



Scenario Analysis Meeting

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Purposes of Studies

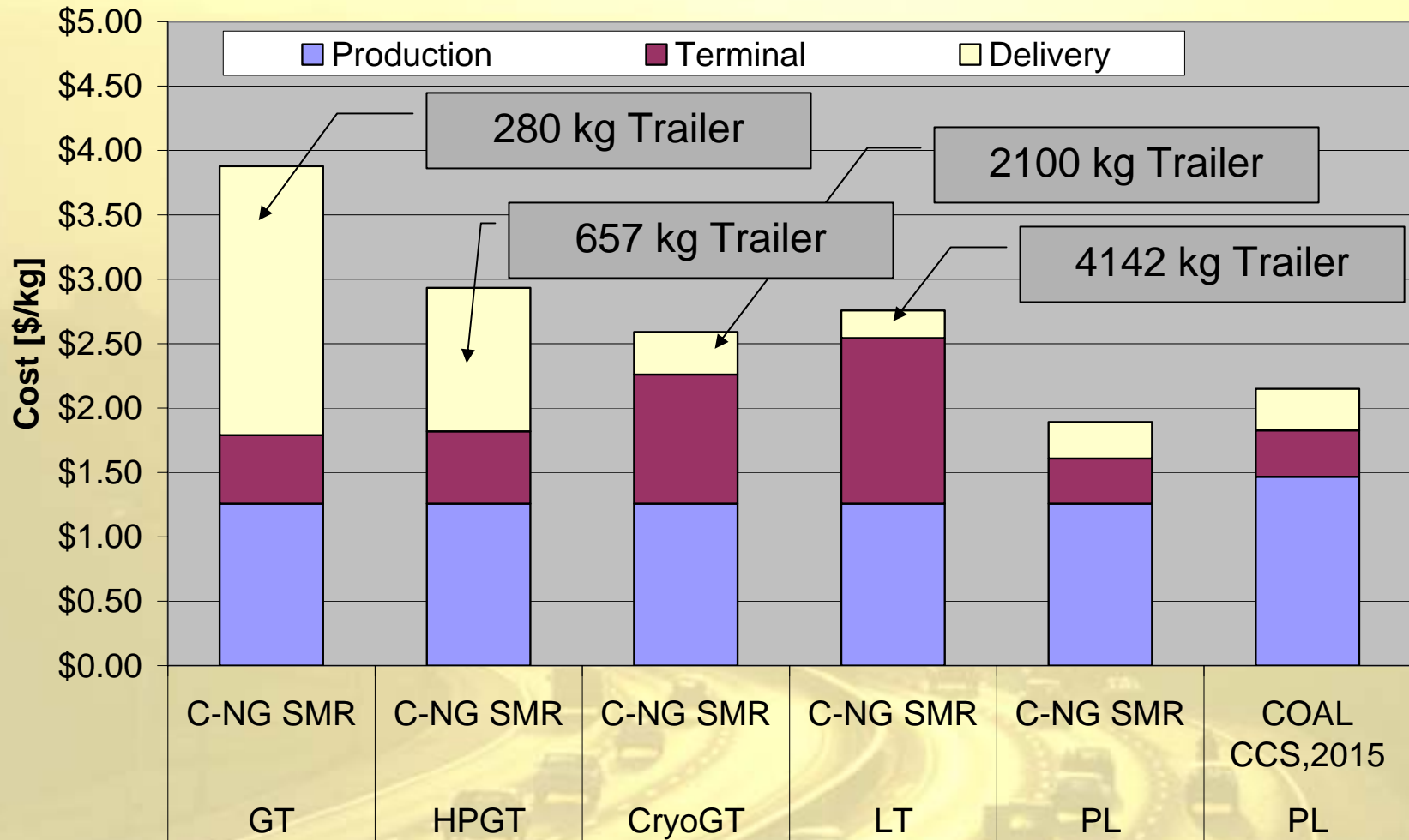
- Assess the costs associated with different scenarios to achieve the market transformation of hydrogen fuel cell vehicles
- No recommendations will be made as to which scenario is to be adopted
- The report will be provided to the National Academy of Sciences and the Hydrogen Technical Advisory Committee in March, 2007 for their utilization

Natural Gas Distributed Reforming R&D

- Praxair Low-Cost Hydrogen Production Platform: DFMA to lower the part count and simplify integration.
- BOC Integrated System: Reforming, purification and compression in an integrated system
- GE Staged Catalytic Partial Oxidation Hydrogen Generator: Short contact time catalysts into a single compact reactor reducing footprint.
- H2Gen Innovations Low Cost Production System: High reformer throughput, low installation costs, reduced footprint
- Air Products and Chemicals Inc. Turn-key fueling station, highly efficient (82%) PSA, overall 65% system efficiency, H2 generator operated more than 2,000 hours

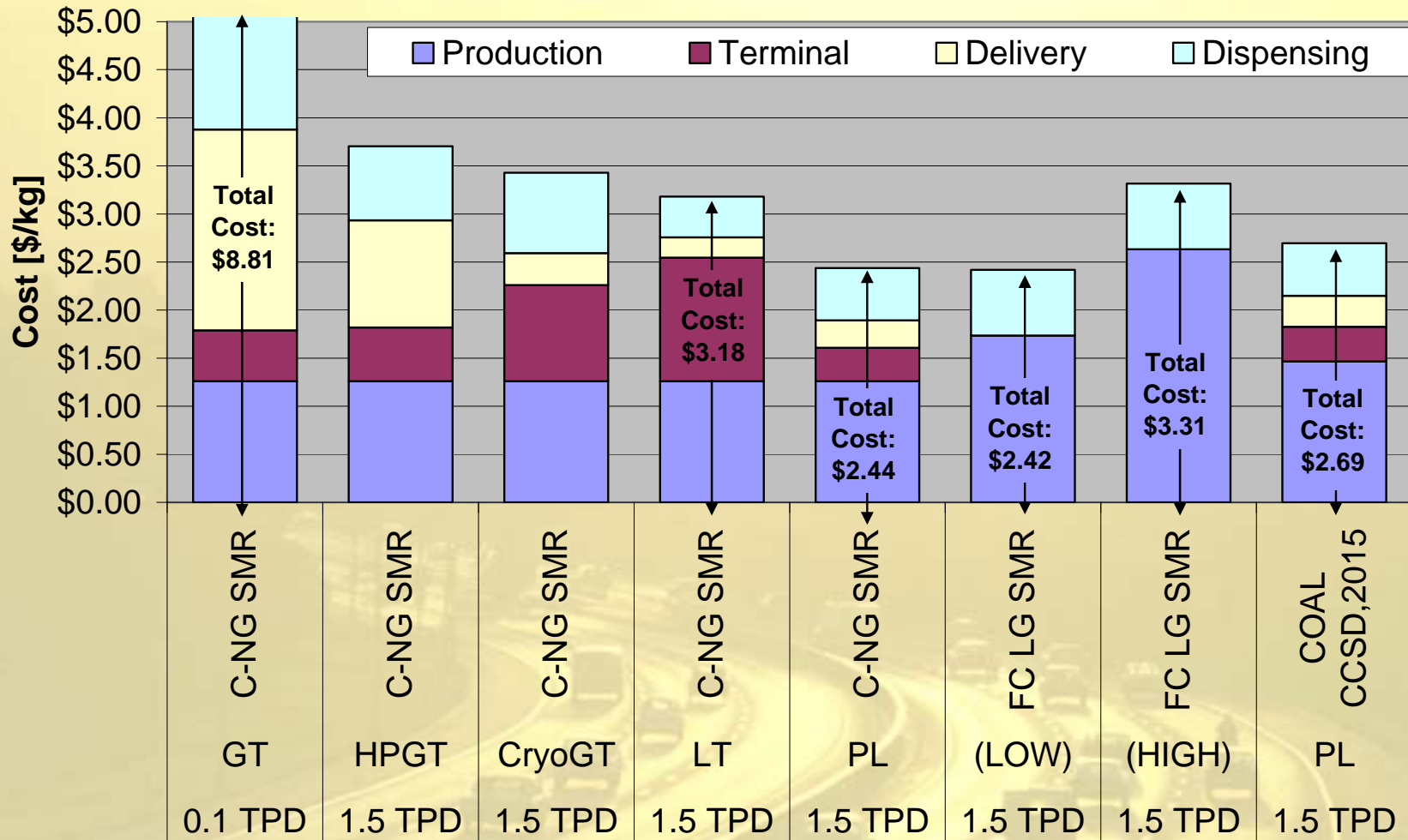


Delivery Costs



30 miles beyond city edge

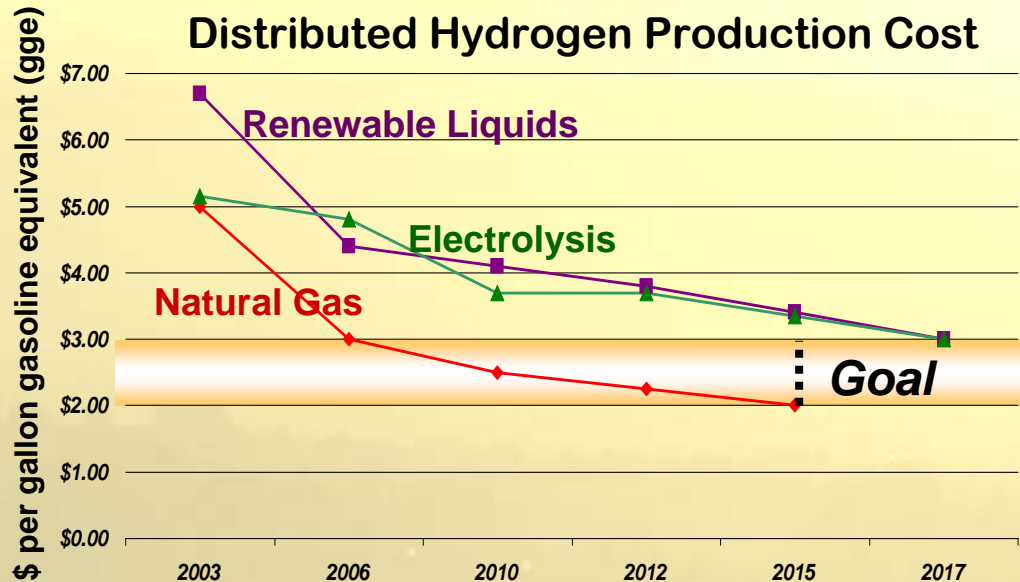
Total Pathway Costs



30 miles beyond city edge

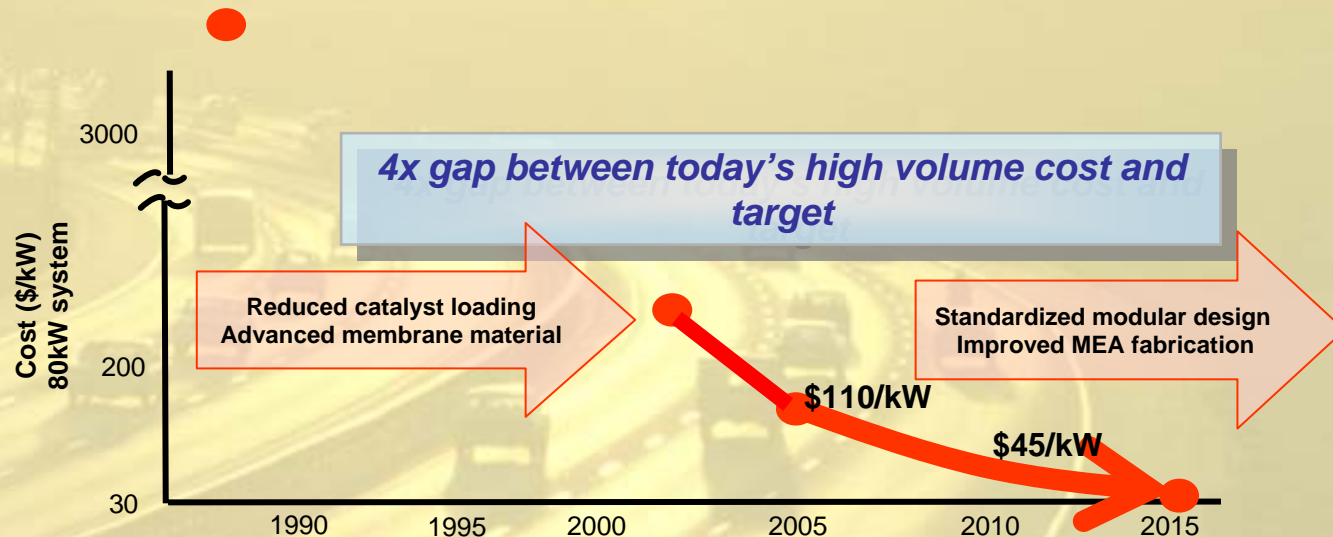
Cost Reduction Accomplishments

Distributed Hydrogen Production Cost



Industry is reducing the cost of distributed hydrogen production technologies.

Industrial programs have reduced the cost of fuel cells.



Technology Validation Progress

Vehicle/Infrastructure Learning Demonstration

- Ten hydrogen fueling stations currently; a total of 18 planned by 2009
- Currently, 69 hydrogen FCVs; an additional 62 planned for 2007-08 with 50,000-mile fuel cell systems
- Fuel cell systems with 53-58% efficiency, vehicle range of 103-190 miles, and durability of 950 hours (~ 30,000 miles)
- Second generation vehicles are being produced with 10,000 psi storage and new fuel cells with longer durability. A series hybrid configuration has been built



up to 40 vehicles/ 4 stations



up to 26 vehicles/ 4 stations



UTC Fuel Cells
A United Technologies Company

up to 32 vehicles/ 4 stations



DAIMLERCHRYSLER

up to 33 vehicles/ 6 stations

2010-2025 Scenario Analyses

2005

2010

2015

2020

2025

Hydrogen Fuel Initiative

R&D to Meet Targets

Technology Readiness based on lab results and high-pressure storage

Learning Demo 1

Learning Demo 2

Gen 1

Gen 2

Gen 3

Gen 4

2,000 hours FC durability
250 mile range
\$3/gge H₂ at pump

5,000 hours FC durability
300+ mile range
\$2.50/gge at pump

Hydrogen Fuel Initiative

Production vehicles

Alternative Scenario Analyses

Learning Demo 2

Gen 3

Gen 4

Cold Start

3,500 hours durability

5,000 hours FC durability
300+ mile range
\$2.50/gge at pump

Lighthouse Valid.

Production vehicles based on road tests and integrated fuel network

Policy Actions

Infrastructure, Vehicle

Market Penetration Scenarios

Transition Analysis Workshops addressed three scenarios

Scenario 1: Hundreds to *thousands* of vehicles per year by 2012 and by 2018 *tens of thousands* of vehicles per year. This option is expected to lead to a market penetration of 2.0 million FCVs by 2025.

Scenario 2: *Thousands* of FCVs by 2012, *tens of thousands* by 2015 and *hundreds of thousands* by 2018. This option is expected to lead to a market penetration of 5.0 million FCVs by 2025.

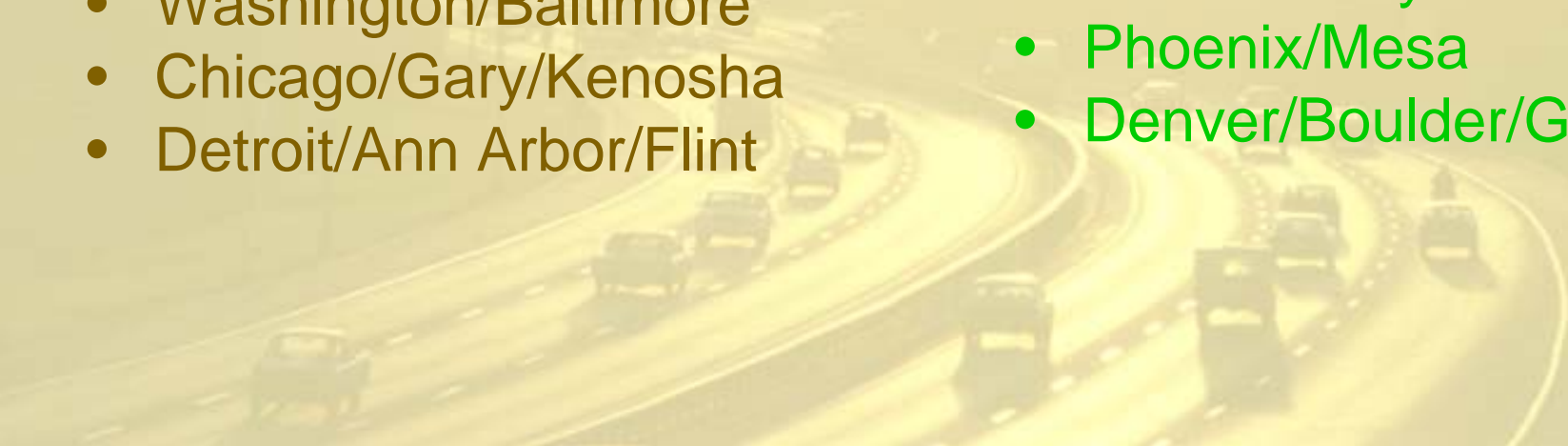
Scenario 3: *Thousands* of FCVs by 2012, and *millions* by 2021 such that market penetration is 10 million by 2025. (NRC scenario)

These scenarios are provided for transition analyses as recommended by the National Research Council to evaluate the transition phase and do not represent any specific policy recommendation.

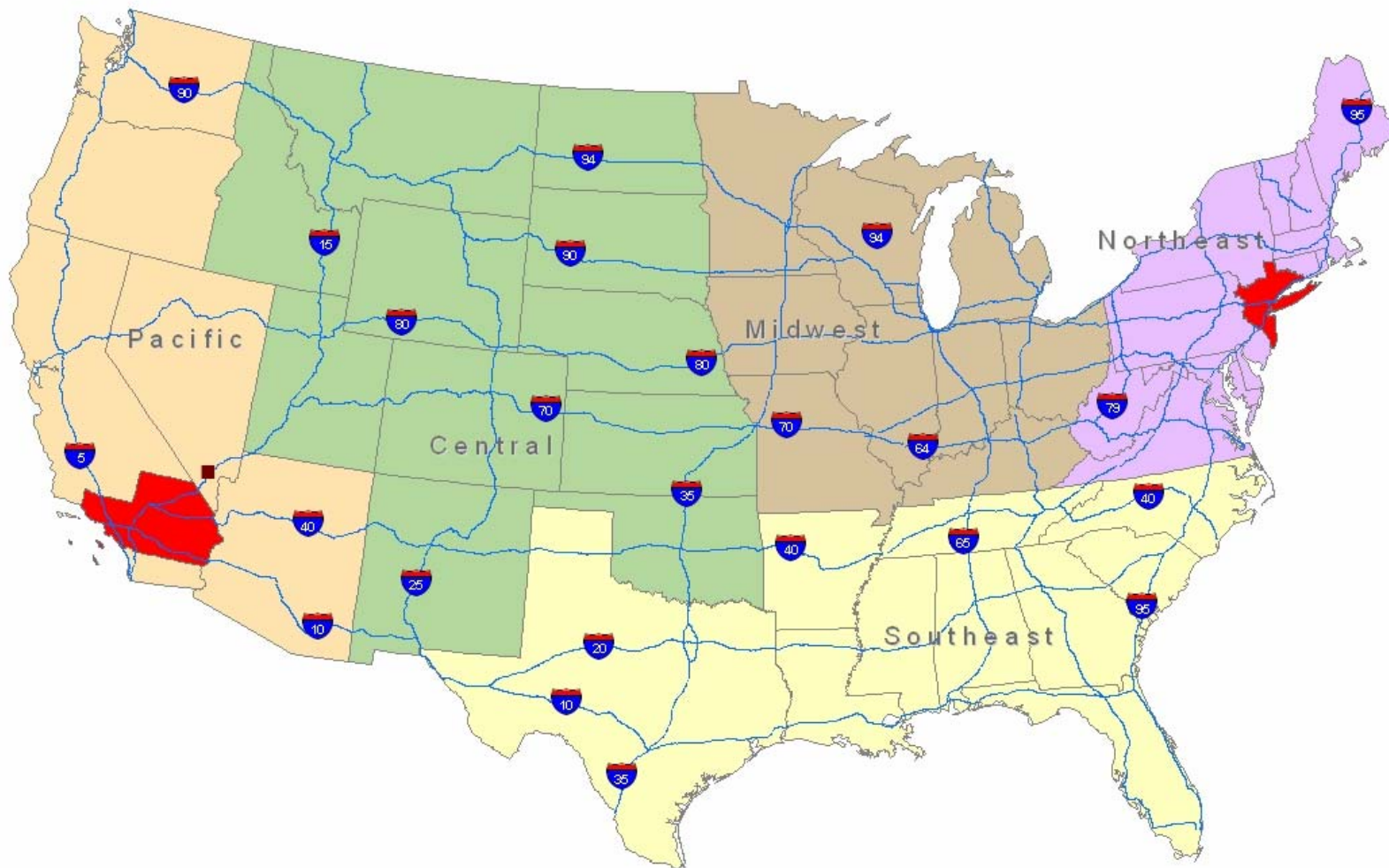
Top Urban Areas

Lighthouse Concept Targets

- New York/Northern NJ/Long Island
- Los Angeles/Riverside/Orange County/San Diego
- 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



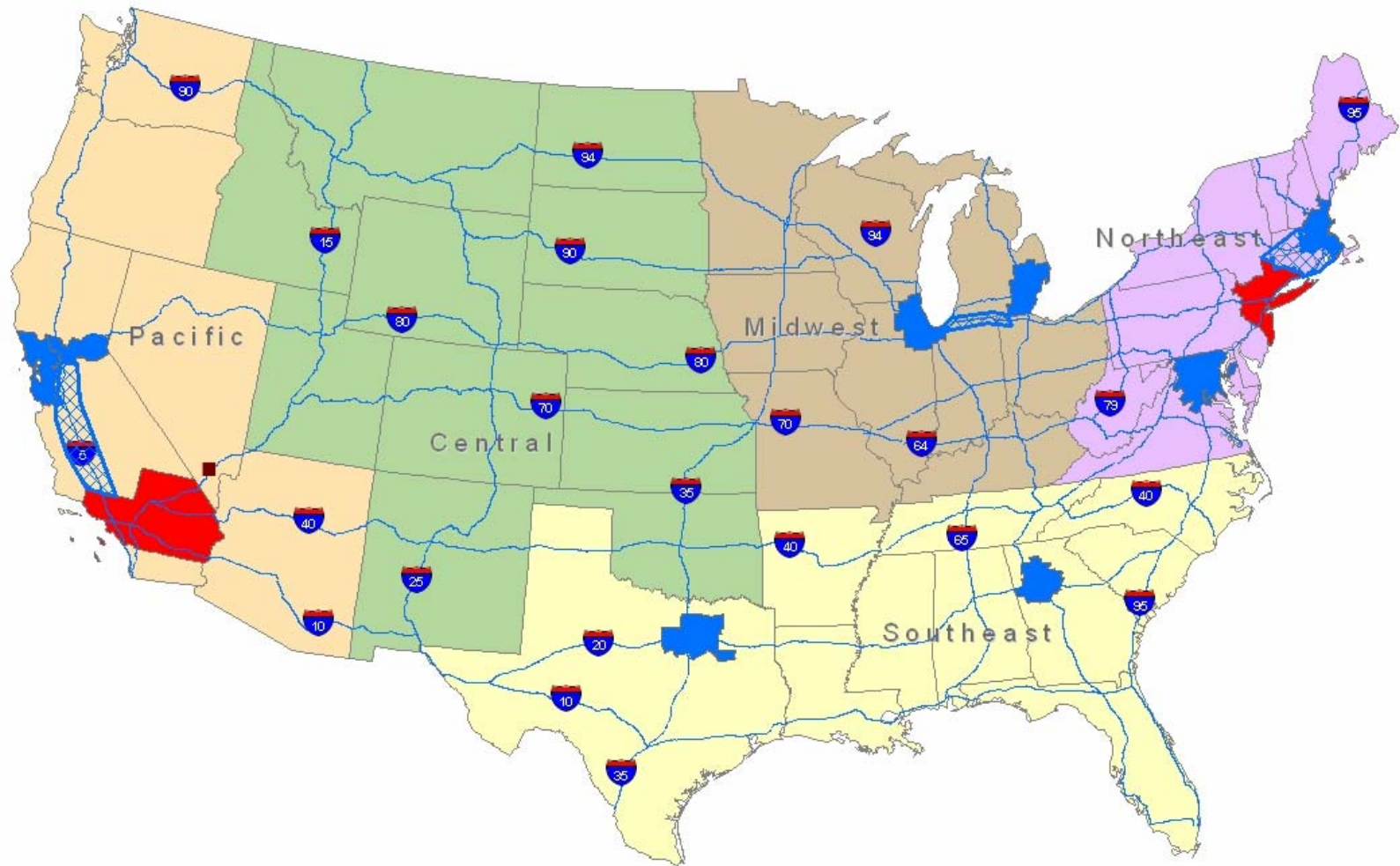
Representative City Deployment and Regional Infrastructure by 2025



Metropolitan Areas

2012 - 2015

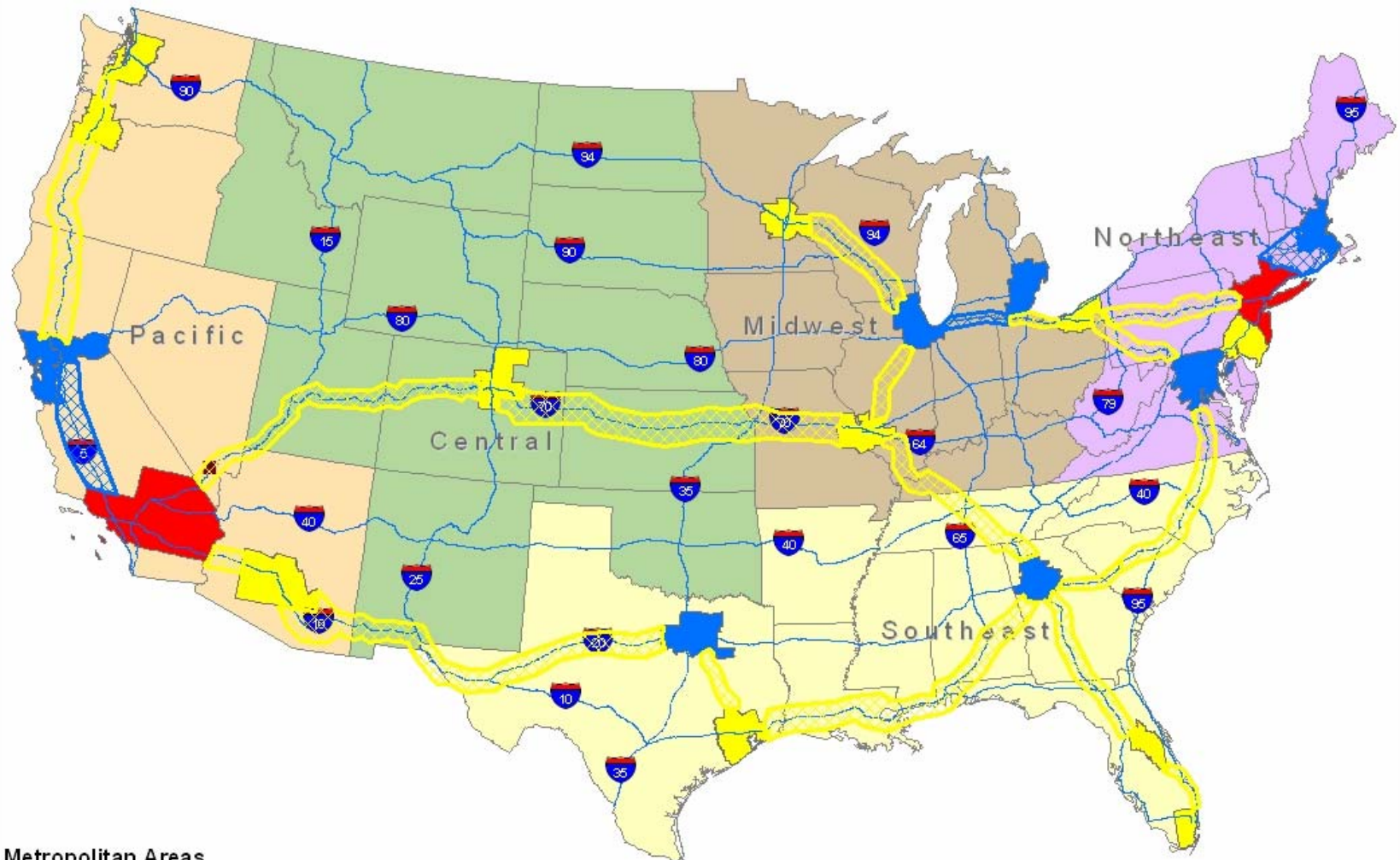
Representative City Deployment and Regional Infrastructure by 2025



Metropolitan Areas



Representative City Deployment and Regional Infrastructure by 2025



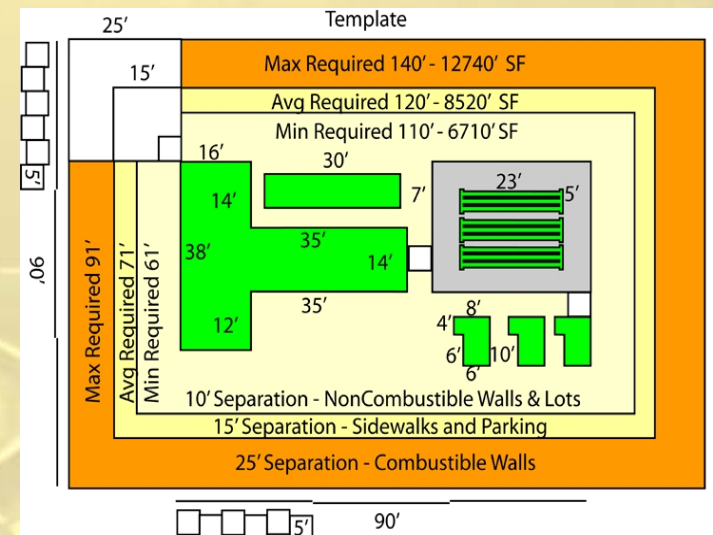
Metropolitan Areas

- 2012 - 2015
- 2016 - 2019
- 2020 - 2025

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 space

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



Policy Options

Part of Prior Legislation

- EPACT 2005 Section 808 – Demonstrations
- EPACT 2005 Section 805 - Programs- H2 Supply
- SAFETEA-LU (DOT) – Ethanol Tax Credit - \$0.50/gal.
- EPAct 2005 Subtitle D— Alternative Motor Vehicles and Fuels Incentives provides a credit for energy efficient vehicles that fall into the following categories*:
 - 1) Fuel Cell Vehicles
 - 2) Advanced Lean Burn Technology Vehicles
 - 3) Hybrid vehicles
 - 4) Alternative Fuel vehicles

New Options

- Investment Tax Credits
- Carbon Taxes
- Accelerated Depreciation
- Loan Guarantees
- CAFÉ Standards
- Early Buy Down Programs

*As defined by the Internal Revenue Code §30B

Cases Evaluated

- Hydrogen Fuel Initiative
- **Case 1** – Cost share incremental costs 50/50 (government/industry)
- **Case 2** – Cost share vehicle costs 50/50 (government/industry) to 2017 and tax credits provided for vehicle incremental cost 2018 to 2025
- **Case 3** – Tax credits provided for market incentives
- **Case 4** – Consider impact of Carbon taxes