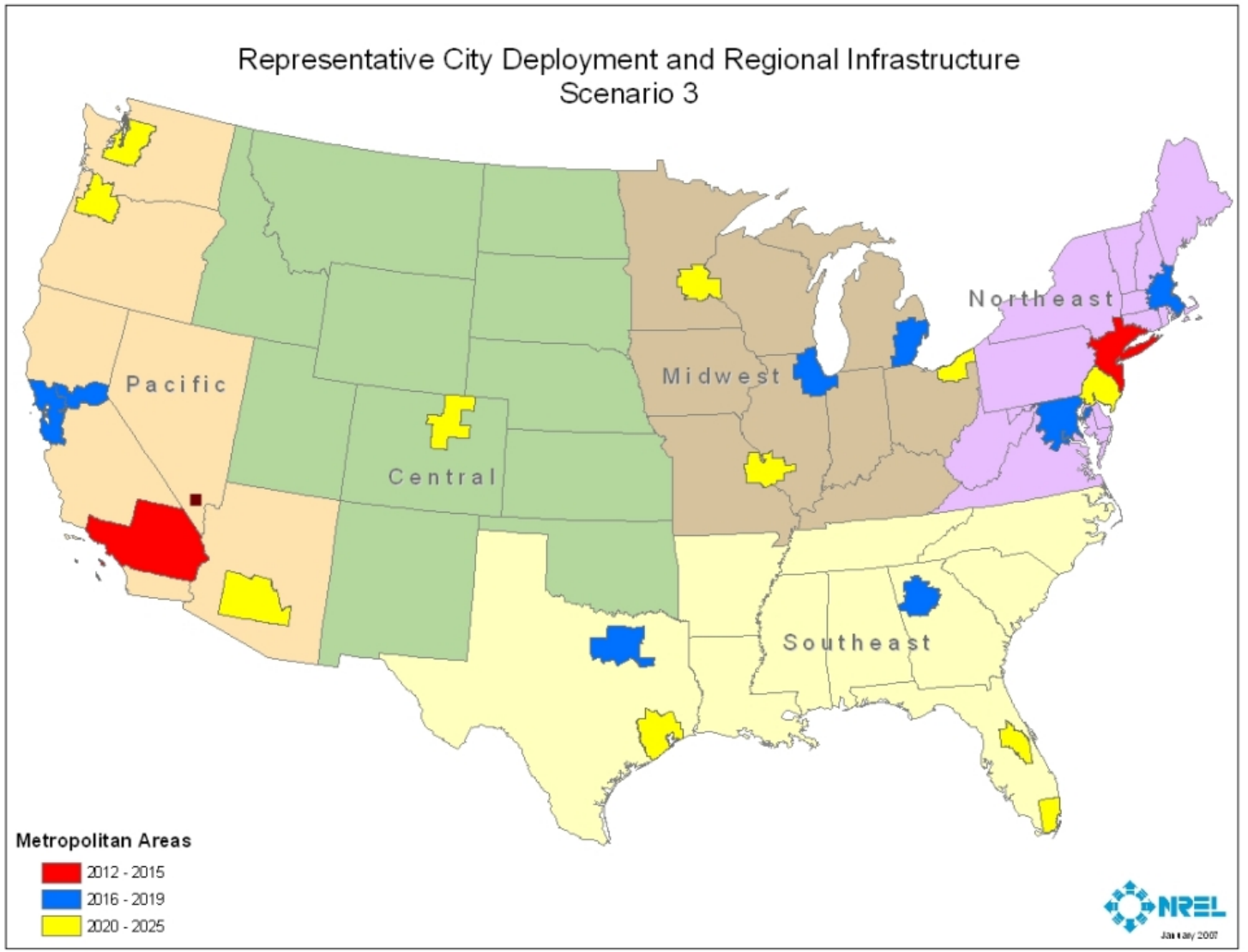

Relative H2 demand

# Top Urban Areas
# Lighthouse Concept Targets

- Los Angeles/Riverside/Orange County/San Diego
- New York/Northern NJ/Long Island
- San Francisco/Oakland/San Jose/ Sacramento/Yolo
- Boston/Worcester/Lawrence
- Washington/Baltimore
- Chicago/Gary/Kenosha
- Detroit/Ann Arbor/Flint
- Dallas/Fort Worth
- Atlanta
- Houston/Galveston/Brazoria
- St. Louis
- Minneapolis/St. Paul
- Philadelphia/Wilmington/ Atlantic City
- Phoenix/Mesa
- Denver/Boulder/Greeley

Urban areas = F(H2demand, population, vehicles)

# Regional Deployment Approach



# Deployment Scenarios
# Infrastructure Rollout

| | 2012-2015 | 2016-2020 | 2021-2025 |
|---|---|---|---|
| **Scenario 1**<br>Limited Cities | <100 Stations | ~200 Stations | ~1500 Stations |
| **Scenario 2**<br>All 20 Cities | <100 Stations | ~1200 Stations | ~4000 Stations |
| **Scenario 3**<br>All 20 Cities | <100 Stations | ~1400 Stations | ~8000 Stations |

7%

15%

# Infrastructure Roll-Out

| Urban Area | 2012-2015 Stations | 2016-2019 Stations | Scenario 2<br>2020-2025 Stations | Scenario 3<br>2021-2025 Stations |
|---|---|---|---|---|
| NY | 20 | 200 | 554 | 1227 |
| LA | 40 | 400 | 751 | 965 |
| San Fran/Sacramento | | 78 | 181 | 401 |
| Boston | | 127 | 296 | 656 |
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| St. Louis | | | 85 | 188 |
| Phoenix | | | 99 | 219 |
| Cleveland | | | 83 | 183 |
| **Total** | **60** | **1282** | **3895** | **7939** |


# Infrastructure Strategy

2012-2015

Initial introduction

Onsite reforming &LH2

Located at retail centers

Very high H2 demand

2016-2019

Targeted growth

Onsite reforming & LH2

High H2 demand (LA/NY)

Good H2 demand

2020-2025

Regional expansion

Onsite and pipeline req'd

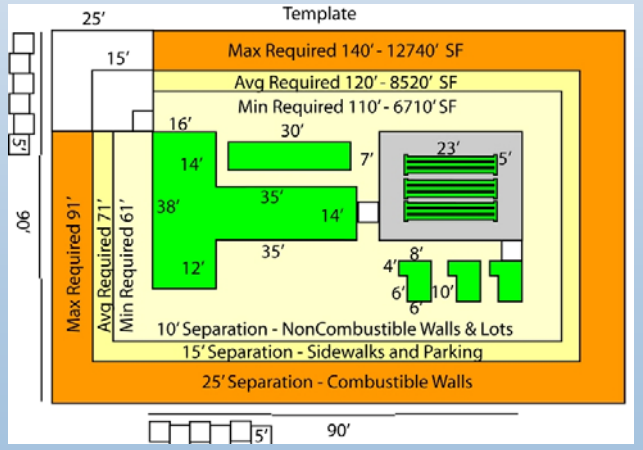
Good H2 demand (LA/NY)

All demand considered

# Infrastructure Feasibility Survey

- Examined Initial targeted gas stations in LA, NY, Dallas
  - best demand areas
  - major civic airports
  - traffic above 200,000 veh per day
  - retail center
  - 3,000 + registered vehicles
  - major and secondary roads
  - balanced coverage
- Identified land area at station compared to required reforming or delivered liquid H2 space

| City | Feasible | Not Feasible | Borderline |
|---|---|---|---|
| LA | 5 | 20 | 15 |
| NY | 4 | 15 | 21 |
| Dallas | 7 | 14 | 19 |




Should we consider pipeline sooner?

# Infrastructure Roll-Out

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Onsite reforming & LH2 focus

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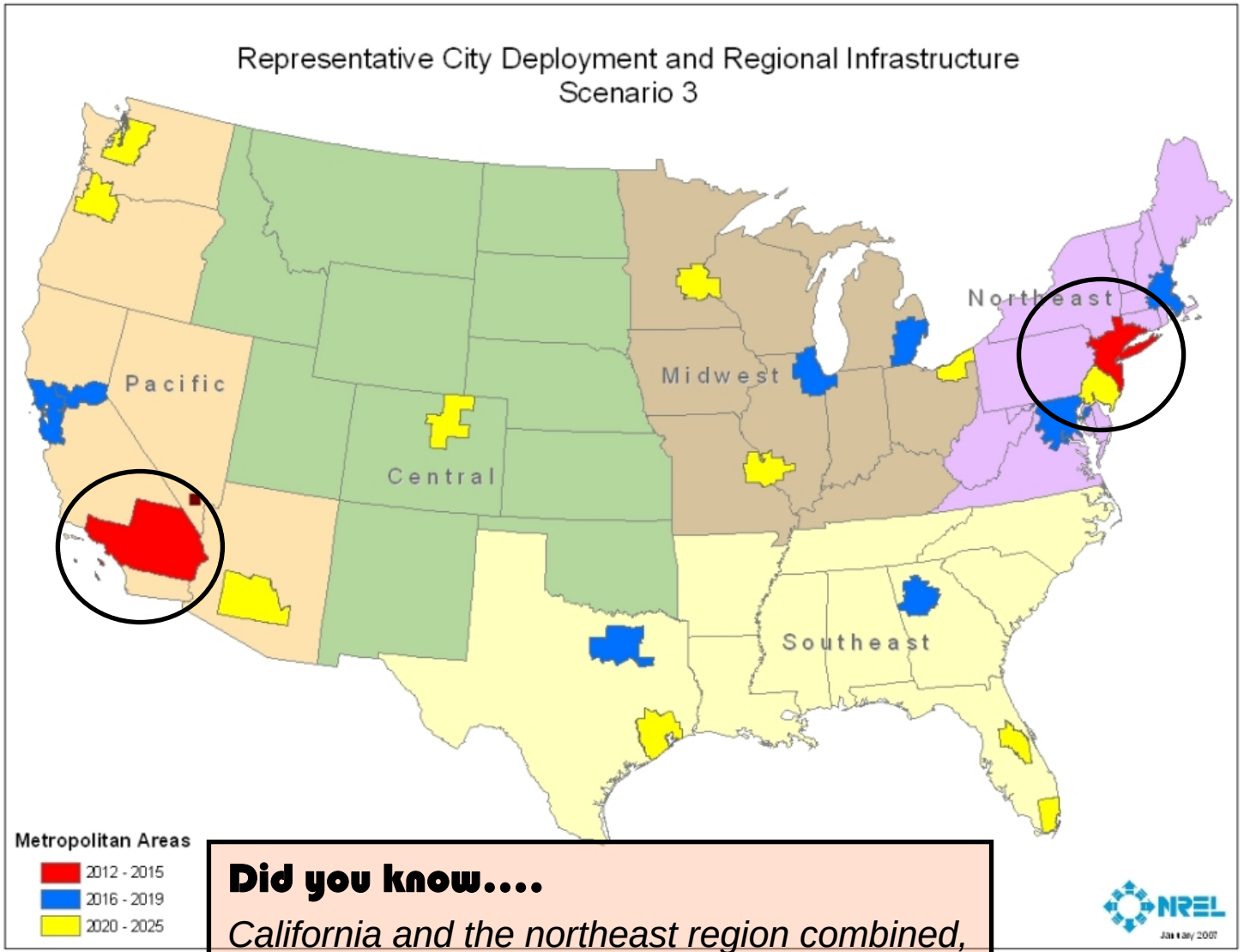
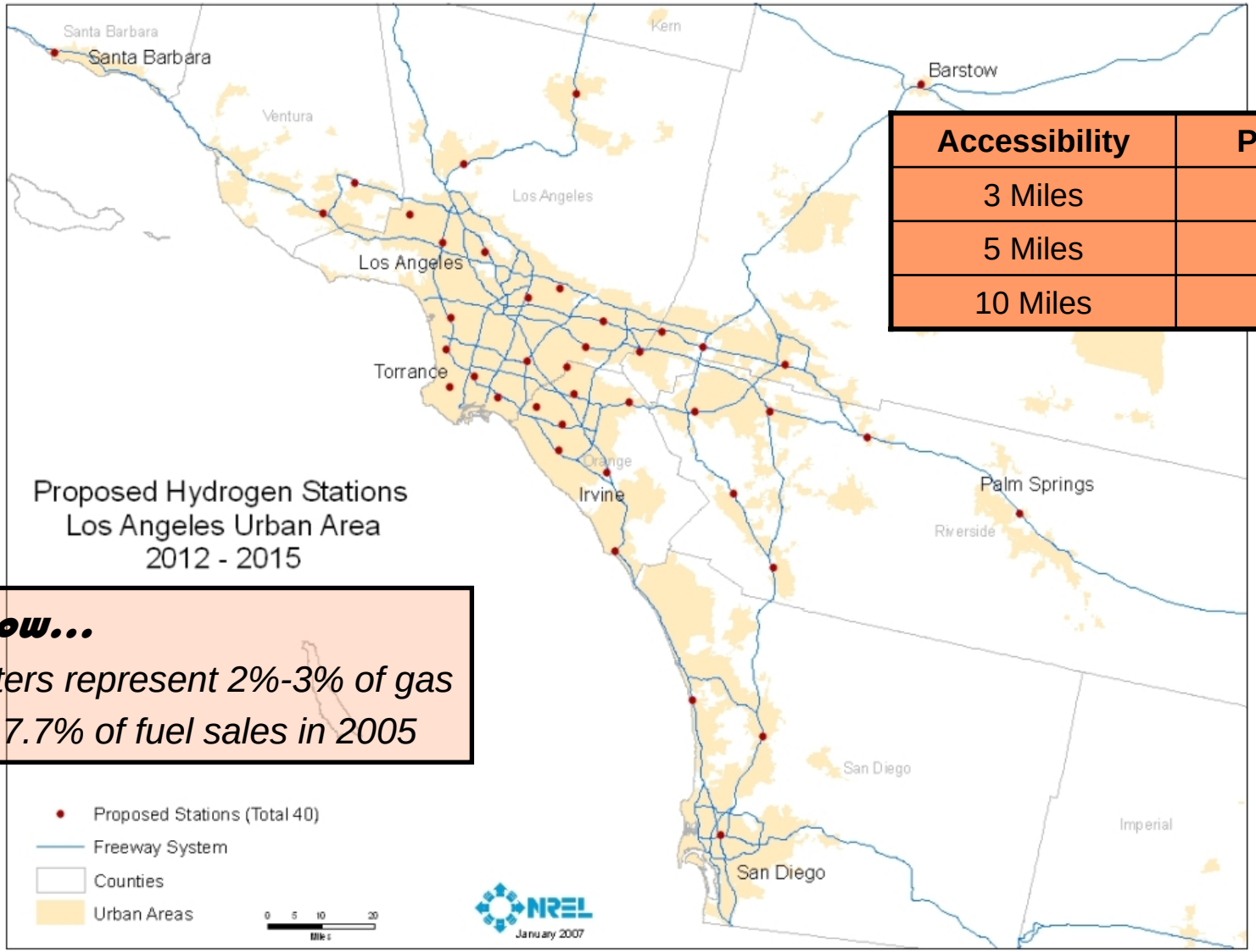



**Did you know....**

*California and the northeast region combined, represent 33% of US gasoline consumption*

# 2012-2015: Initial introduction - LA

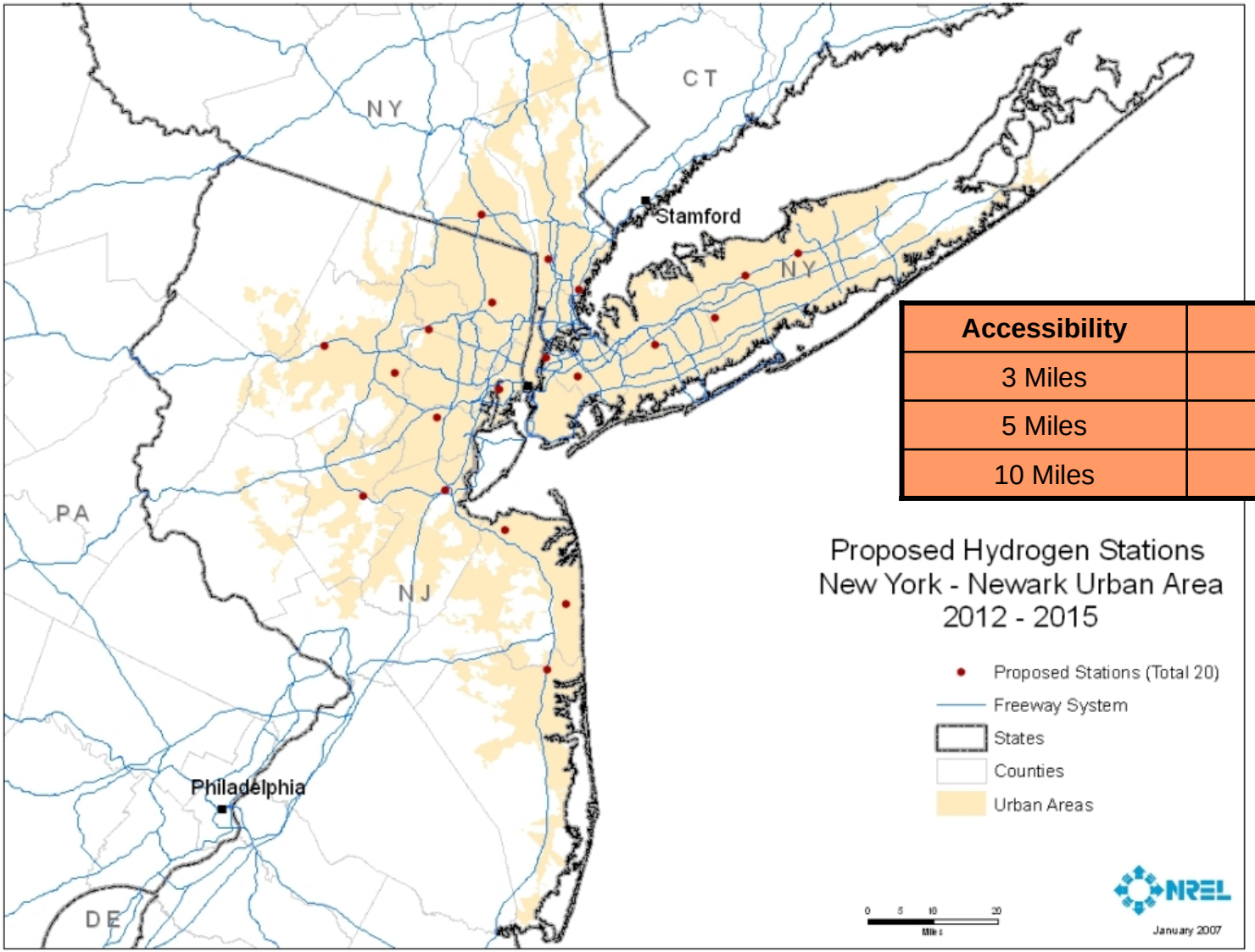



| Accessibility | Population |
|---|---|
| 3 Miles | 23% |
| 5 Miles | 51% |
| 10 Miles | 88% |

***Did you know...***

*Hypermarketers represent 2%-3% of gas stations and 7.7% of fuel sales in 2005*

# 2012-2015: Initial introduction - NY

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2016-2019: Targeted growth
Onsite reforming & LH2 focus
High H2 demand (LA/NY)
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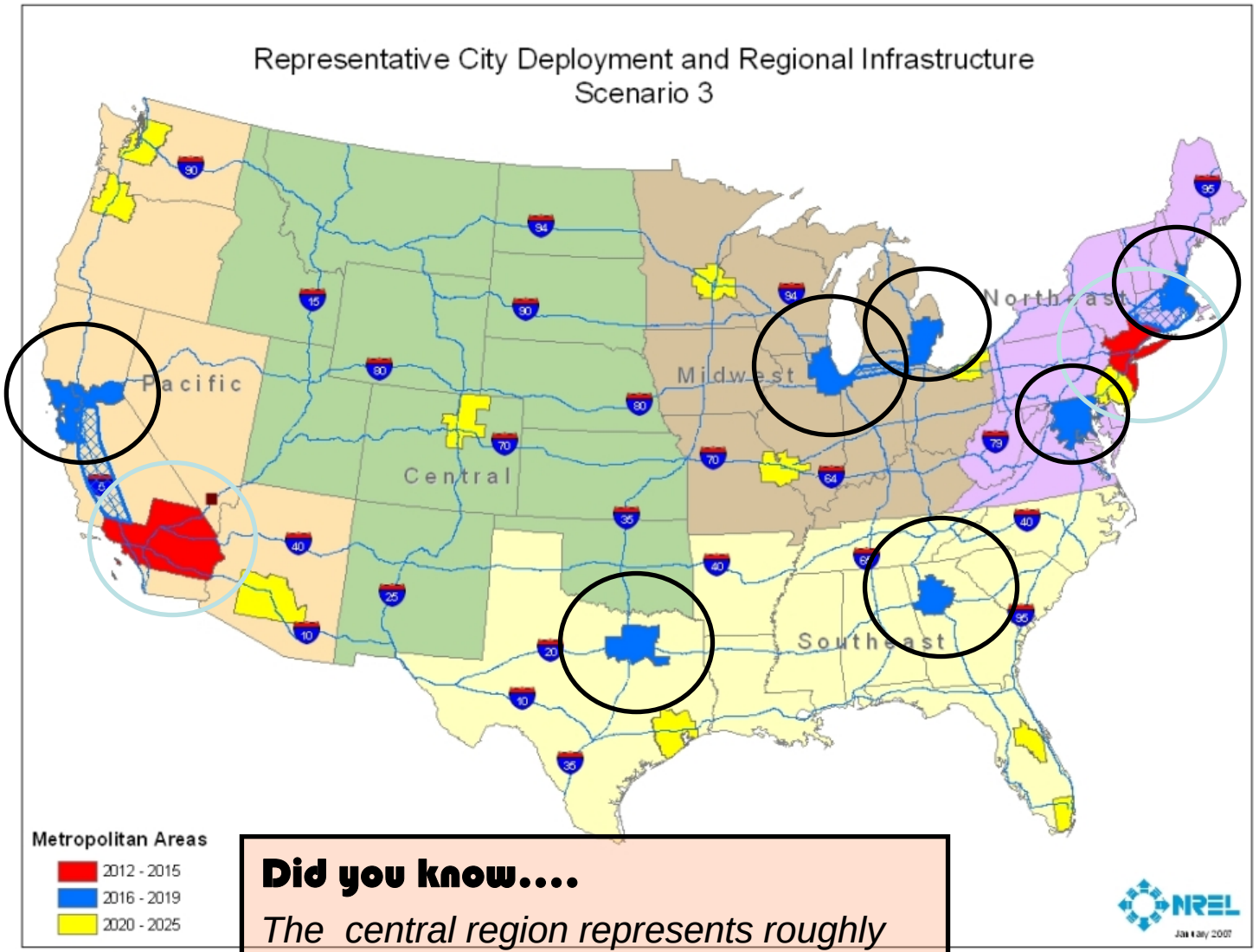
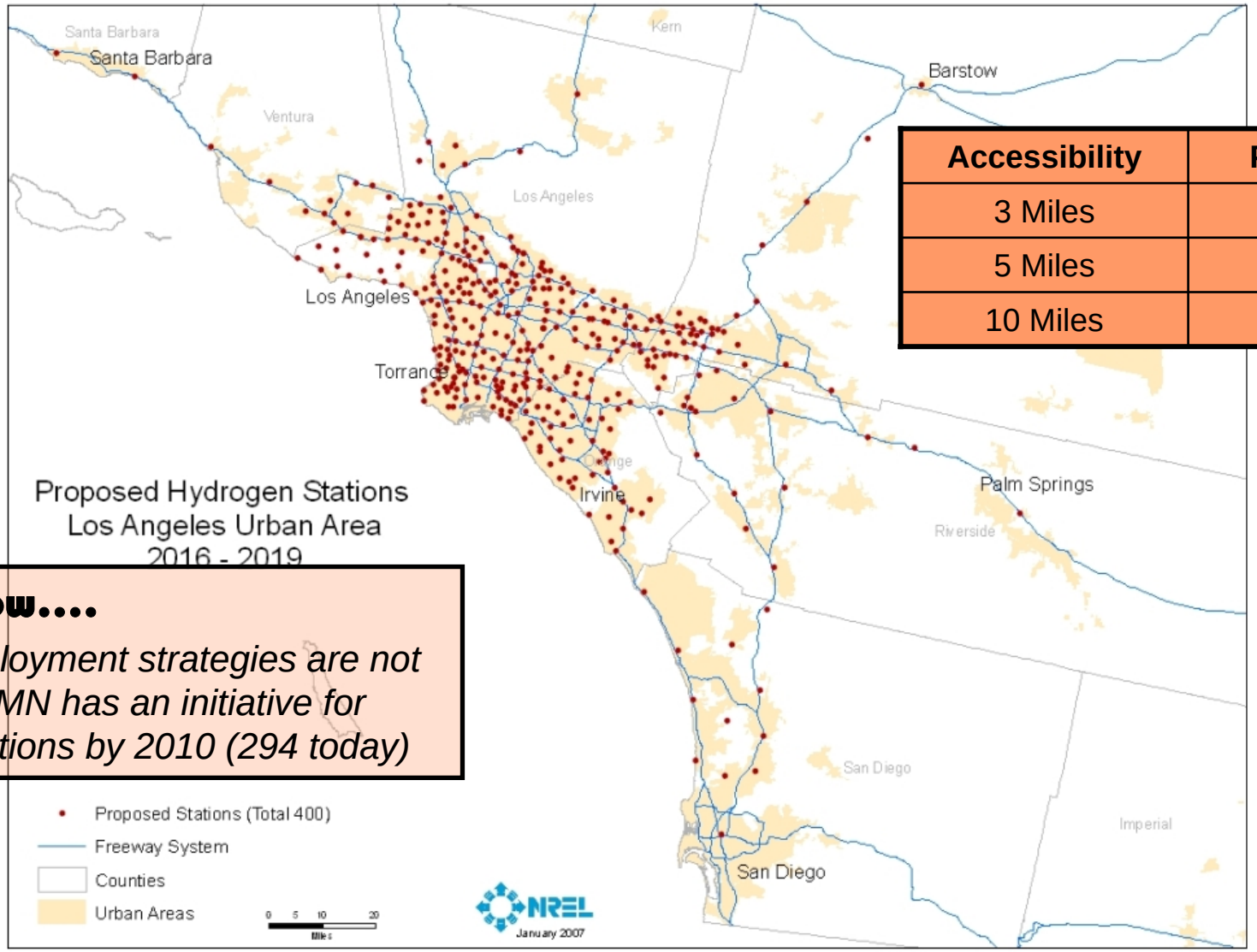
# 2016-2019: Targeted growth




**Did you know....**

*The central region represents roughly 10% of US gasoline consumption*

# 2016-2019: Targeted growth - LA

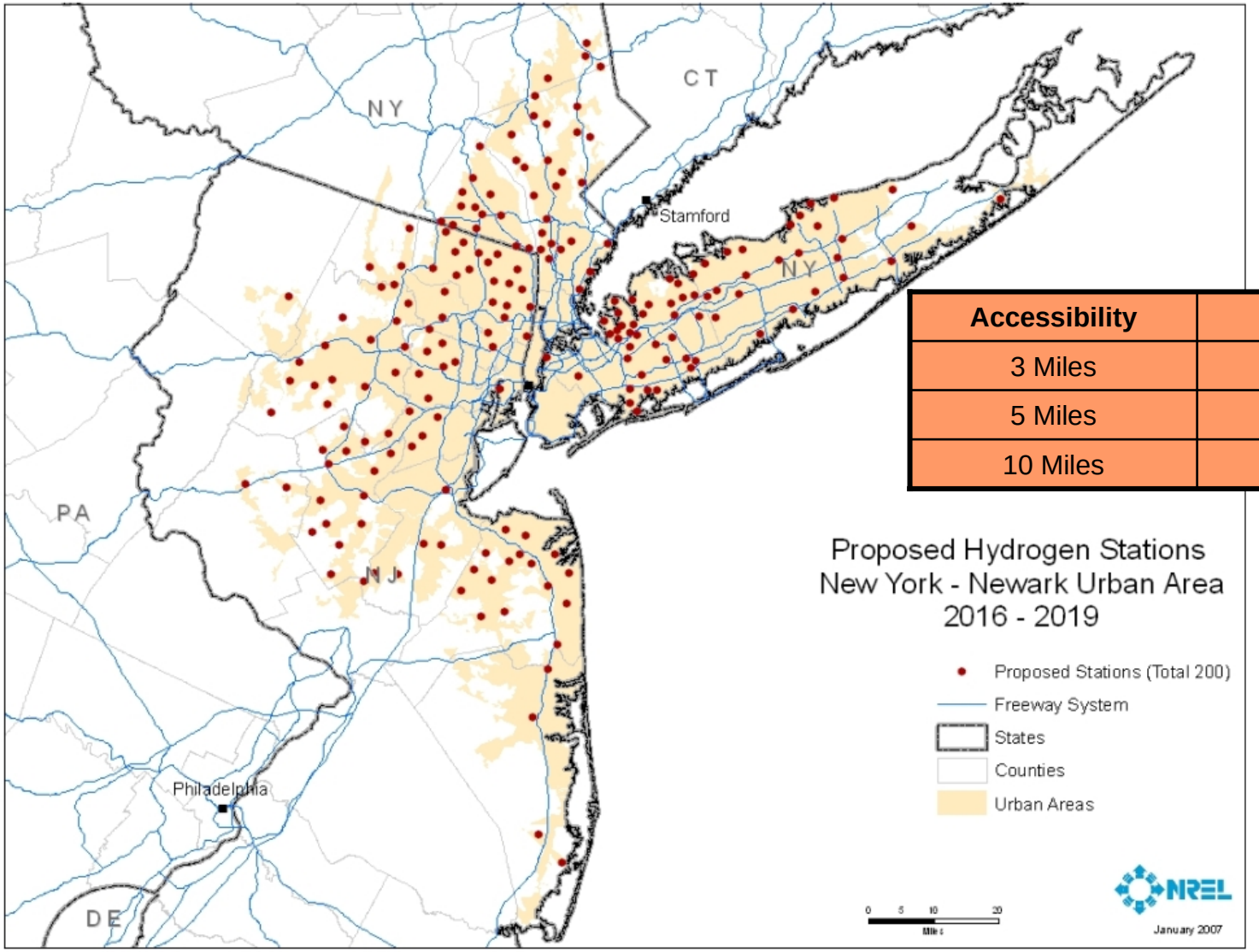



| Accessibility | Population |
|---|---|
| 3 Miles | 73% |
| 5 Miles | 83% |
| 10 Miles | 94% |

**Did you know....**

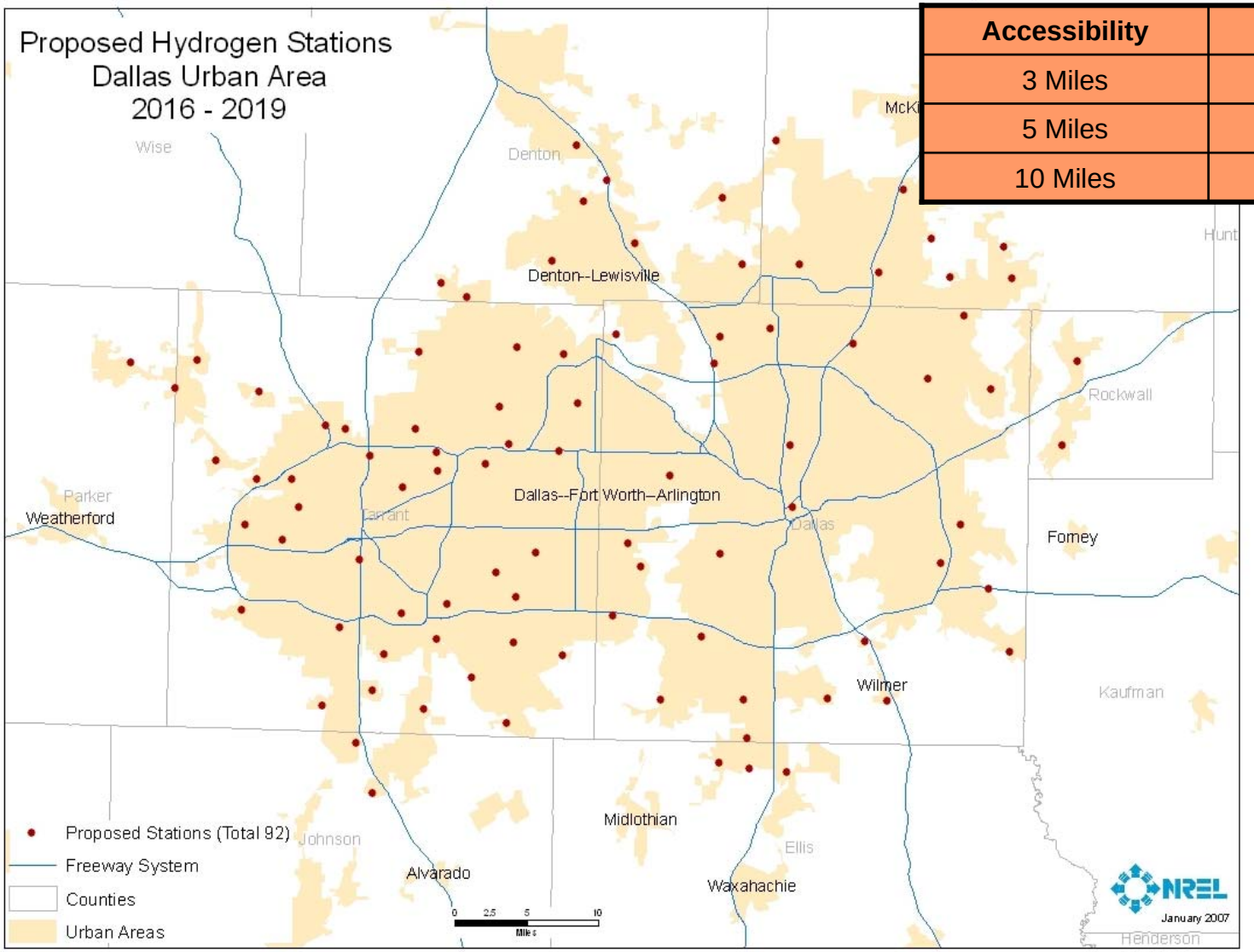
Targeted *deployment strategies are not uncommon. MN has an initiative for 1800 E85 stations by 2010 (294 today)*

# 2016-2019: Targeted growth - NY




| Accessibility | Population |
|---|---|
| 3 Miles | 57% |
| 5 Miles | 73% |
| 10 Miles | 76% |

# 2016-2019: Targeted growth - Dallas




| Accessibility | Population |
|---|---|
| 3 Miles | 62% |
| 5 Miles | 86% |
| 10 Miles | 96% |

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| **Total** | **60** | **1282** | **3895** | **7939** |

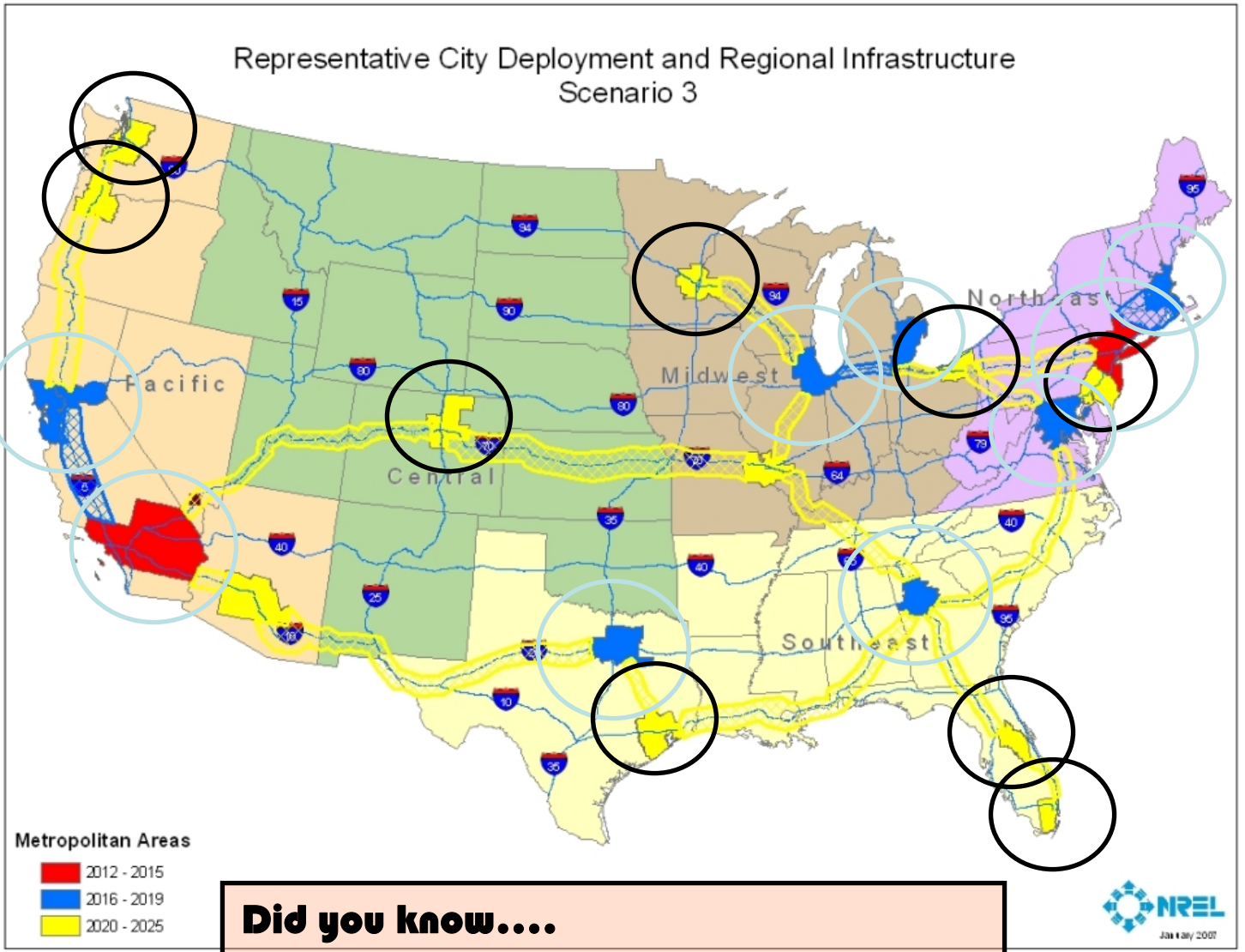
2020-2025: **Inter-Regional expansion**

Pipelines become critical

Good H2 demand (LA/NY)

All demand considered

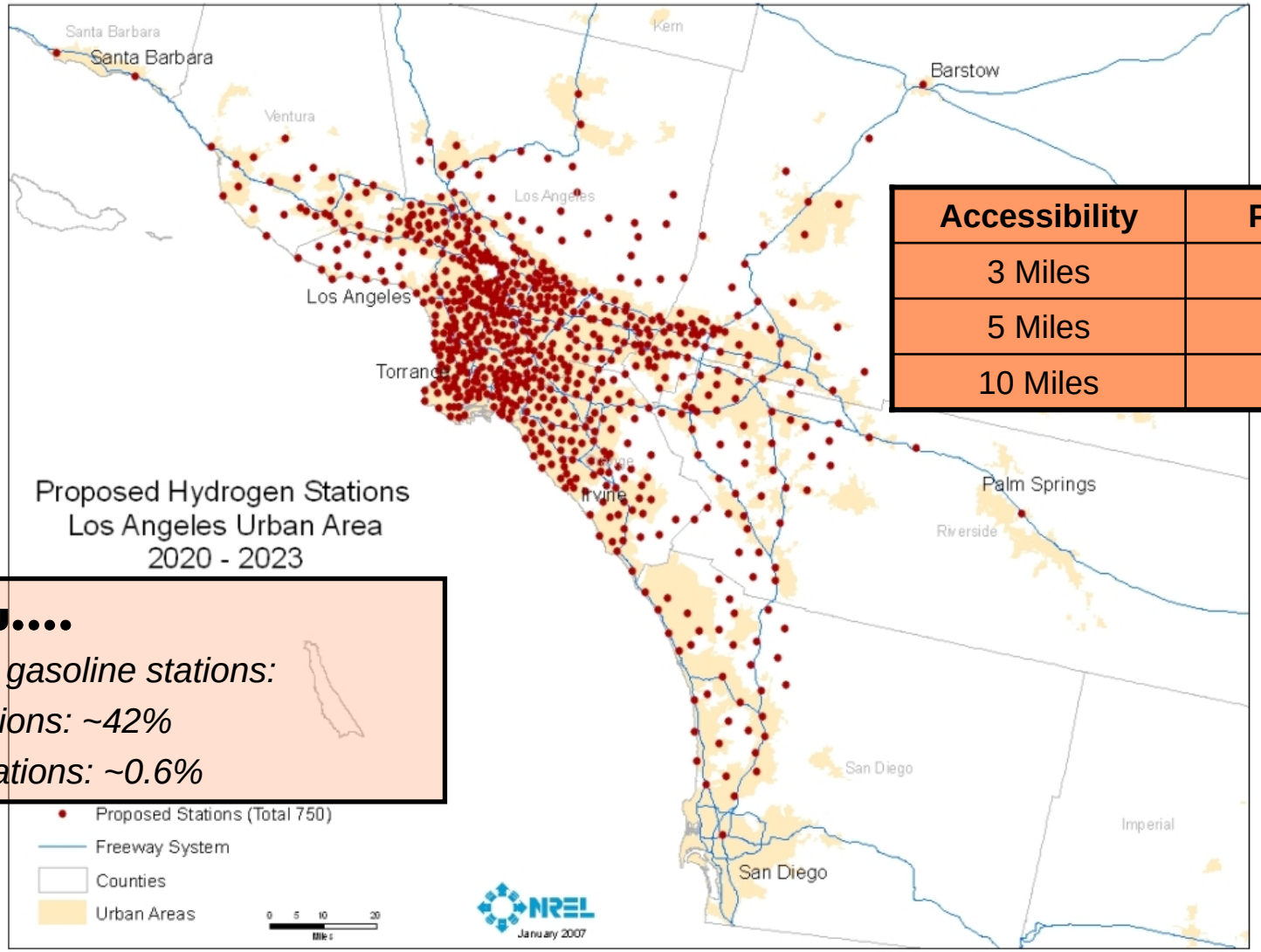
# 2020-2025: Inter-Regional Expansion




**Did you know....**

*Central region represents 7% of US vehicles.*

# 2020-2025: Inter-Regional expansion LA




| Accessibility | Population |
|---|---|
| 3 Miles | 83% |
| 5 Miles | 89% |
| 10 Miles | 95% |

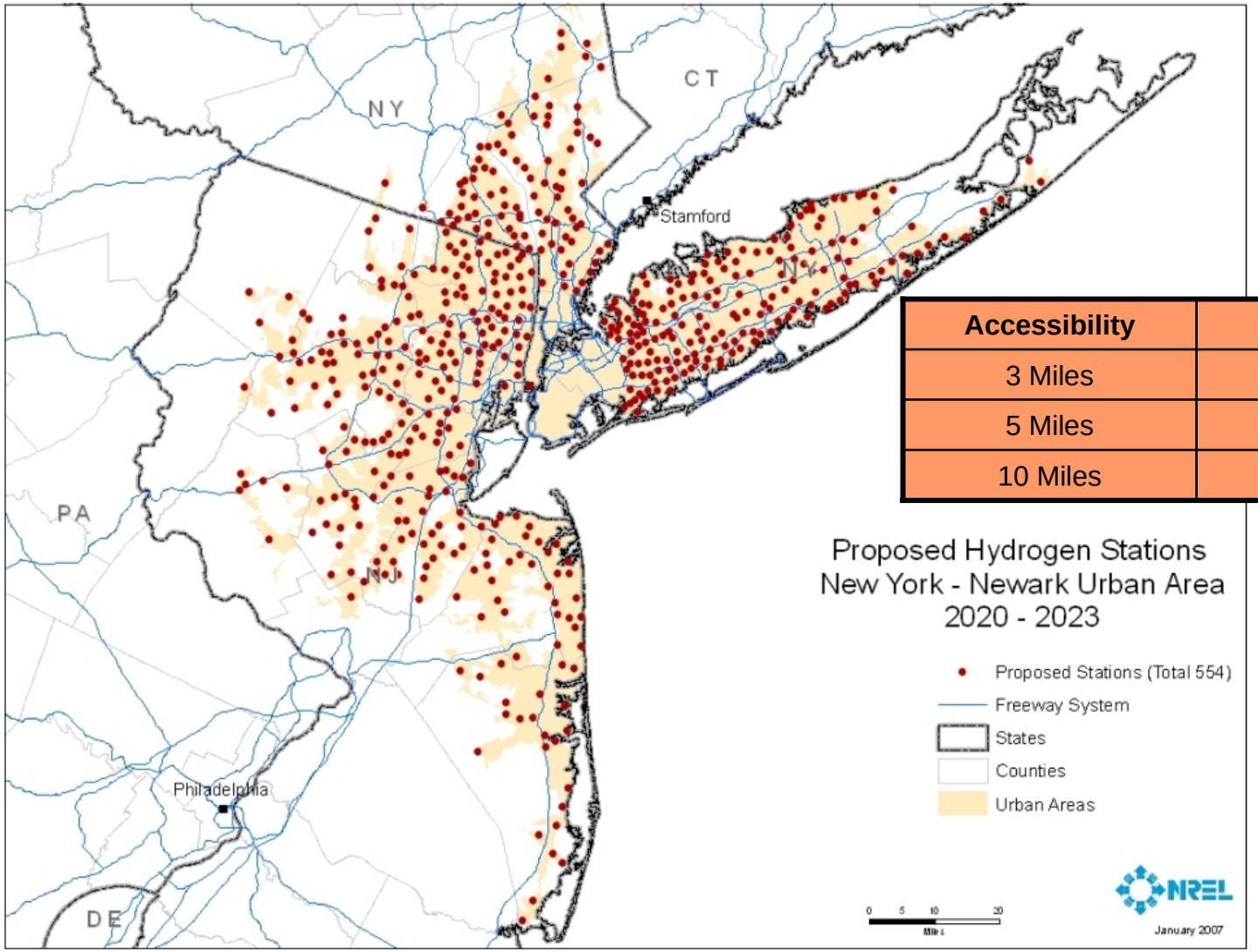
**Did you know....**

*Penetration into gasoline stations:*

*Diesel stations: ~42%*

*Ethanol stations: ~0.6%*

# 2020-2025: Inter-Regional expansion NY

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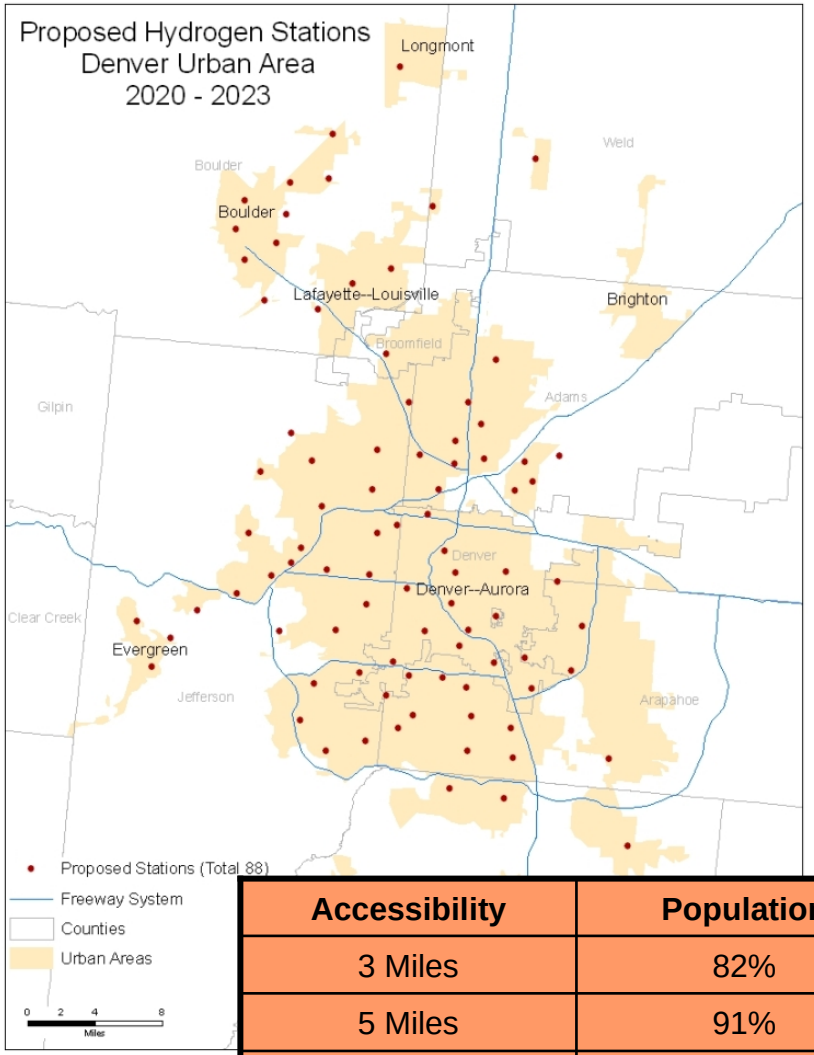
# 2020-2025: Inter-Regional Expansion
# Denver and Minneapolis

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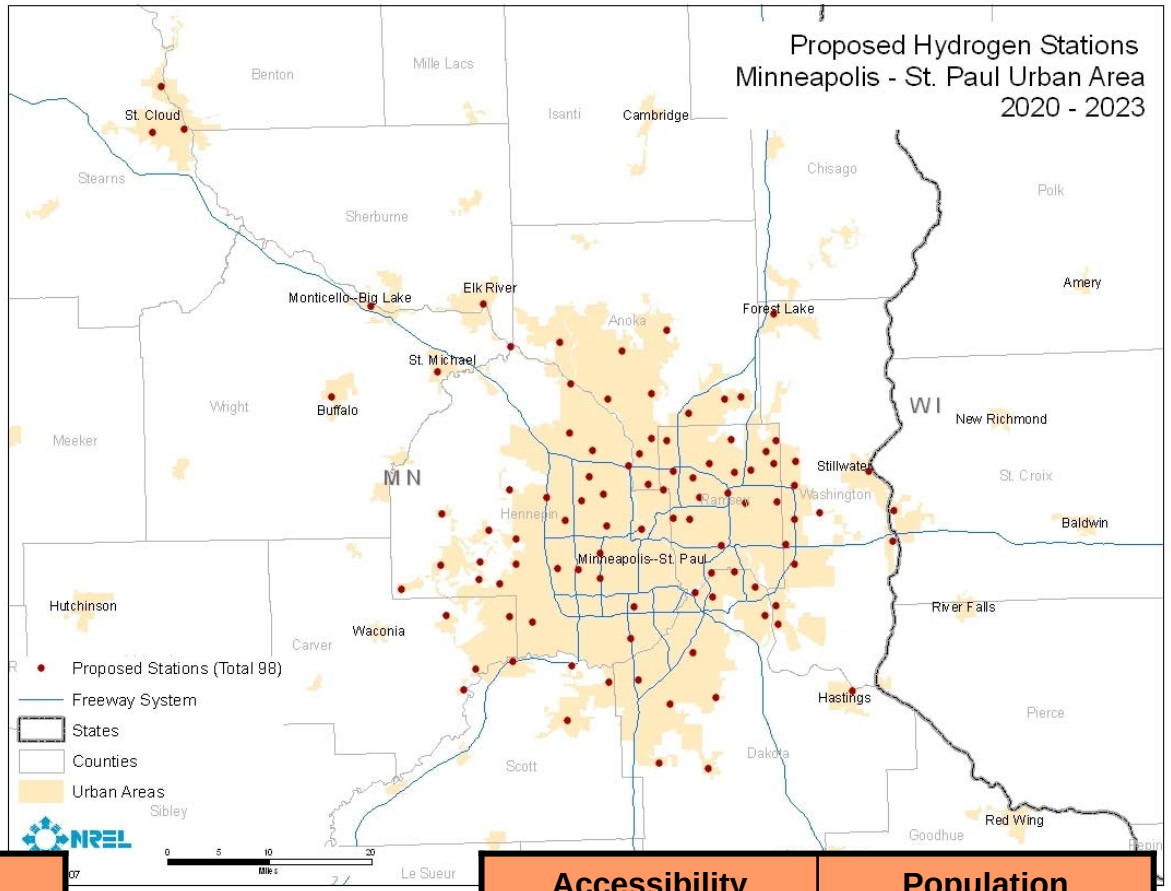


| Accessibility | Population |
|---|---|
| 3 Miles | 78% |
| 5 Miles | 93% |
| 10 Miles | 99% |

# Station Progression and Coverage

| LA – 40 Stations | |
|---|---|
| **Accessibility** | **Population** |
| 3 Miles | 23% |
| 5 Miles | 51% |
| 10 Miles | 88% |

| NY – 20 Stations | |
|---|---|
| **Accessibility** | **Population** |
| 3 Miles | 12% |
| 5 Miles | 31% |
| 10 Miles | 66% |

| LA – 400 Stations | |
|---|---|
| **Accessibility** | **Population** |
| 3 Miles | 73% |
| 5 Miles | 83% |
| 10 Miles | 94% |

| NY – 200 Stations | |
|---|---|
| **Accessibility** | **Population** |
| 3 Miles | 57% |
| 5 Miles | 73% |
| 10 Miles | 76% |

| LA – 750 Stations | |
|---|---|
| **Accessibility** | **Population** |
| 3 Miles | 83% |
| 5 Miles | 89% |
| 10 Miles | 95% |

| NY – 560 Stations | |
|---|---|
| **Accessibility** | **Population** |
| 3 Miles | 80% |
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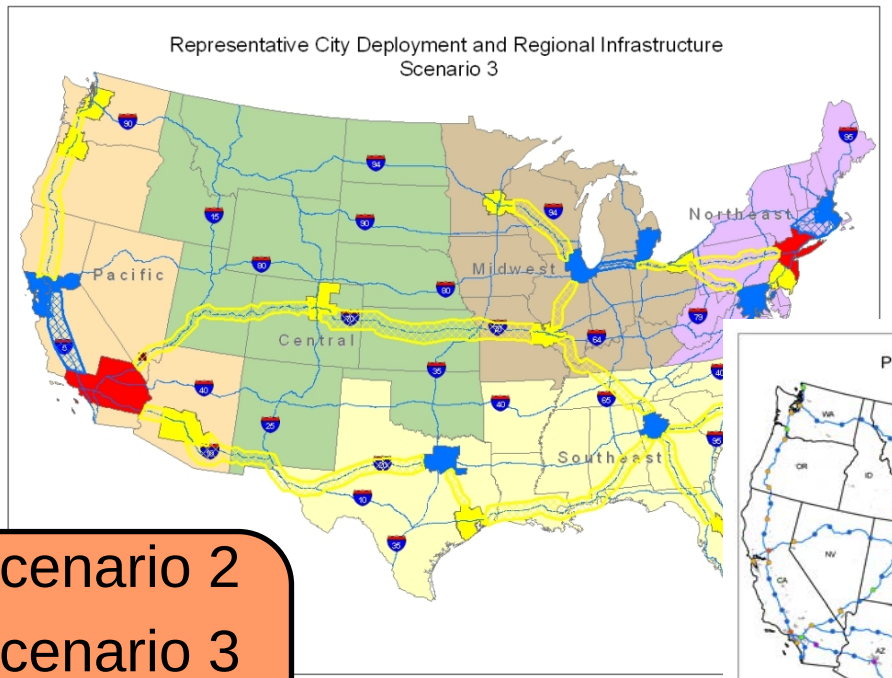
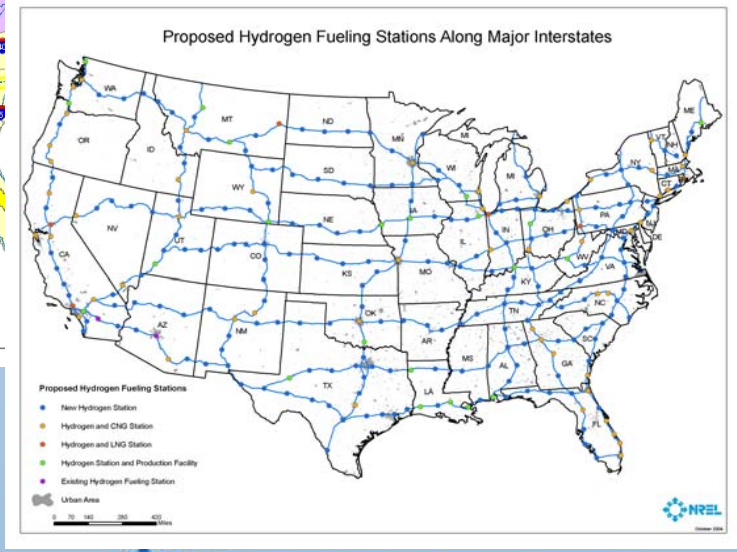
# 2021-2025: Widespread utilization in Scenario 3

- 15%+ of existing gasoline stations in key cities
- Connecting stations enable inter-regional transport
- Focus on pipeline distribution




4000 stations in scenario 2

8000 stations in scenario 3

~85 interconnect stations

~200 other interstate stations

# Project Summary and Conclusions

- Each geographic location has unique properties that make infrastructure unique
- Strategically placing stations maximizes coverage early
- Rollouts are very aggressive, but at 7% to 15% there is adequate coverage for transition (based upon 3, 5, and 10 mile travel distances)