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

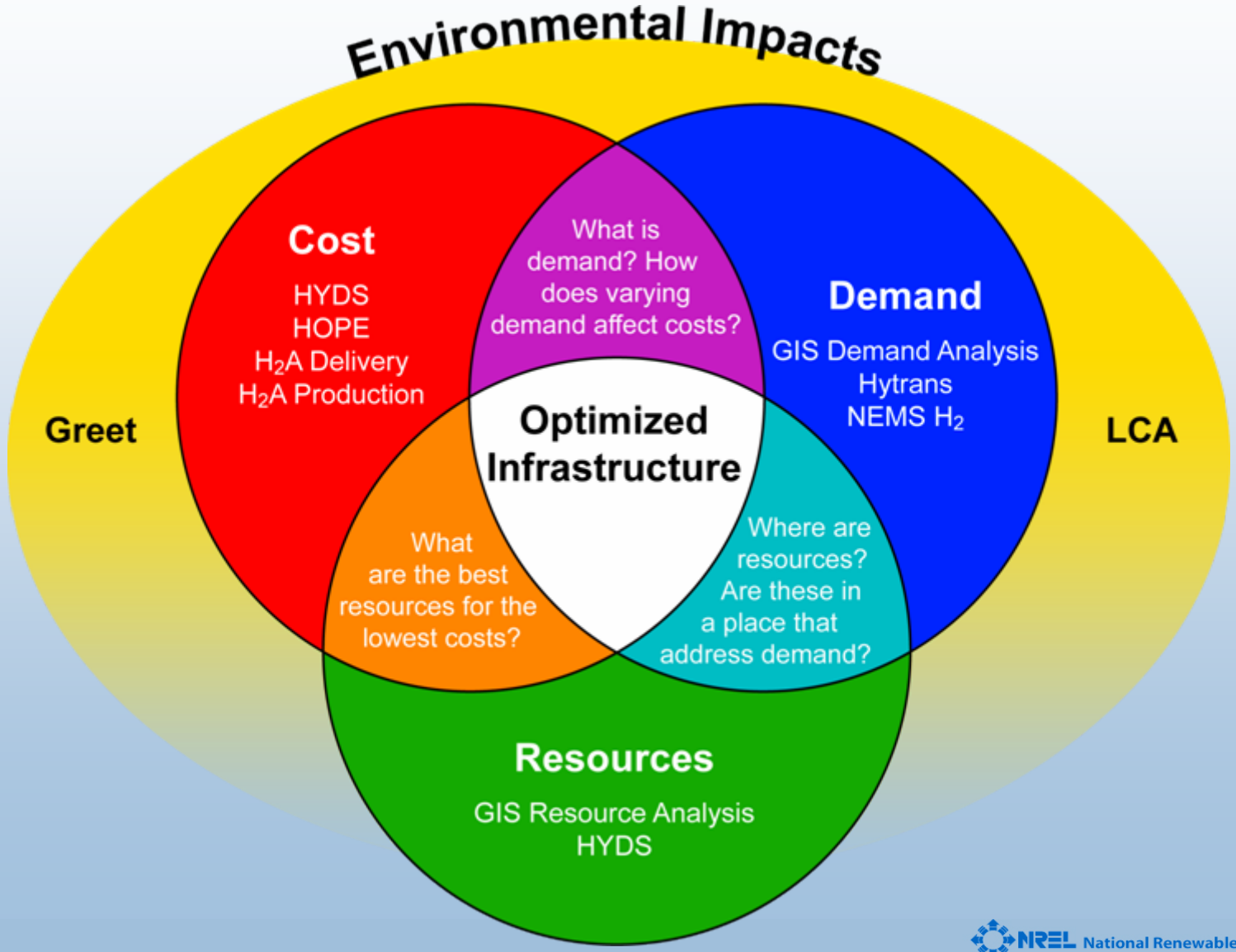
FY 2005

- Quantify and locate a minimal interstate-based hydrogen infrastructure

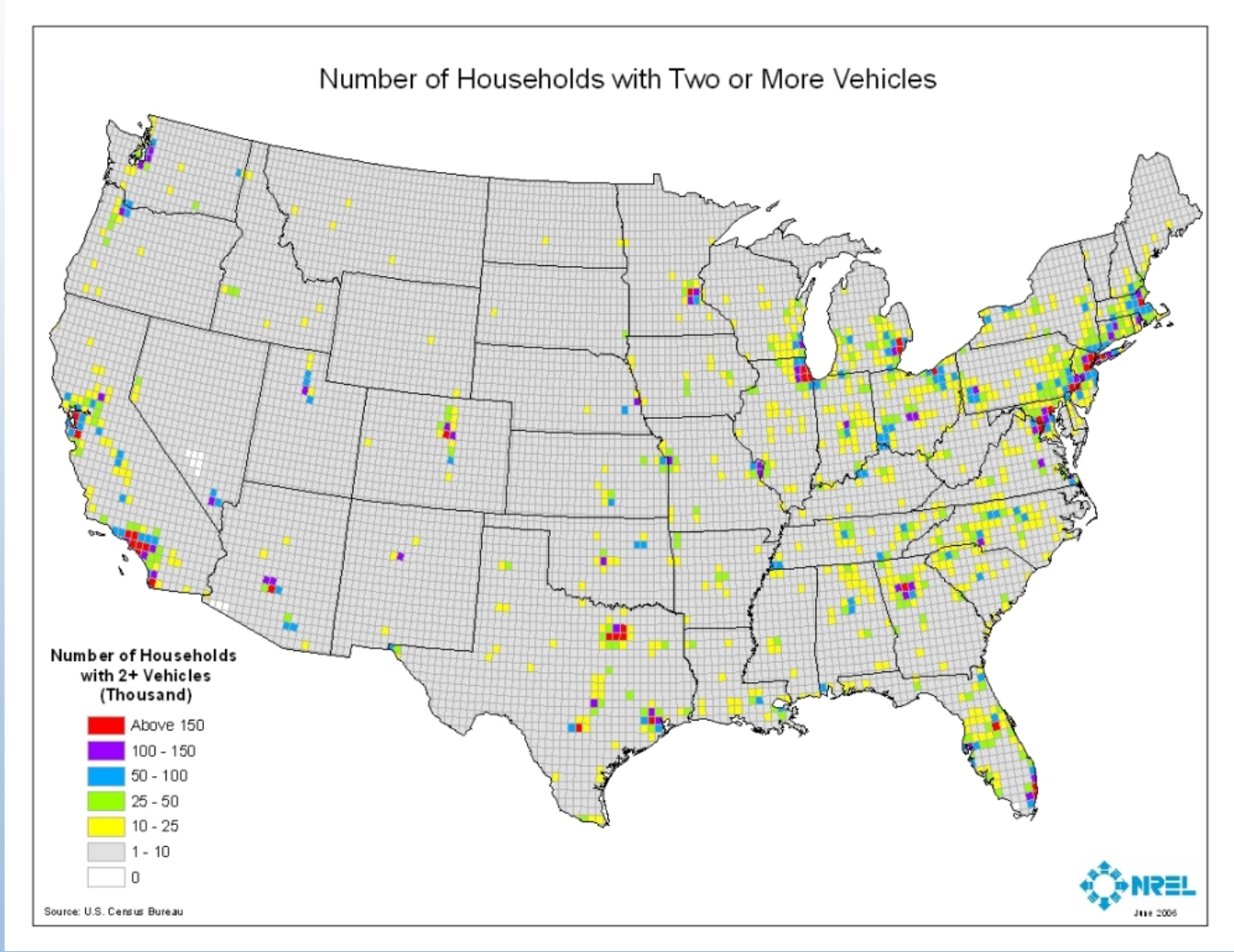
Approach

- 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

Hydrogen Analysis Diagram

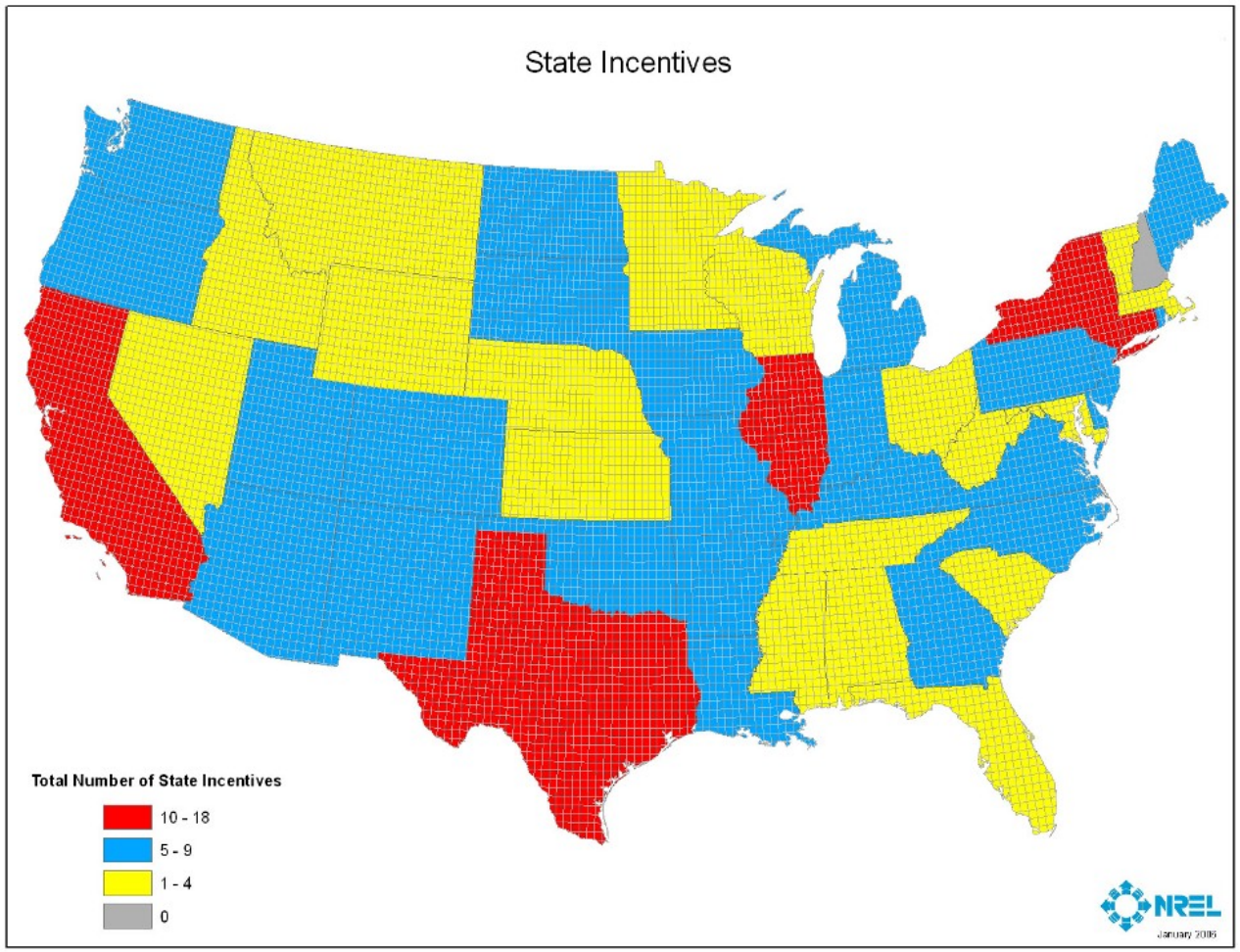


Identify Key Demographic Attributes



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

Identify Key Policy Attributes



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

Baseline Scenario Analysis

Consumer hydrogen vehicle demand = **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

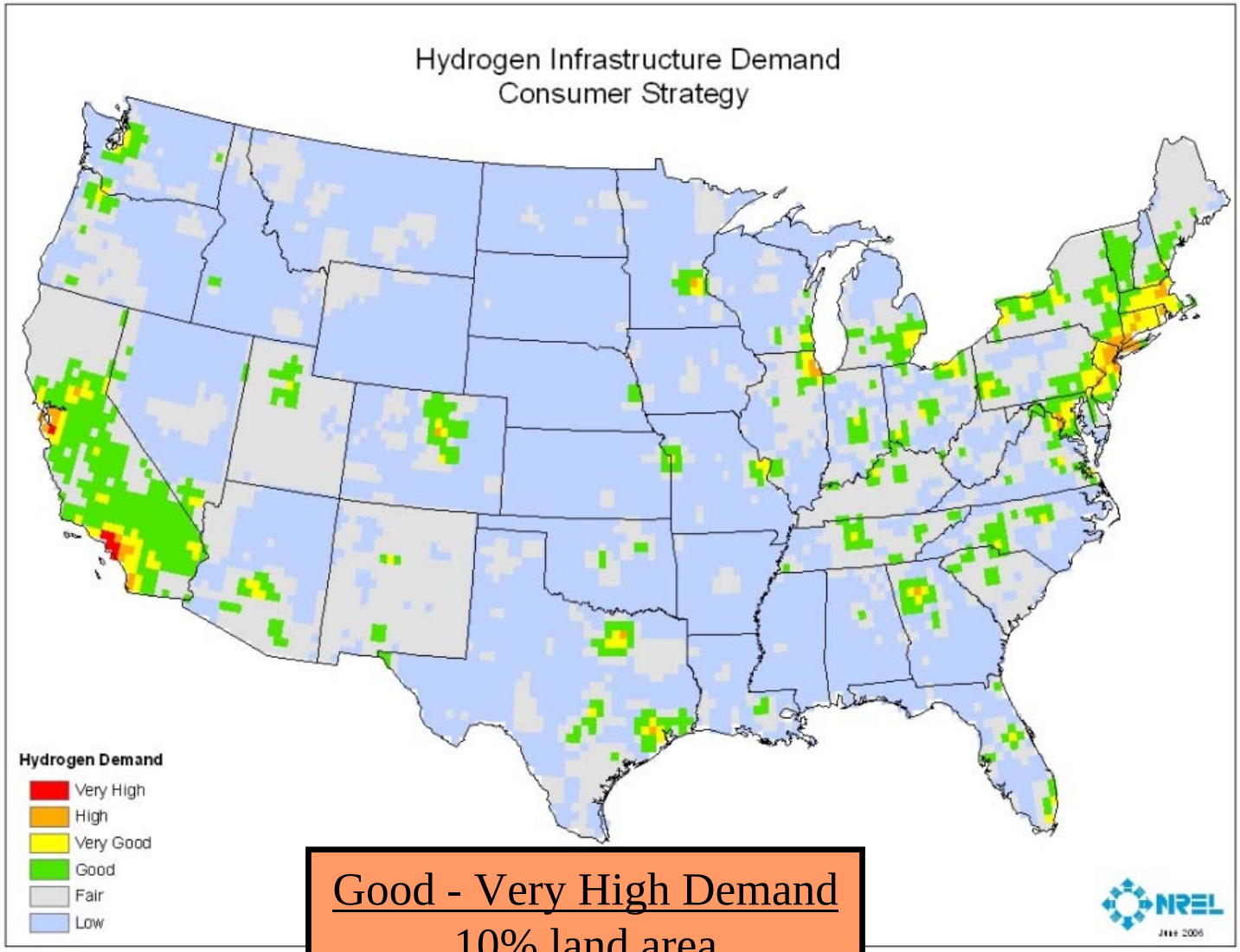
Classes ranked

Influence on demand weighed

All attribute weightings combined

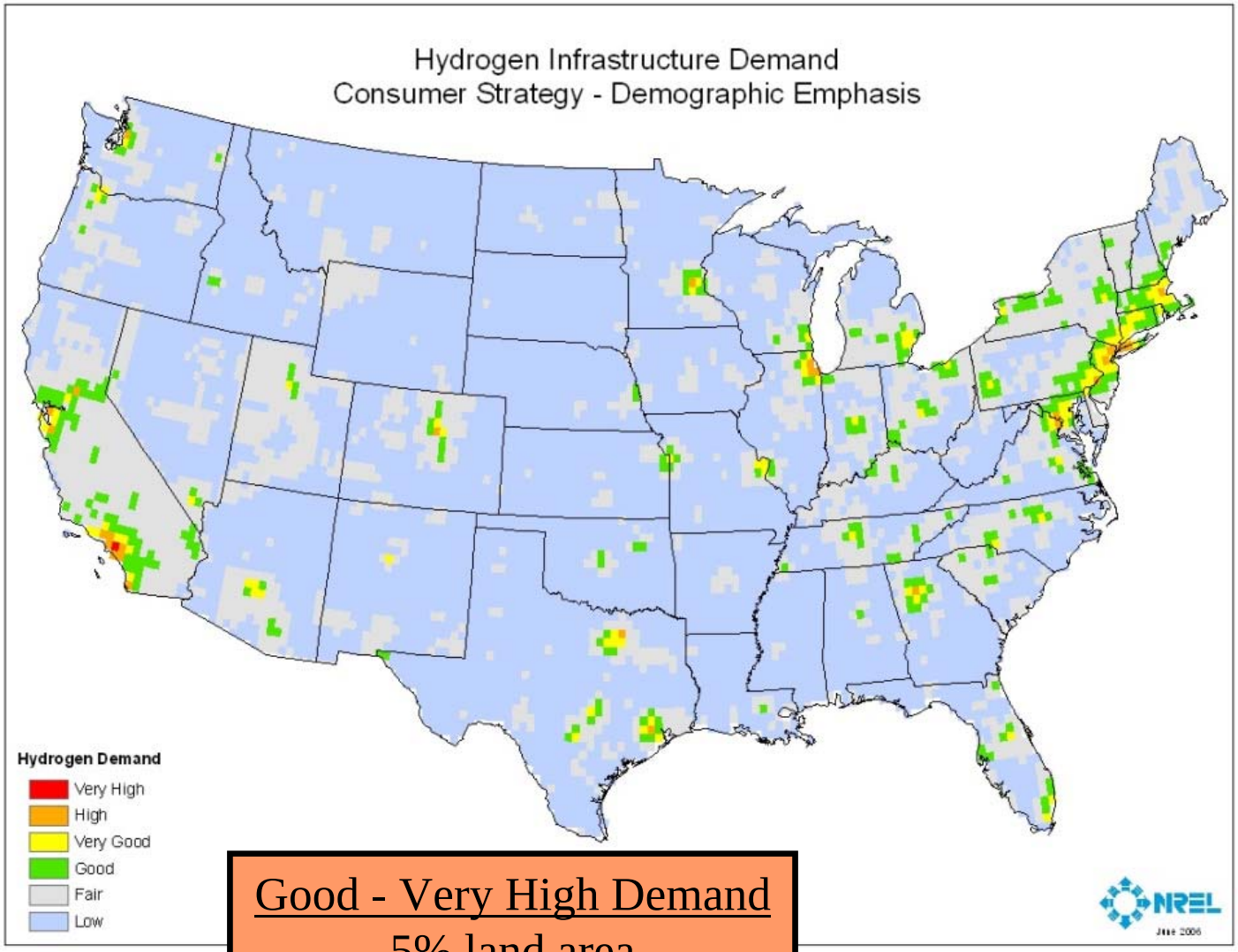
Attribute	Values and Classification (number of households)	Scoring of Classification	Weighting
Two or more vehicles per household	0 – 8,064	2	15% (High)
	8,065 – 30,239	3	
	30,240 – 68,542	4	
	68,543 – 118,940	5	
	118,941 – 179,418	6	
	179,419 – 312,470	7	
	312,471 – 516,079	7	

Baseline Results



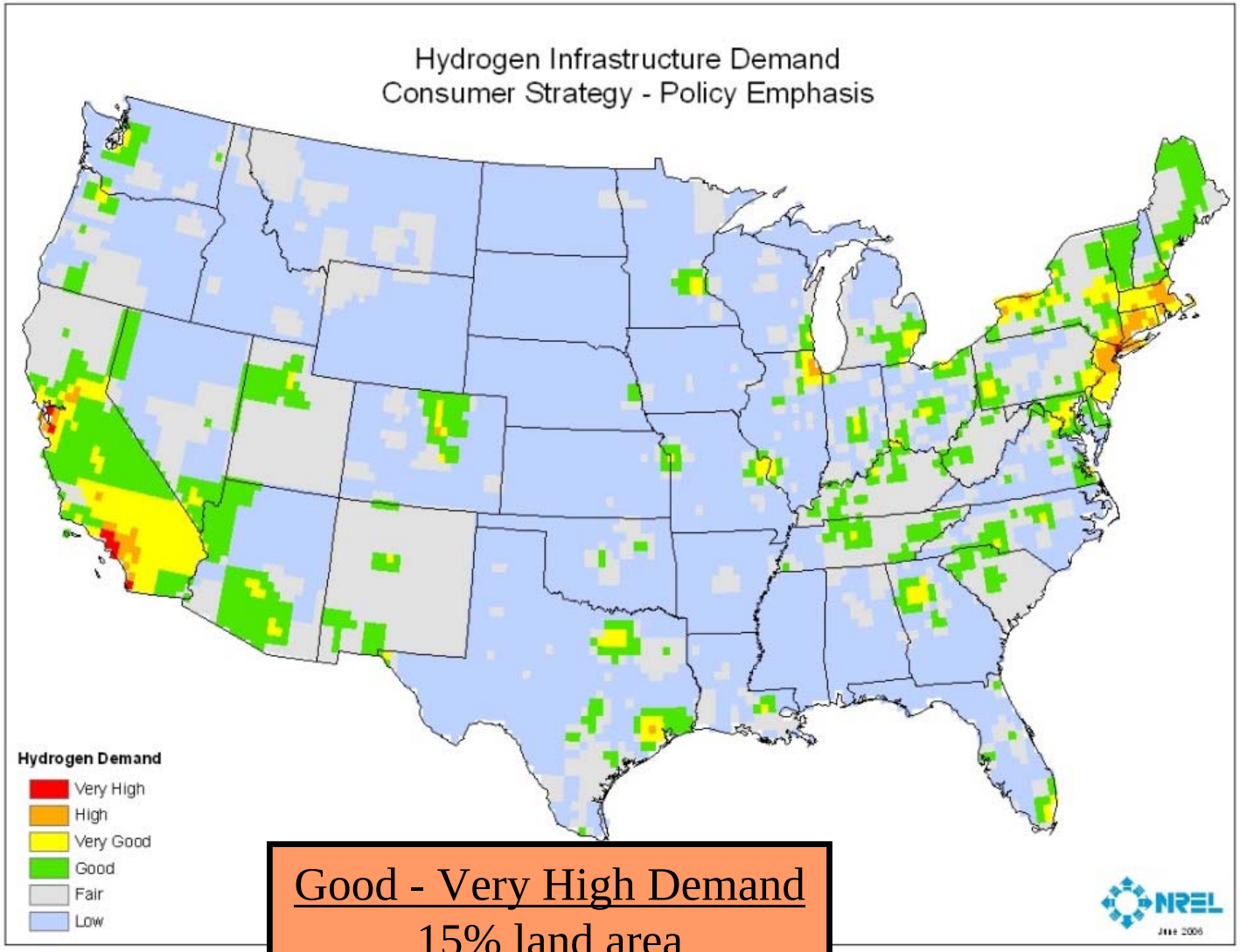
Good - Very High Demand
10% land area
64% targeted population

Consumer Demographic Emphasis



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

Consumer Policy Emphasis



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

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

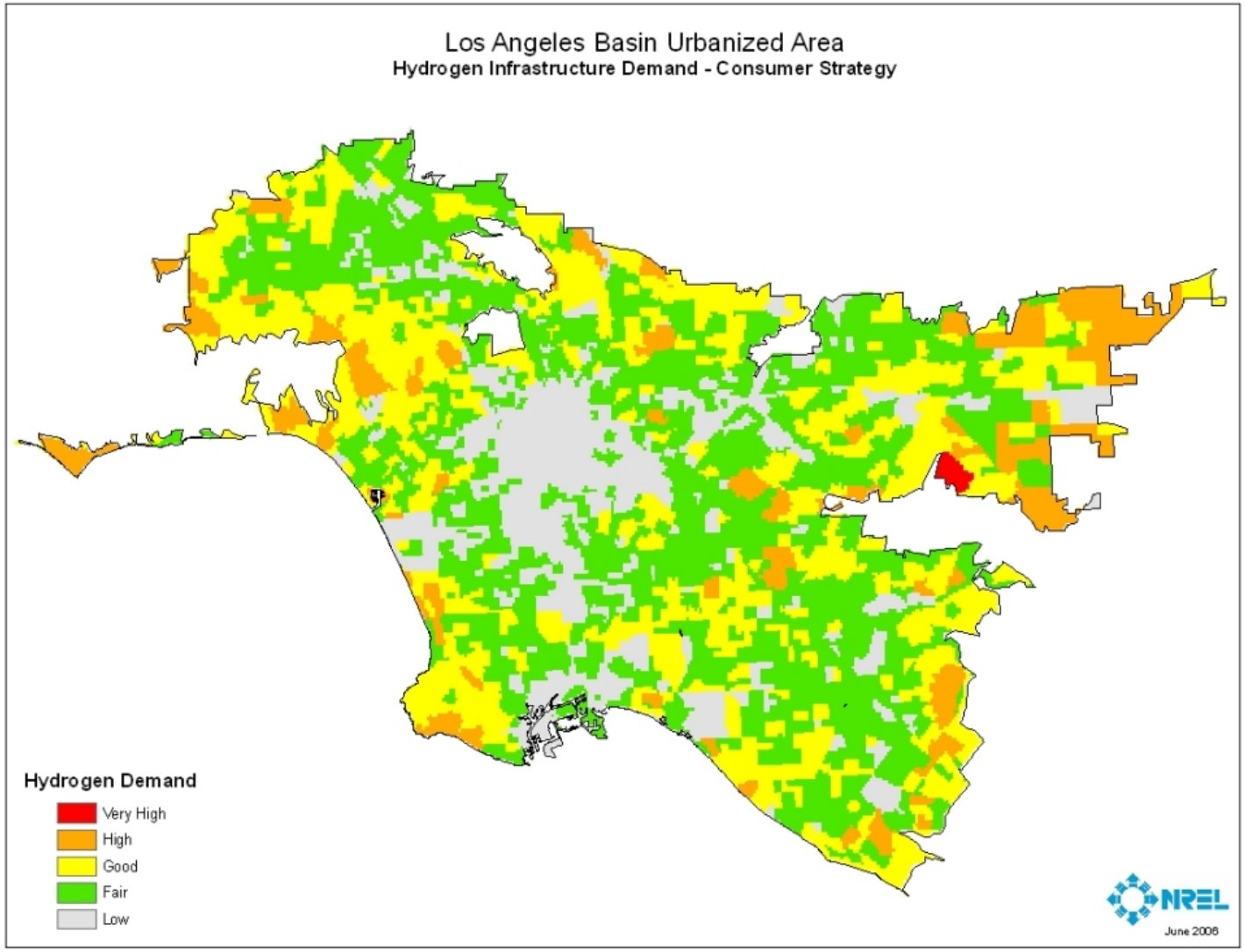
Option 2 – Vehicle Distribution 2010-2025 Scenario Analysis

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

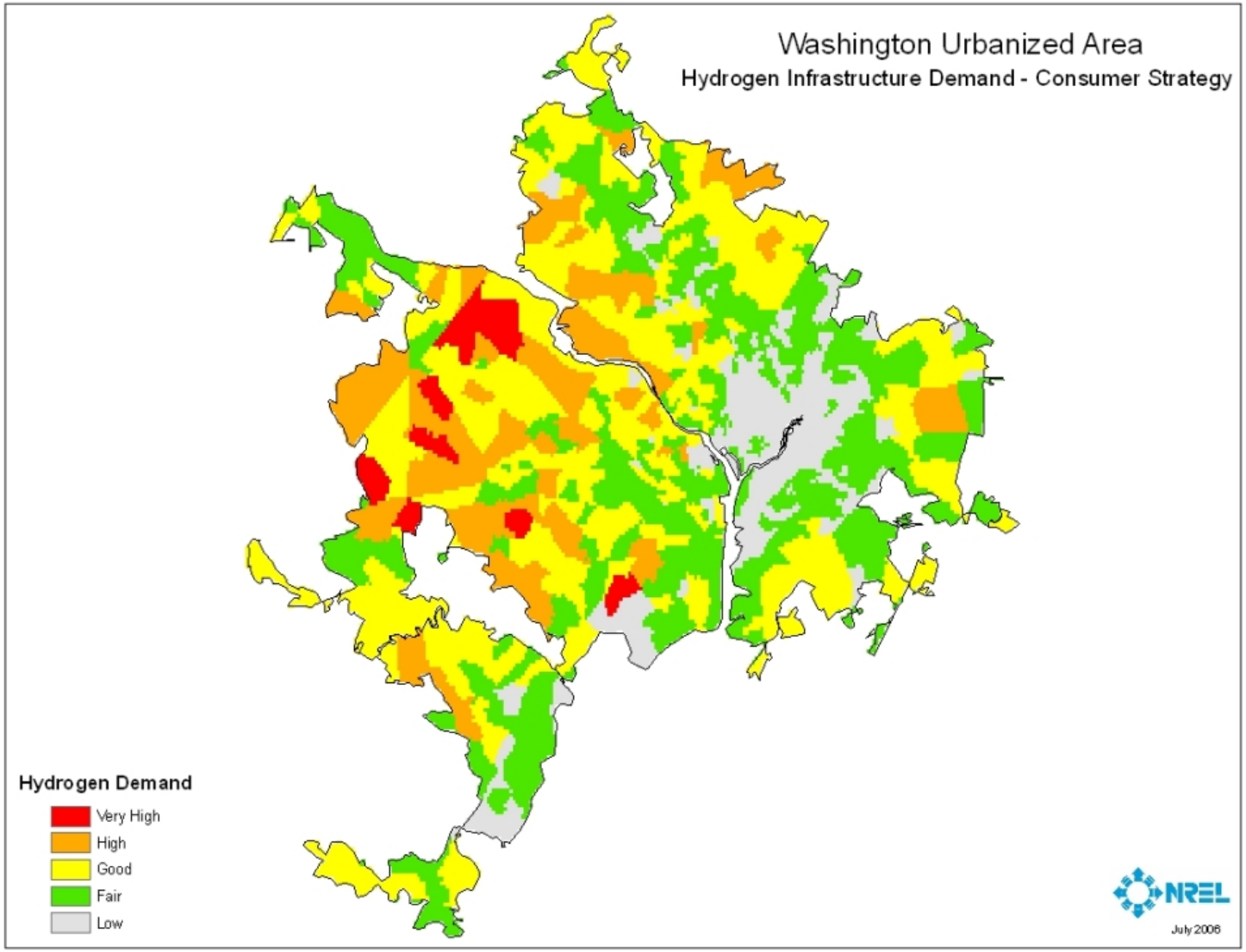
Option 3 – Vehicle Distribution 2010-2025 Scenario Analysis

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

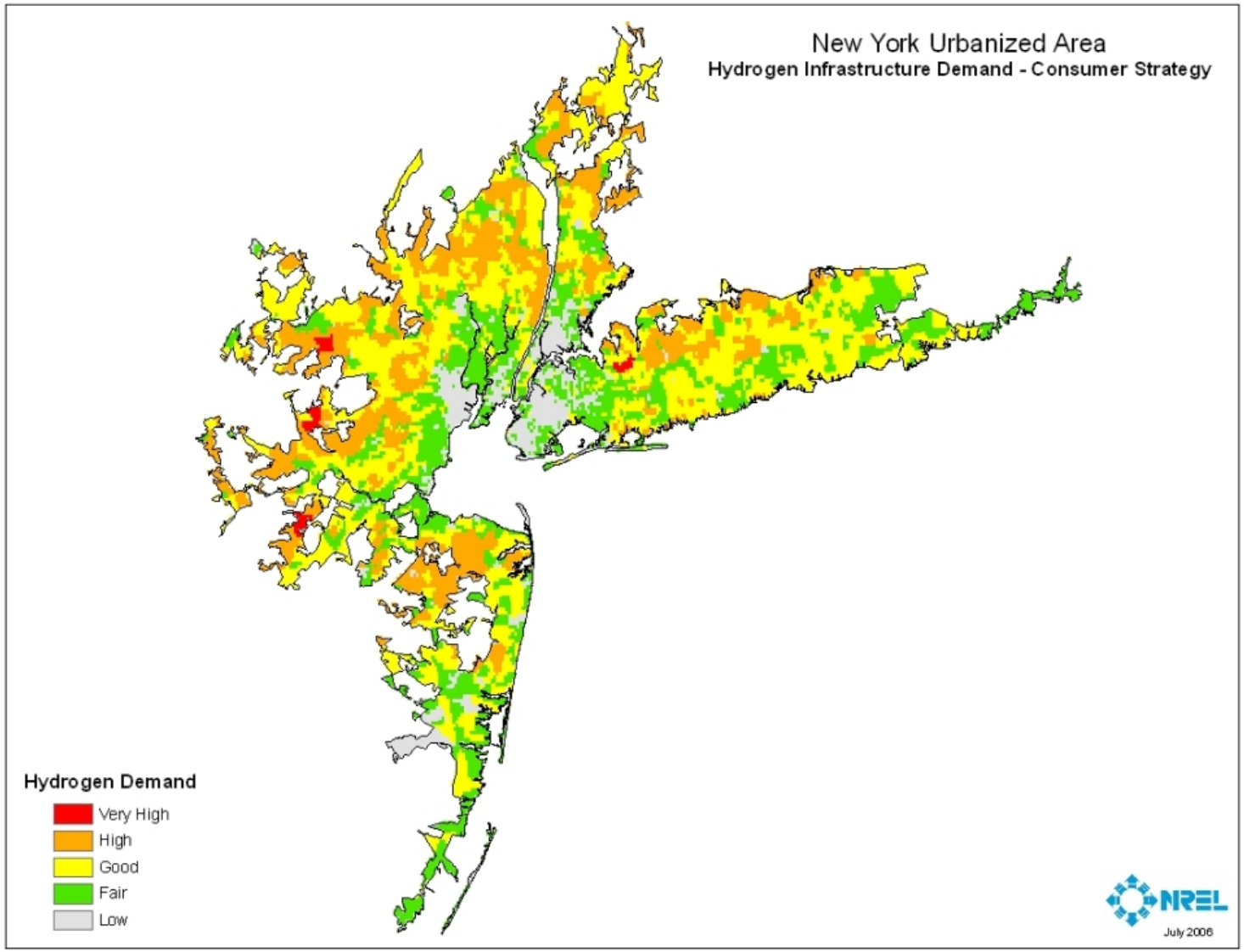
Local Demand Analyses



Local Demand Analyses



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)