Geographically Based Hydrogen Demand & Infrastructure Analysis

Prepared for:

2010-2025 H2 Scenario Analysis Meeting

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Objectives

FY 2006

- Quantify hydrogen demand in the U.S.
- Propose infrastructure scenarios to meet emerging hydrogen demand

FY 2005

- Quantify and locate a minimal interstate-based hydrogen infrastructure

Approach

- Identify key attributes affecting hydrogen vehicle adoption by consumers
    - Demographic
    - Policy
- Prioritize and combine attributes
- Evaluate scenarios
- Determine H2 demand based upon likelihood of vehicle adoption
- Understand infrastructure options at various penetration rates

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Hydrogen Analysis Diagram
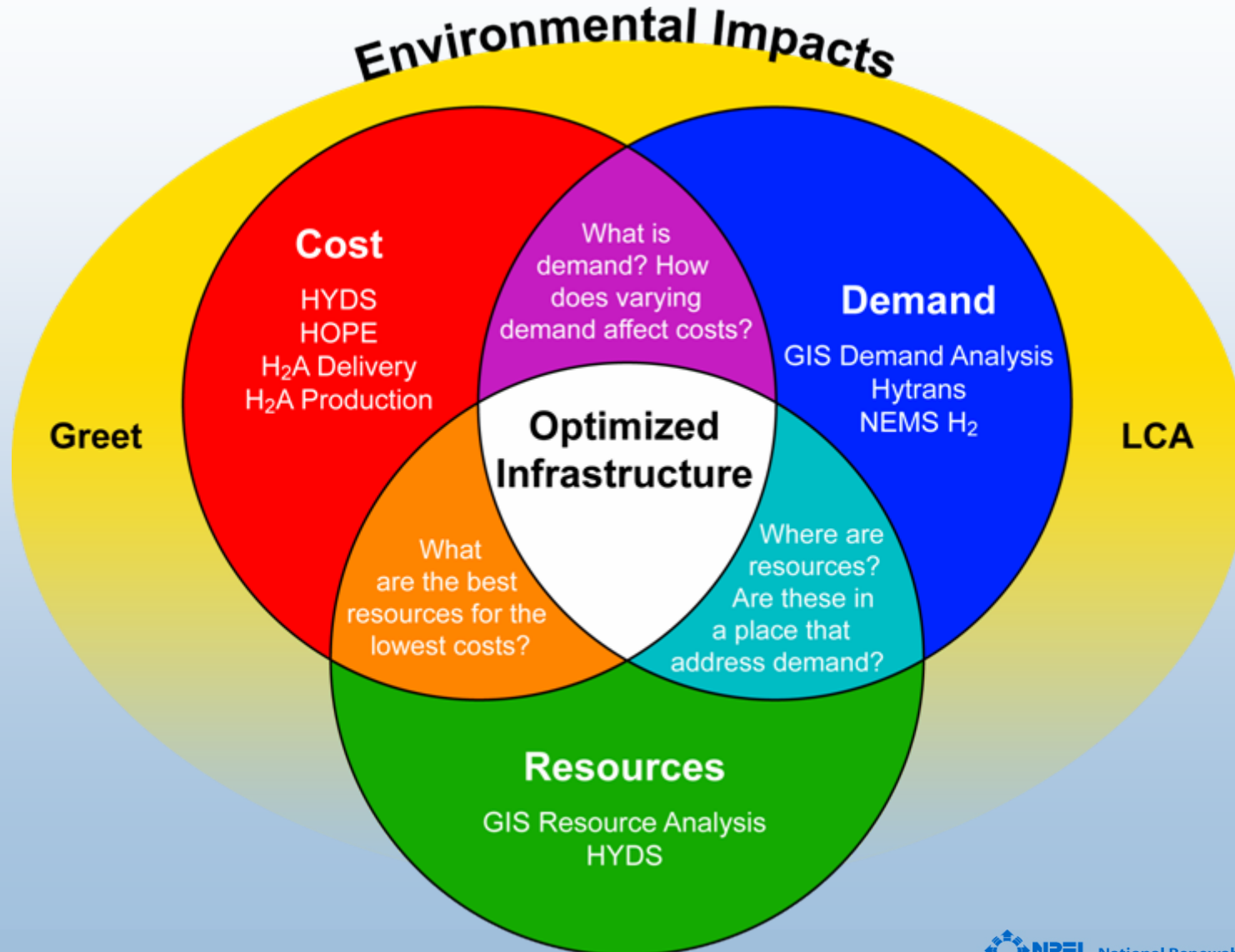
Identify Key Demographic Attributes

Number of Households with Two or More Vehicles

Number of Households with 2+ Vehicles (Thousand)
- Above 150
- 100 - 150
- 50 - 100
- 25 - 50
- 10 - 25
- 1 - 10
- 0

Source: U.S. Census Bureau

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June 2006
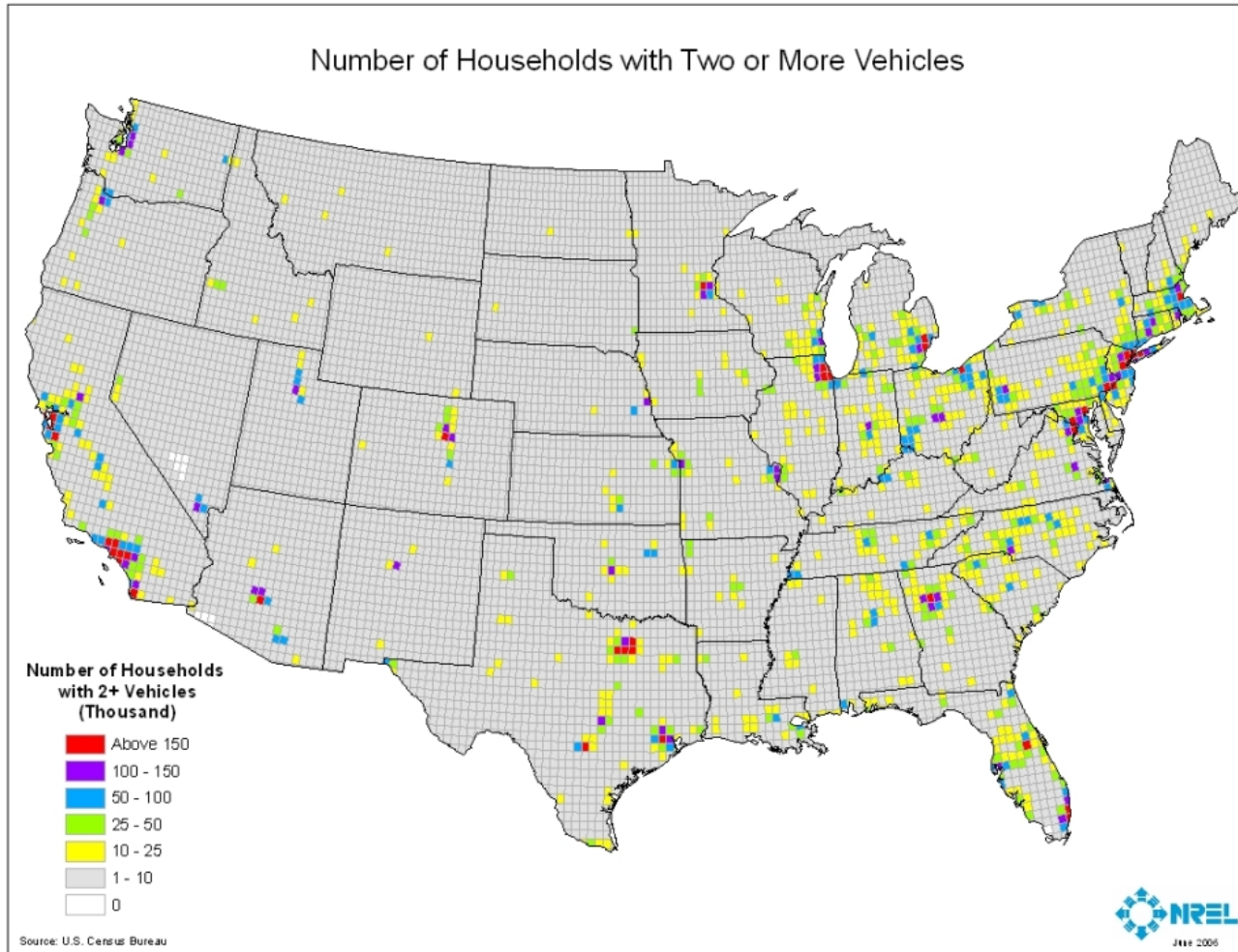
- 2+ vehicle households
- Education
- Commuting distance
- Household income

Identify Key Policy Attributes

State Incentives

Total Number of State Incentives
- 10 – 18
- 5 – 9
- 1 – 4
- 0

January 2006
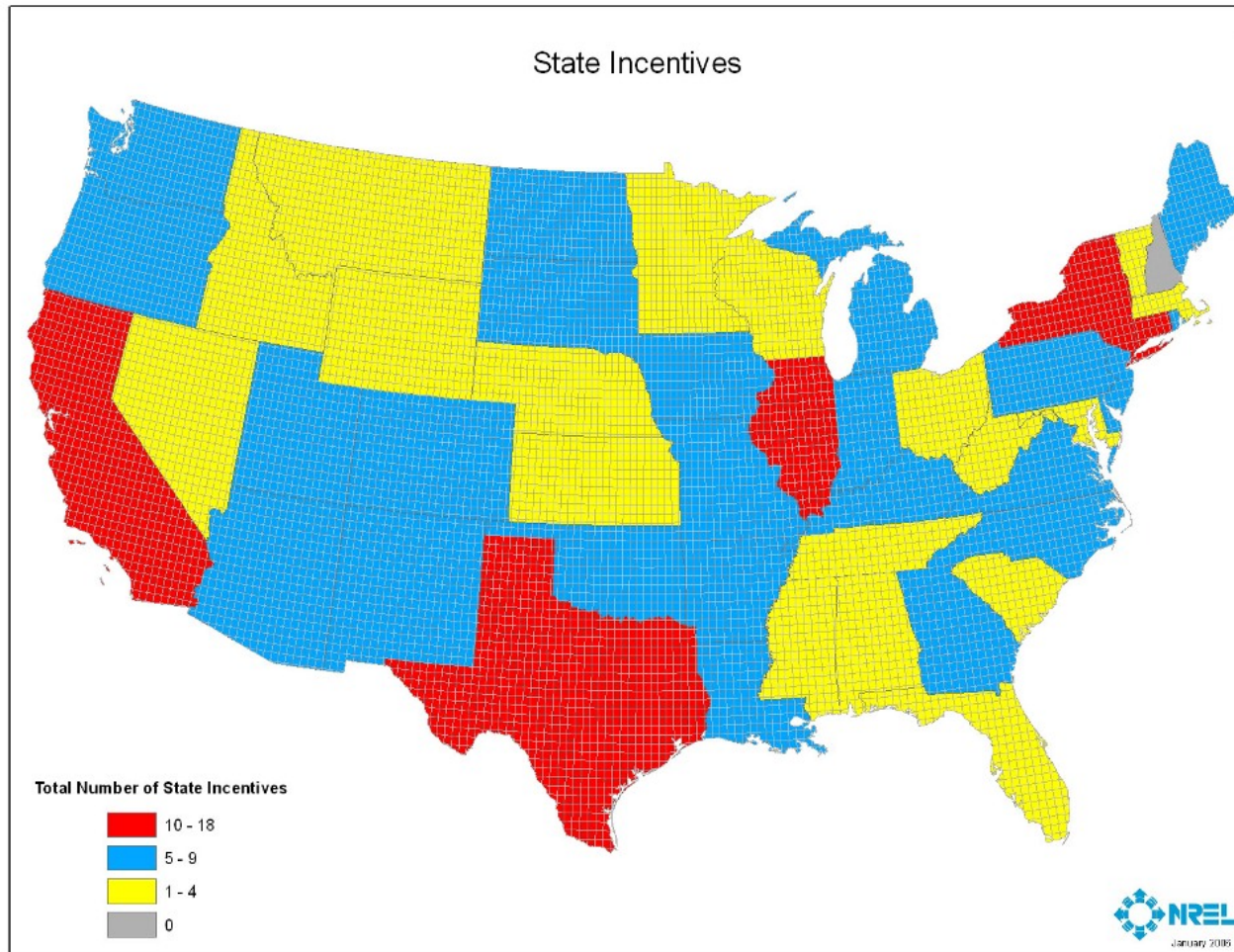
- Air quality
- State incentives
- Clean Cities coalitions
- Hybrid registrations
- ZEV mandate

Baseline Scenario Analysis

Consumer hydrogen vehicle demand = $\mathbf{F}$ (attributes)

Attribute	Impact
Households with 2+ vehicles	High
Education	Medium
Household income	High
Commute distance	Medium
State incentives	Medium
Clean Cities Coalitions	Medium
Air quality	Medium
Hybrid vehicle registrations	Medium
Zero-emission vehicle (ZEV) sales mandate	Medium

Baseline Scenario Analysis

"Natural Break" method used to classify attribute

Classes ranked

Influence on demand weighed

Attribute	Values and Classification (number of households)	Scoring of Classification	Weighting
Two or more vehicles per household	0 – 8,064	2	
	8,065 – 30,239	3	
	30,240 – 68,542	4	All attribute weightings combined
	68,543 – 118,940	5	
	118,941 – 179,418	6	
	179,419 – 312,470	7	15% (High)
	312,471 – 516,079	7	

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Baseline Results

Hydrogen Infrastructure Demand
Consumer Strategy

Hydrogen Demand
- Very High
- High
- Very Good
- Good
- Fair
- Low

Good - Very High Demand
10% land area
64% targeted population

Consumer Demographic Emphasis

Hydrogen Infrastructure Demand
Consumer Strategy - Demographic Emphasis

Hydrogen Demand

- Very High
- High
- Very Good
- Good
- Fair
- Low
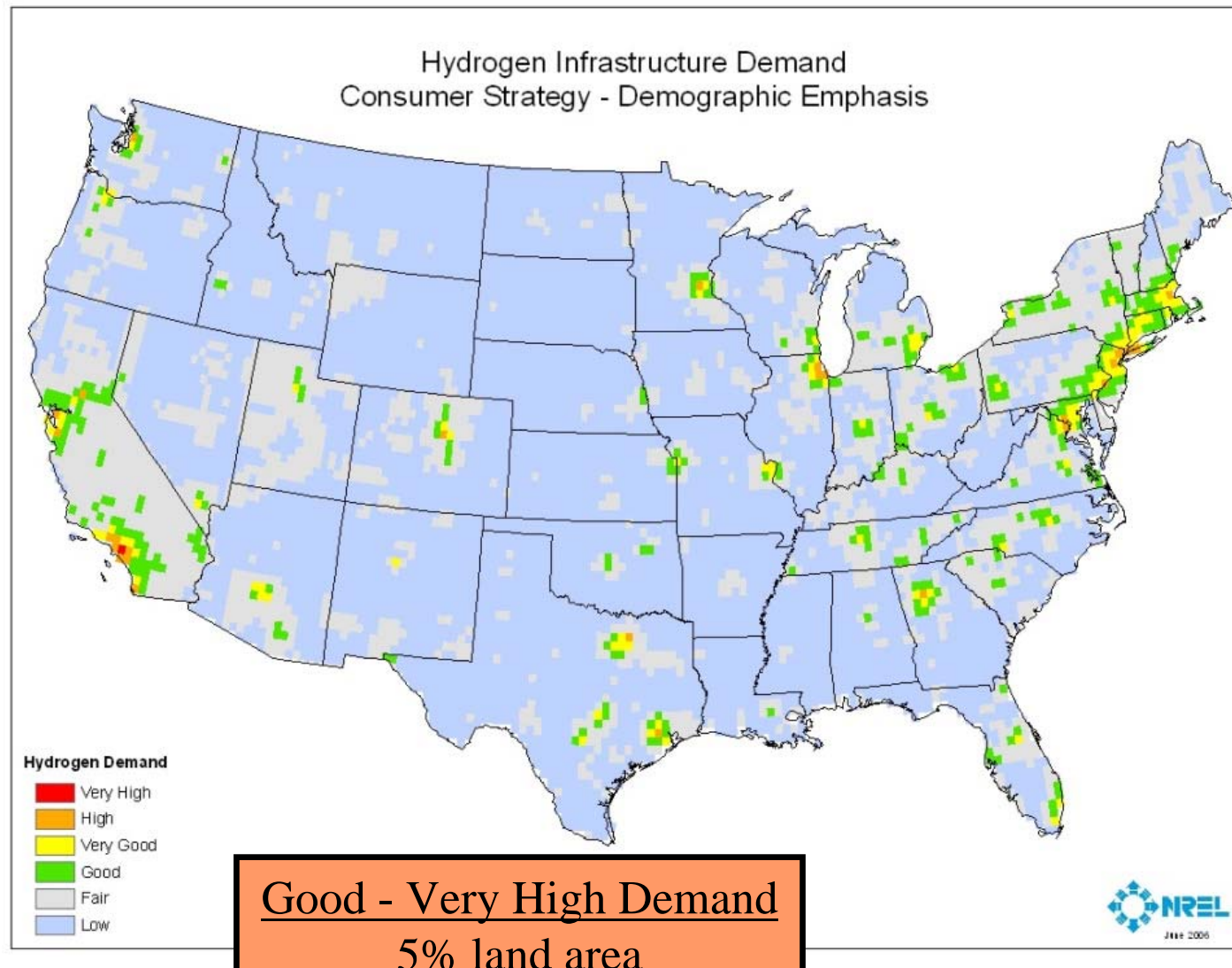
Good - Very High Demand
5% land area
58% targeted population

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Consumer Policy Emphasis

Hydrogen Infrastructure Demand
Consumer Strategy - Policy Emphasis

Hydrogen Demand
- Very High
- High
- Very Good
- Good
- Fair
- Low

Good - Very High Demand
15% land area
64% targeted population

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June 2006

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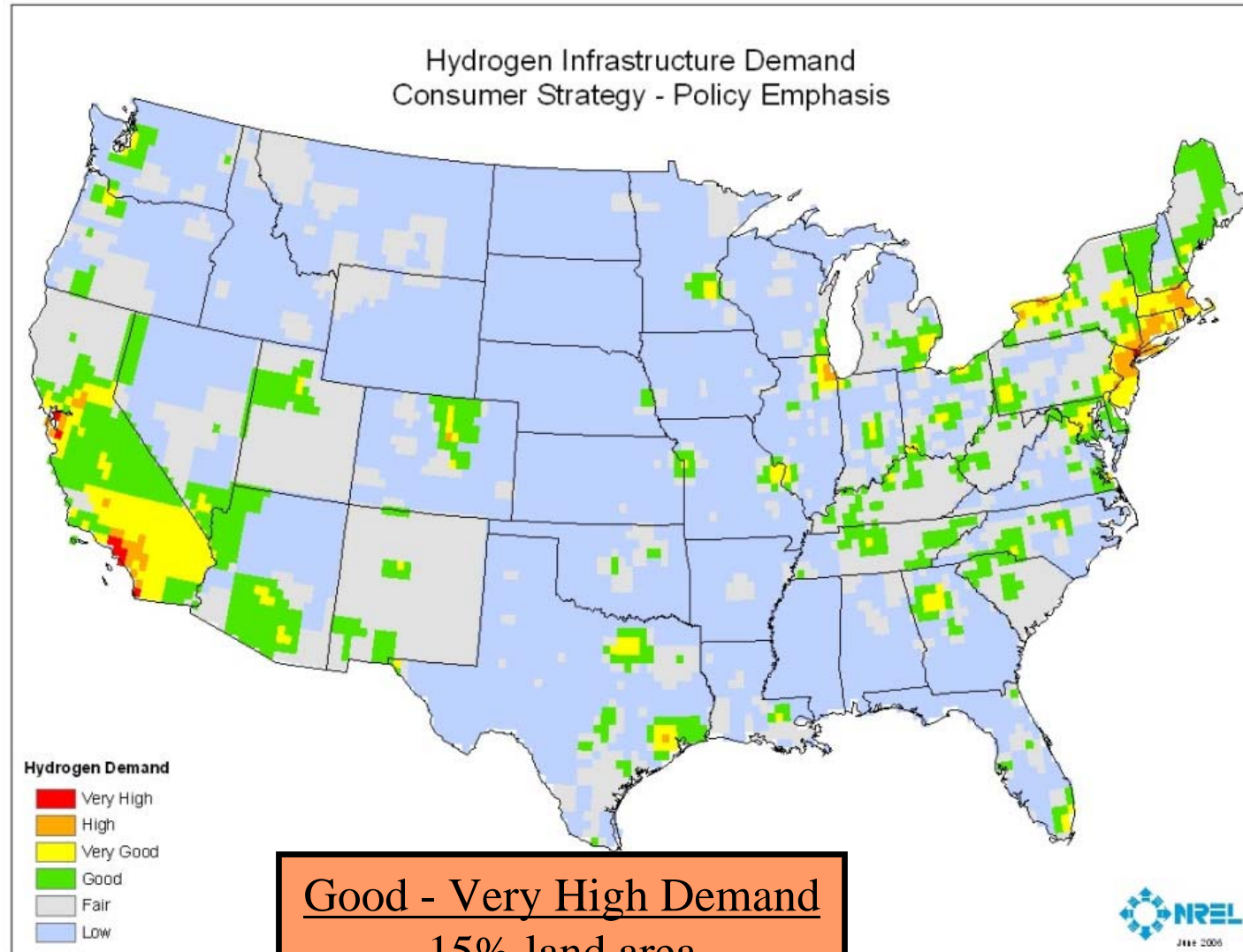
Top Urban Areas
Lighthouse Concept Targets

- New York/Northern NJ/Long Island
- Los Angeles/Riverside/Orange County
- San Francisco/Oakland/San Jose
- Boston/Worcester/Lawrence
- Philadelphia/Wilmington/Atlantic City
- Chicago/Gary/Kenosha
- Washington/Baltimore
- Sacramento/Yolo
- San Diego

- Dallas/Fort Worth
- Houston/Galveston/Brazoria
- Hartford
- Minneapolis/St. Paul
- Atlanta
- Detroit/Ann Arbor/Flint
- Phoenix/Mesa
- Denver/Boulder/Greeley
- Cleveland/Akron
- Providence/Fall River/Warwick
- Rochester

Option 1 – Vehicle Distribution 2010-2025 Scenario Analysis

2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Los Angeles													
0.6	0.8	1.1	5	5	7	20	40	55	70	85	90	100	120
				New York									
				3	5	20	40	50	60	60	70	80	100
						Chicago, San Francisco							
						10	20	30	40	50	60	70	80
								Washington/Baltimore, Boston, Philadelphia					
								15	20	30	50	60	70
								Detroit, Dallas					
									10	15	25	30	40
									Atlanta, Houston				
										10	15	25	40
										Phoenix, Minneapolis, Miami			
											15	20	30
											Denver, Seattle, Cleveland		
												15	20
													Pitts-burgh
													5

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Option 2 – Vehicle Distribution 2010-2025 Scenario Analysis

2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Los Angeles													
1	2	2	40	60	80	100	120	130	140	150	160	190	205
New York													
			10	25	40	50	70	90	100	110	120	135	140
Chicago, San Francisco													
				15	20	30	50	70	90	100	110	125	130
Washington/Baltimore, Boston													
					10	15	30	50	65	75	90	110	120
Philadelphia													
						5	10	15	25	30	35	50	60
Dallas, Houston, Detroit													
							20	35	45	60	70	85	95
Atlanta, Minneapolis													
								10	20	30	40	55	60
Miami, Cleveland, Phoenix, Seattle													
									15	25	35	55	70
Denver, Pittsburgh, Portland, Cincinnati, Indianapolis, St. Louis													
										20	25	40	50
Kansas City, Milwaukee, Columbus, Orlando													
											15	40	50
Charlotte, Nashville, Salt Lake City													
												15	20
Buffalo													
													5

Option 3 – Vehicle Distribution 2010-2025 Scenario Analysis

2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Los Angeles													
1	2	2	25	40	50	85	120	160	190	210	250	270	300
New York, Chicago													
			25	40	50	85	120	150	175	185	225	240	270
San Francisco, Washington/Baltimore													
				20	30	55	85	120	140	160	190	210	230
Boston, Philadelphia, Dallas													
					20	50	85	120	145	165	195	210	220
Detroit, Houston													
						25	50	80	120	140	160	190	210
Atlanta, Minneapolis, Miami													
							40	75	100	115	130	160	180
Cleveland, Phoenix, Seattle													
								45	70	90	120	150	170
Denver, Pittsburgh, Portland, St. Louis, Cincinnati, Indianapolis, Kansas City													
									60	80	110	130	150
Milwaukee, Charlotte, Orlando, Columbus, Salt Lake City													
										55	80	110	130
Nashville, Buffalo, Raleigh													
											40	70	90
Nationwide													
												260	540

Local Demand Analyses

Los Angeles Basin Urbanized Area
Hydrogen Infrastructure Demand - Consumer Strategy

Hydrogen Demand
- Very High
- High
- Good
- Fair
- Low

June 2006

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Local Demand Analyses

Washington Urbanized Area
Hydrogen Infrastructure Demand - Consumer Strategy

Hydrogen Demand
- Very High
- High
- Good
- Fair
- Low

July 2006

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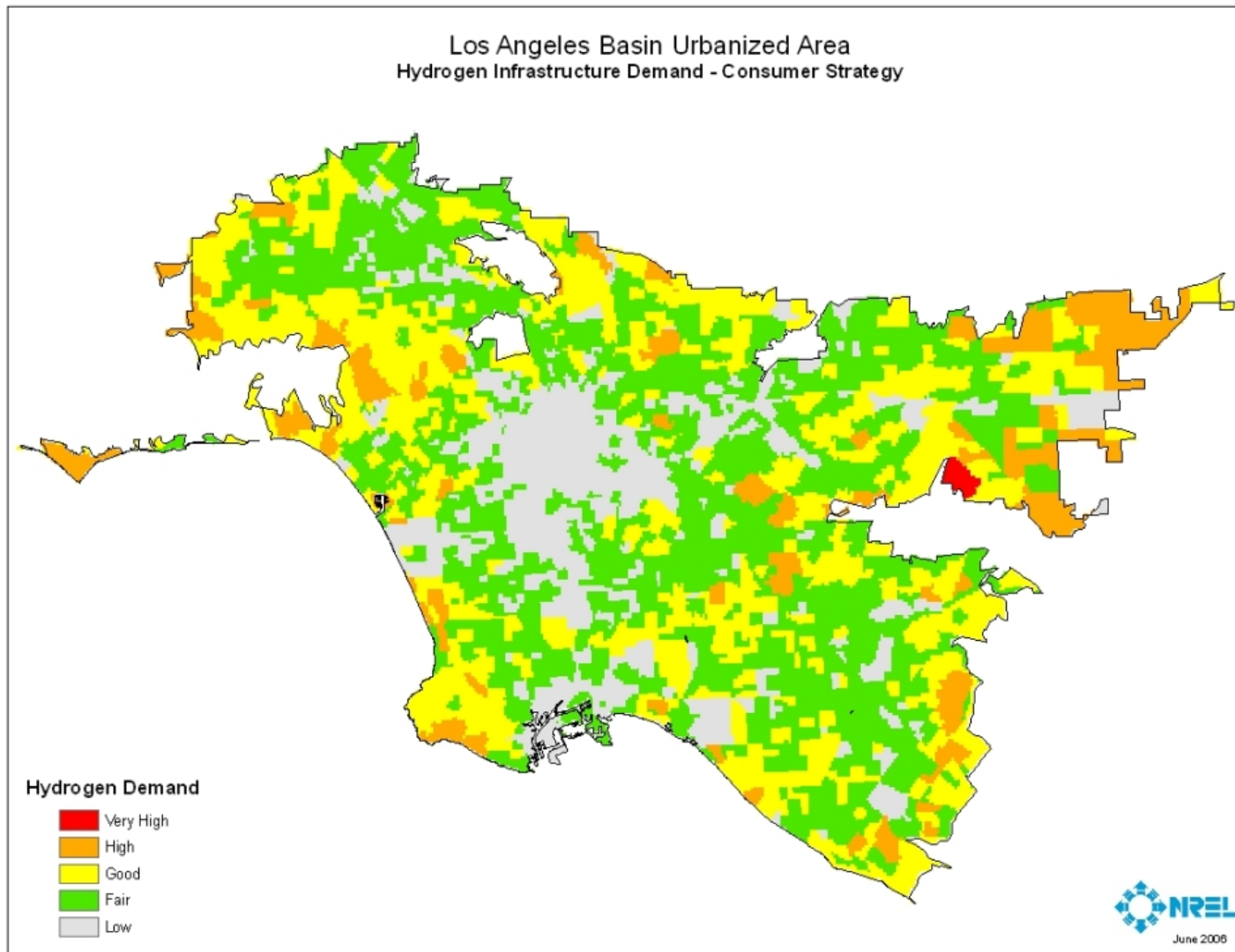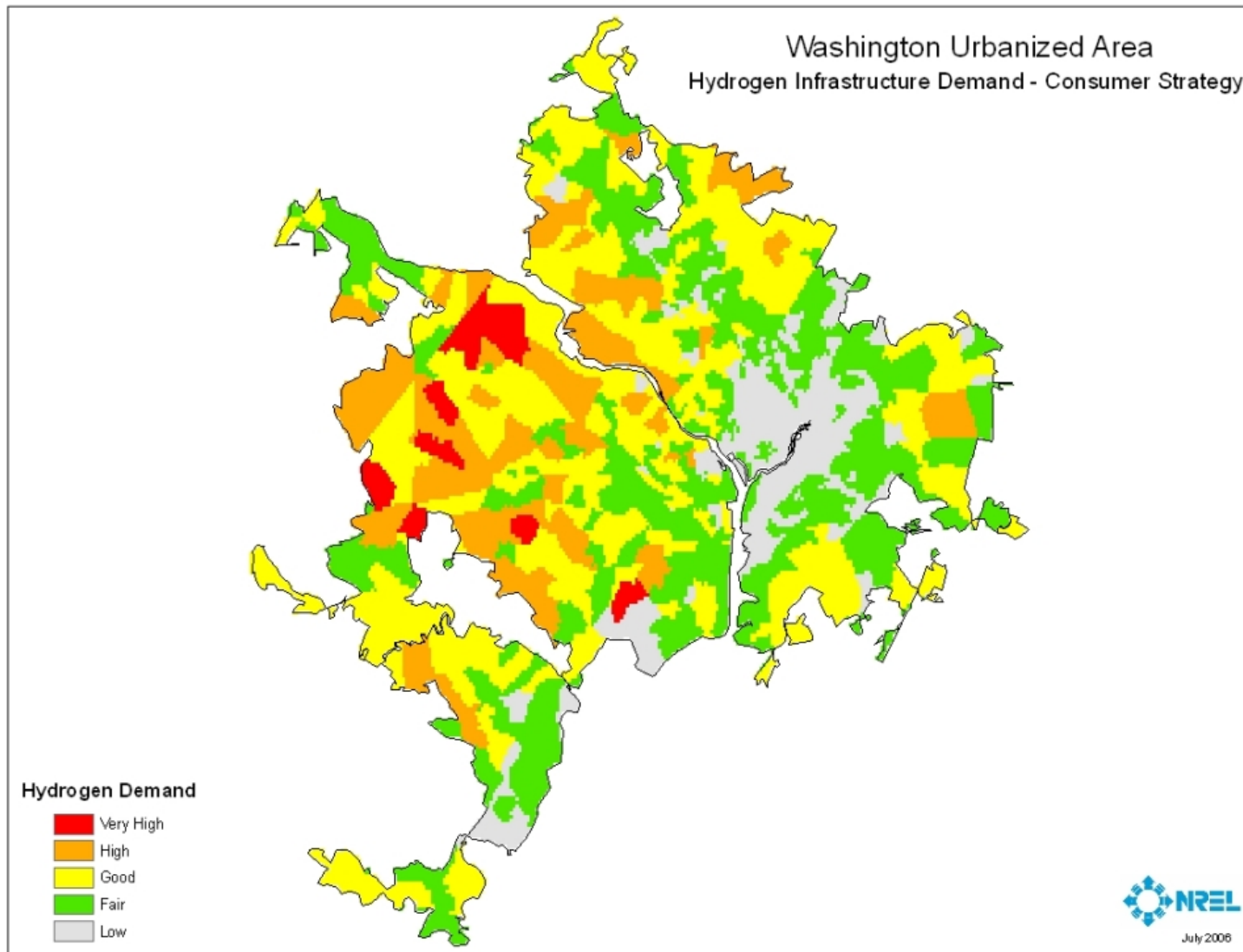
Local Demand Analyses

Related Work

- Urban infrastructure scenarios at NREL
  - LA
  - NY
- State analyses being done at ASU
  - Florida
- Regional analysis
  - FY07

Project Summary

- Government policies can influence spread of H2 vehicles

- Different demographic and geographic constraints affect hydrogen vehicle demand

- Geographic demand is critical to infrastructure analysis
  - Provide a spatial component to other transition analyses (HyTrans, HYDS, MSM)
  - Provide a spatial component to non-transition analyses (HOPE, H2A)

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