Regional Hydrogen Infrastructure Panel

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Washington, DC
June 14, 2018

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The Northeast Experience

- Direction
- Markets
- Action
- Policy
- Results

Direction

Goals

- Clean/Low Carbon Emissions
- Efficiency
- Reliability
- Durability
- Lower Costs
- Clean Energy Jobs

Market Drivers

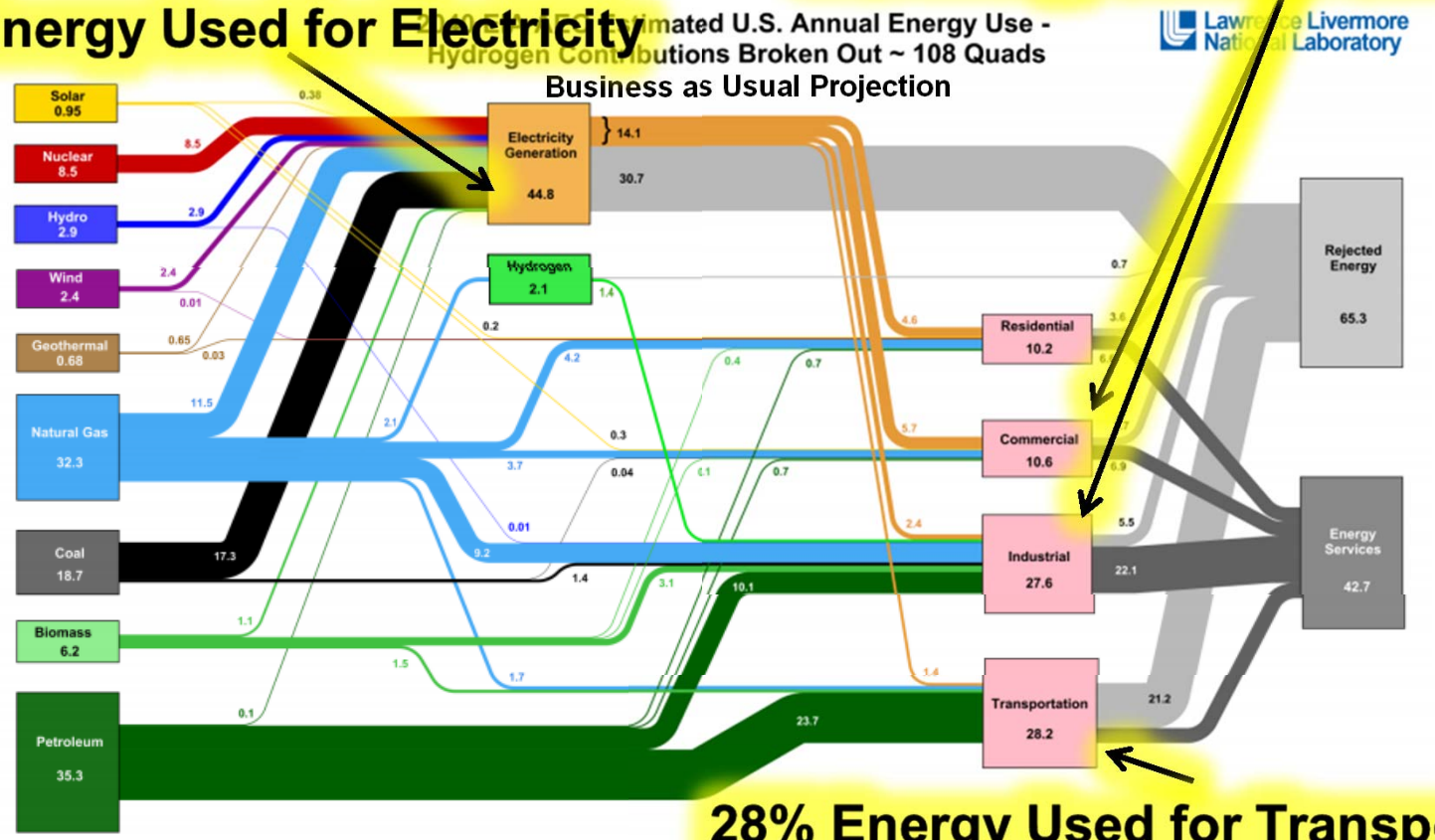
- Emissions Reductions
- Renewable Integration
- Energy Reliability/Resiliency
- Efficiency/Cost
- Economic Incentives

Direction

Energy Flow

30% Energy Used for C/I Heating

45% Energy Used for Electricity



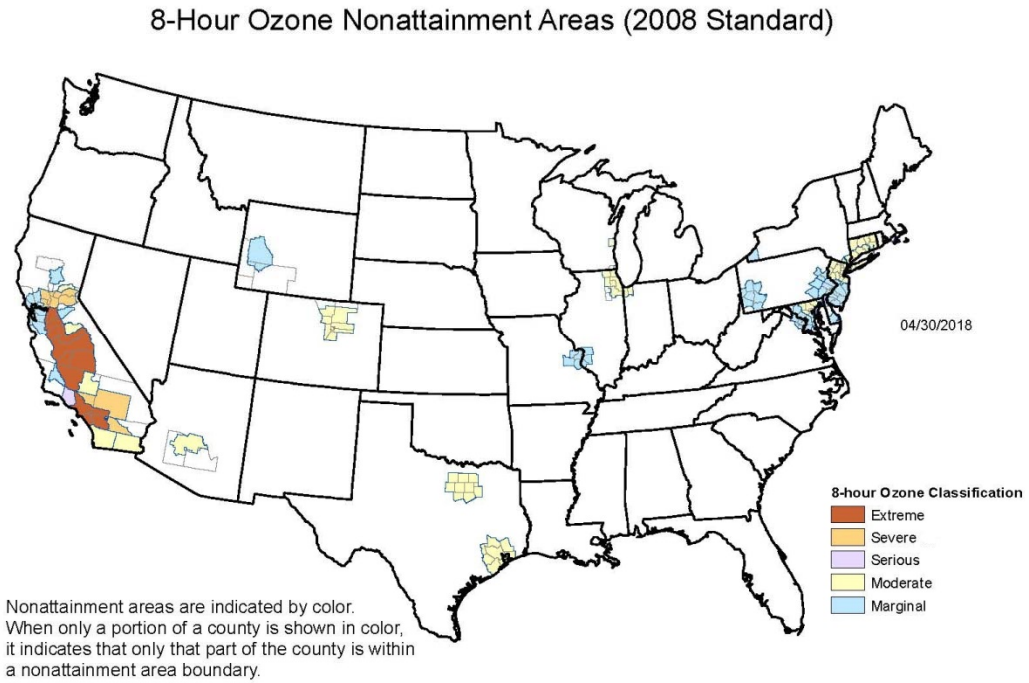
28% Energy Used for Transportation

Please note, all results presented on this slide are PRELIMINARY and may be subject to corrections and/or changes. A cursory analysis was performed using available information and estimates of impacts due to changes to the modeled energy systems.

Direction

Air Quality (NAAQS) Nonattainment

The transportation sector releases significant quantities of hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides (NOx), (and particulates in the case of diesel vehicles). Vehicles account for over 55 percent of the total NOx emissions in the United States (U.S.)

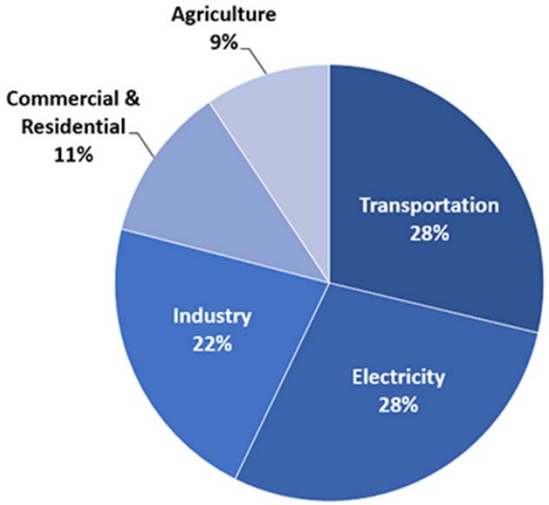


5 U.S. EPA; "8-Hour Ozone Nonattainment Areas (2008 Standard);" https://www3.epa.gov/airquality/greenbook/map8hr_2008.html; 2018

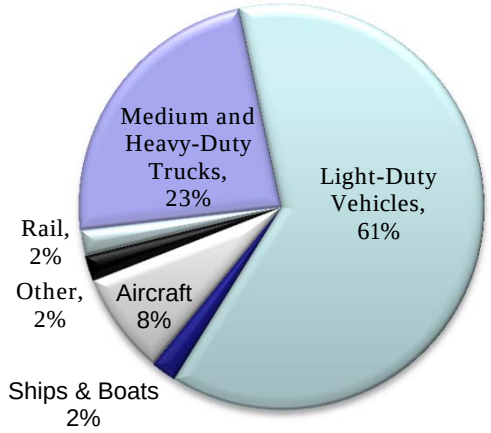
Direction

U.S. Transportation Emissions

- 28% of GHG emissions come from the transportation sector
- 61% of transportation emissions come from light-duty vehicles



Total U.S. Greenhouse Gas Emissions by Economic Sector 2016



Share of U.S. Transportation Sector Emissions by Source (CO2)

US EPA; GHG Emissions; https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions; 2018

US EPA; "Fast Facts;" https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100ONBL.pdf; 2016

Direction

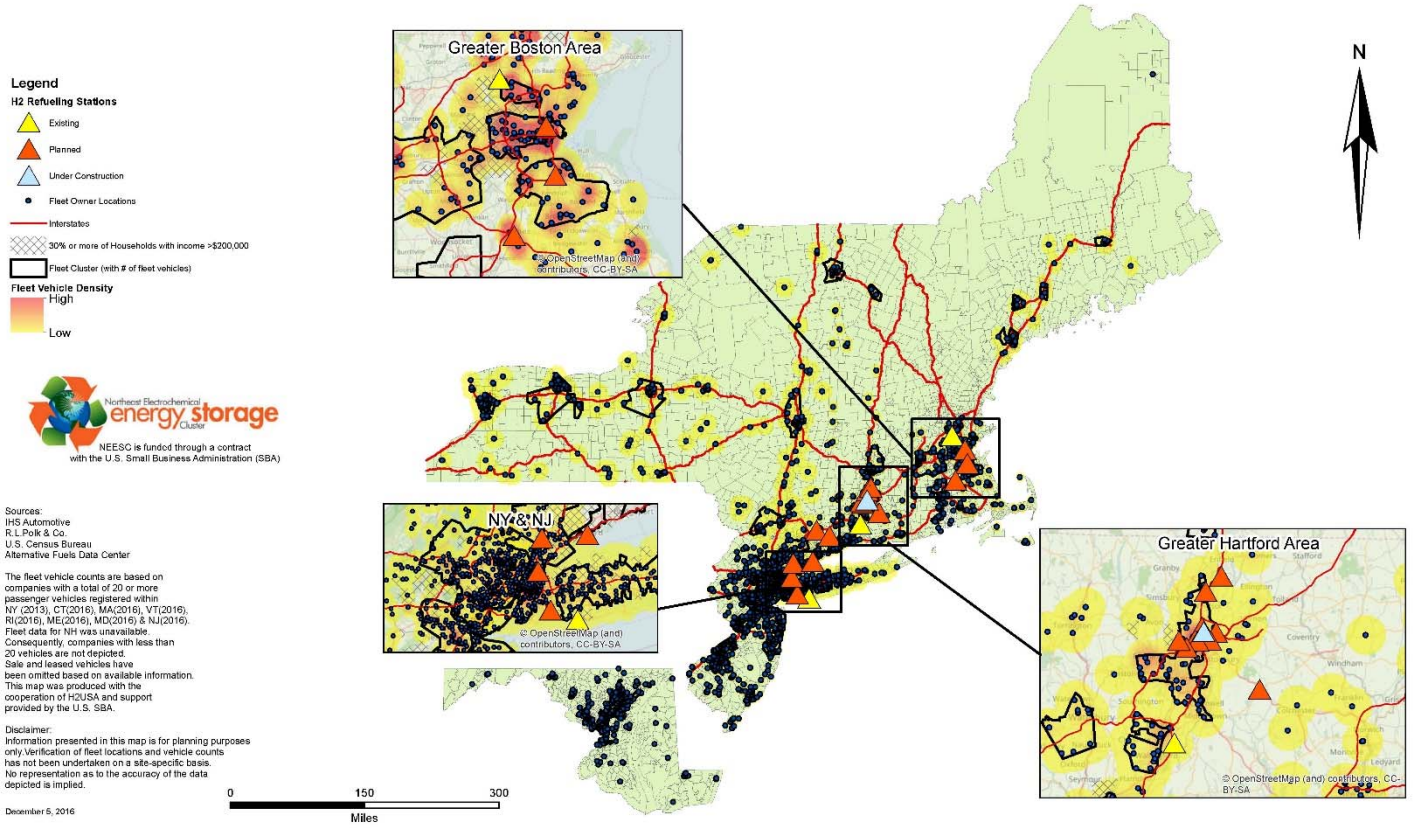
Transportation Market Targets (Fleets)

- Fleet Deployment
  - FCEV (Light-Duty)
  - Fuel Cell Electric Buses (FCEB)
  - Specialty Fuel Cell Vehicles
    - Material Handlers
    - Airport Tugs
  - Hydrogen Refueling
  - Hydrogen for Energy Storage

Markets

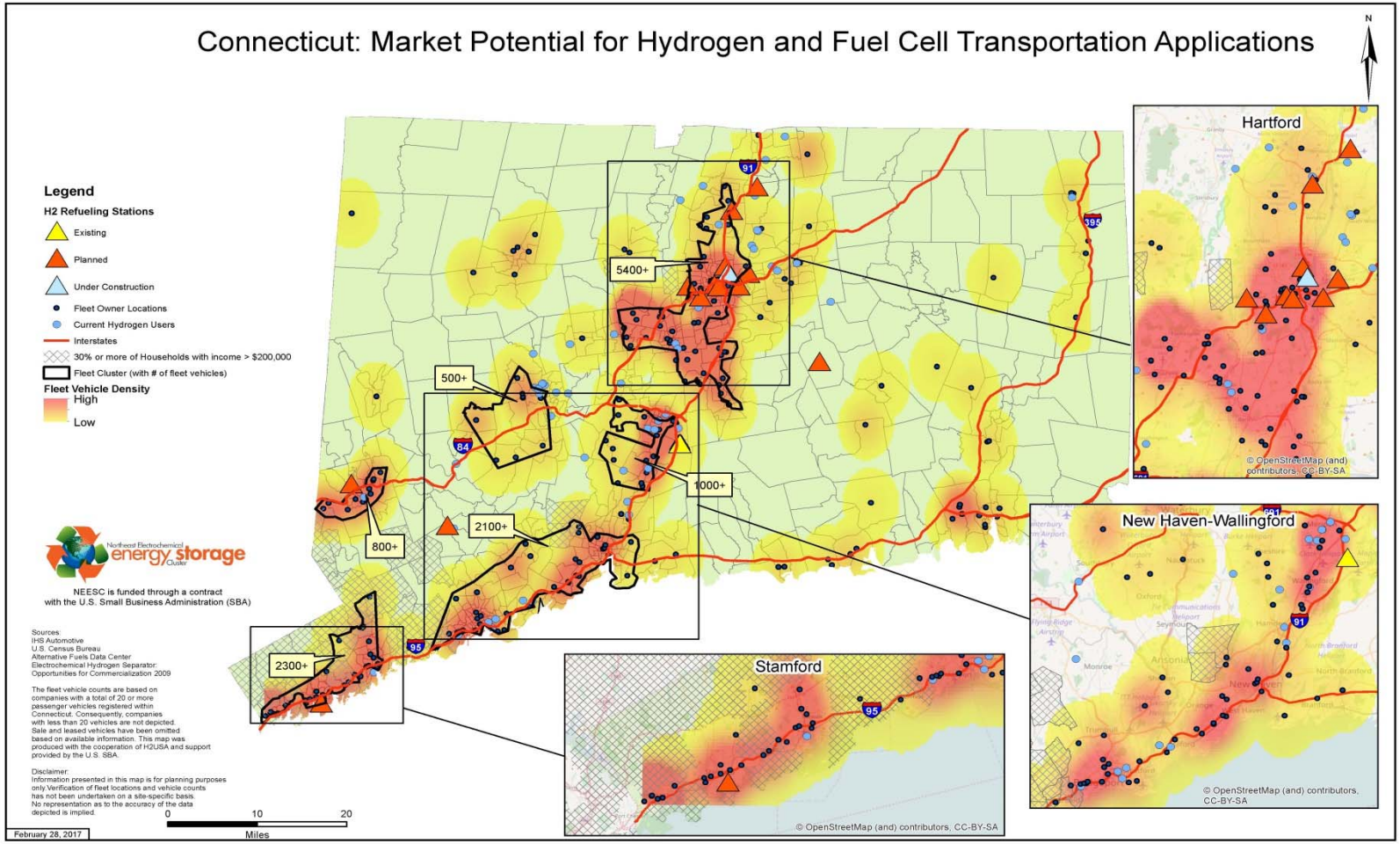
Regional Transportation Targets

Northeast Region: Market Potential for Hydrogen and Fuel Cell Transportation Applications



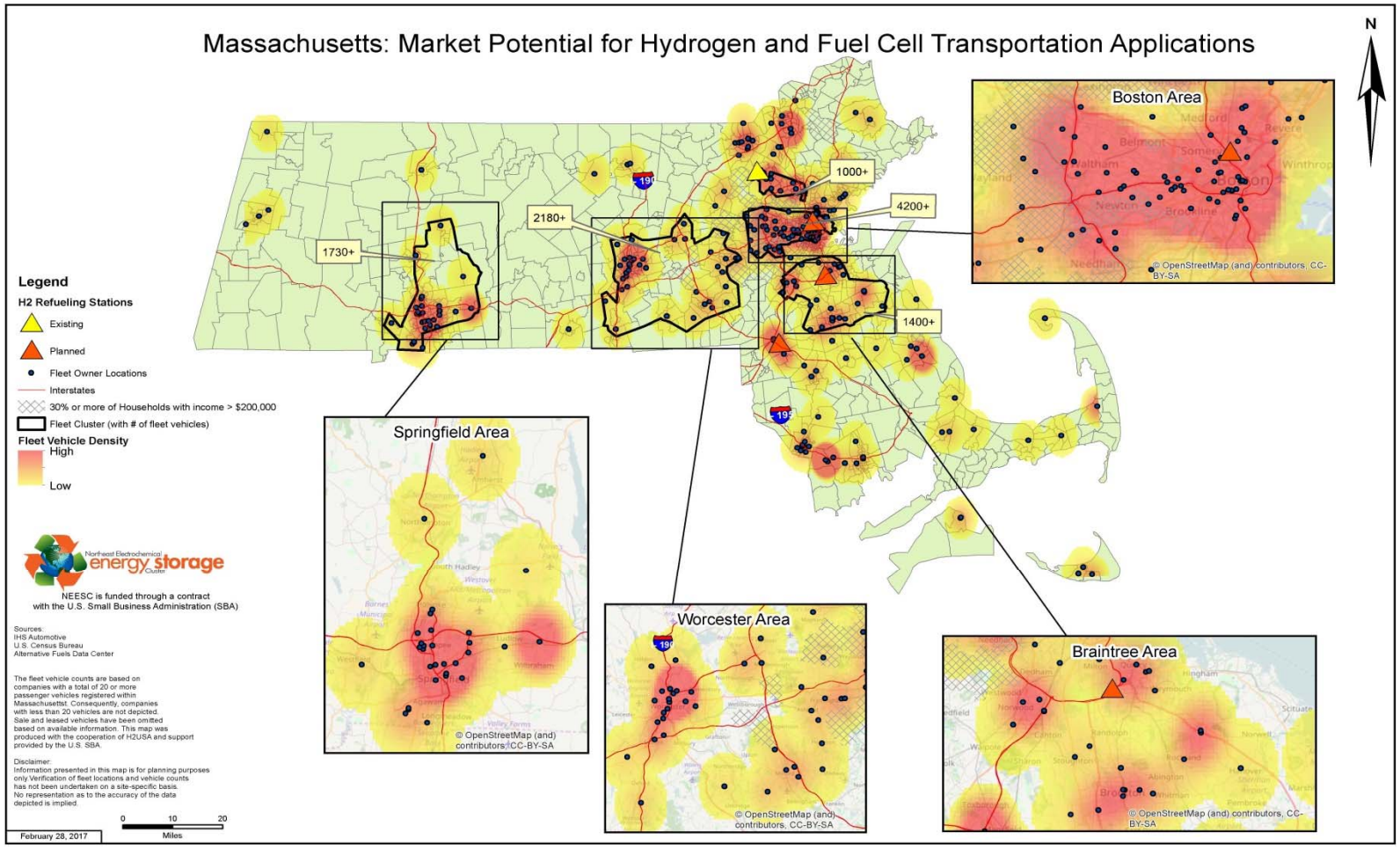
Markets

Regional Transportation Targets



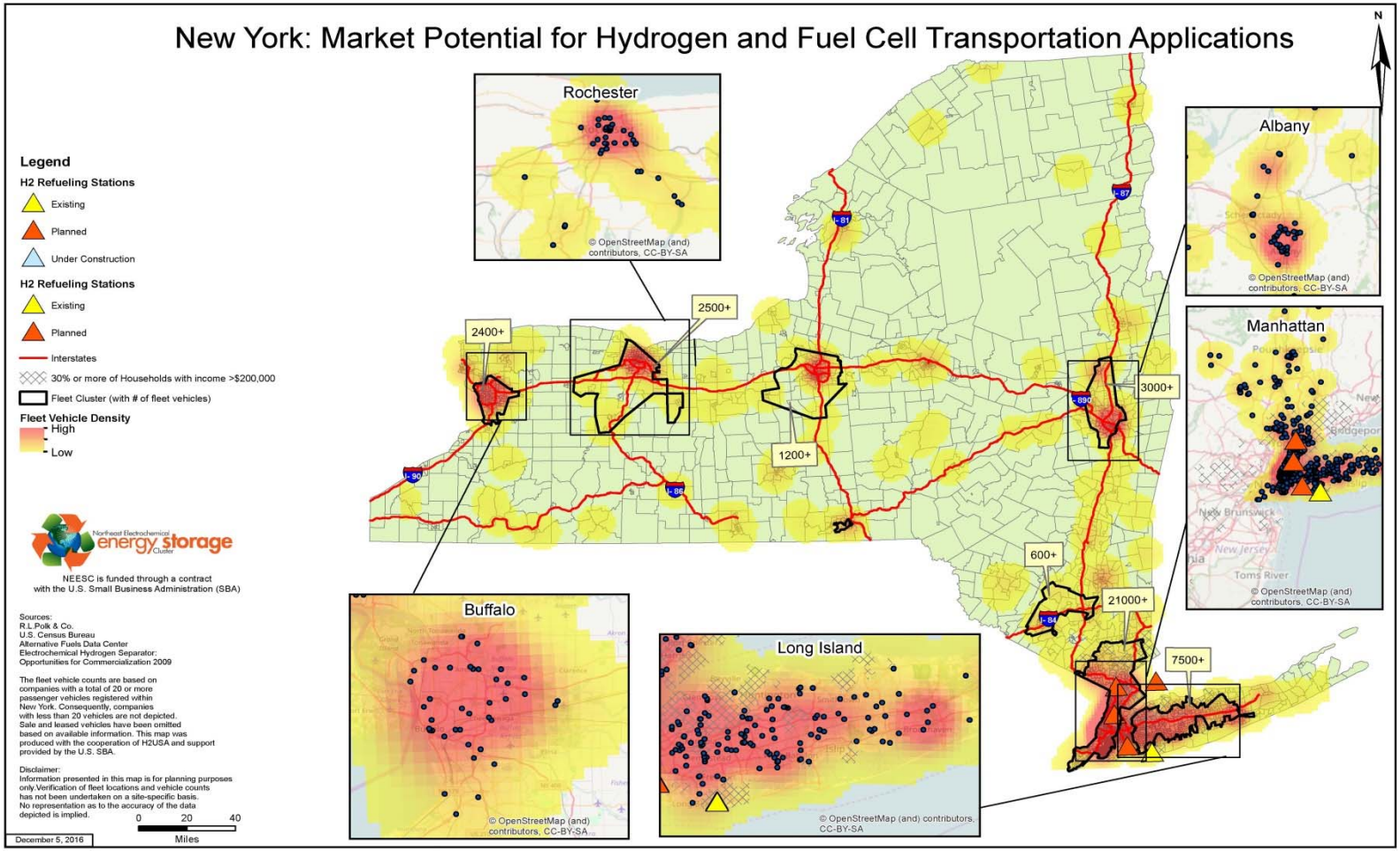
Markets

Regional Transportation Targets



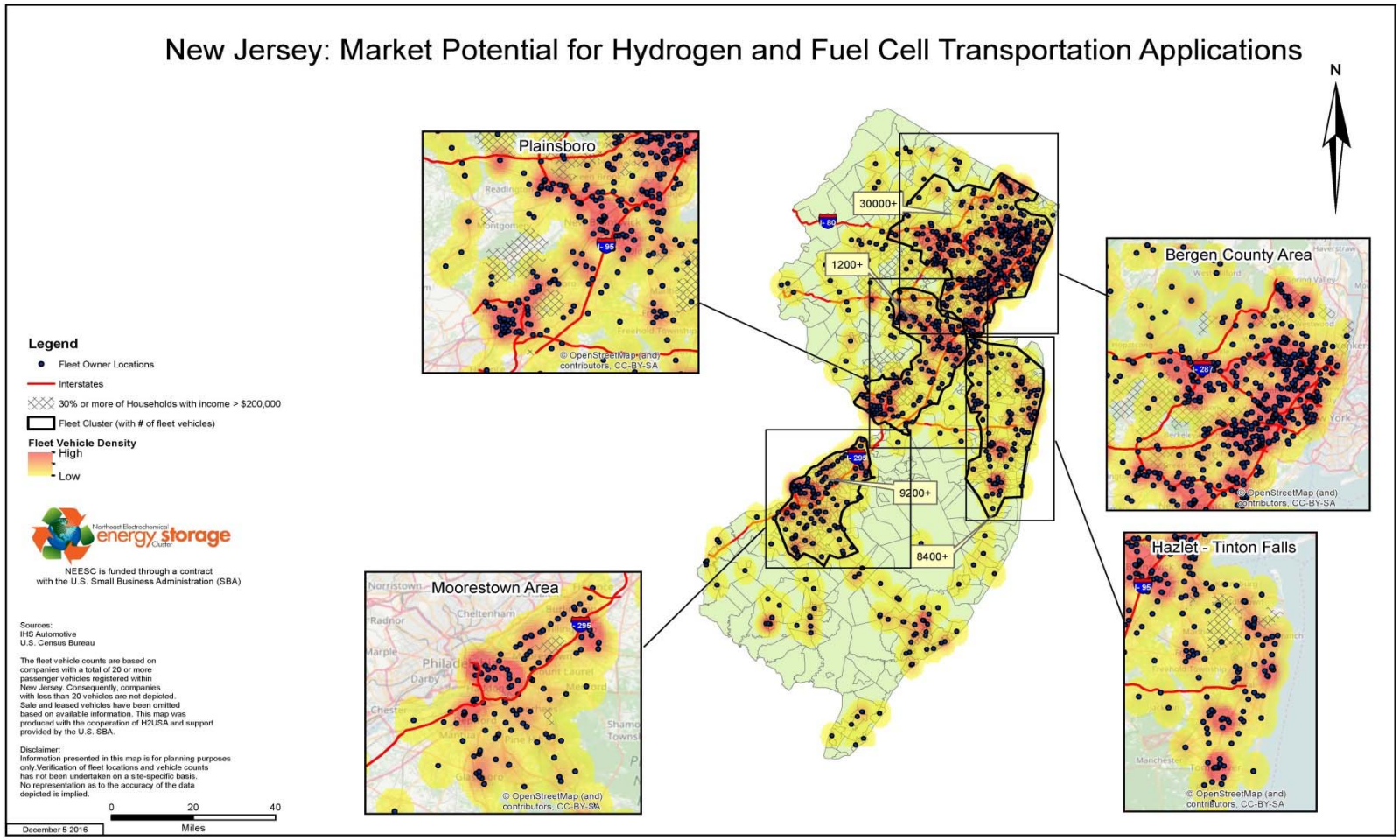
Markets

Regional Transportation Targets



Markets

Regional Transportation Targets



Markets

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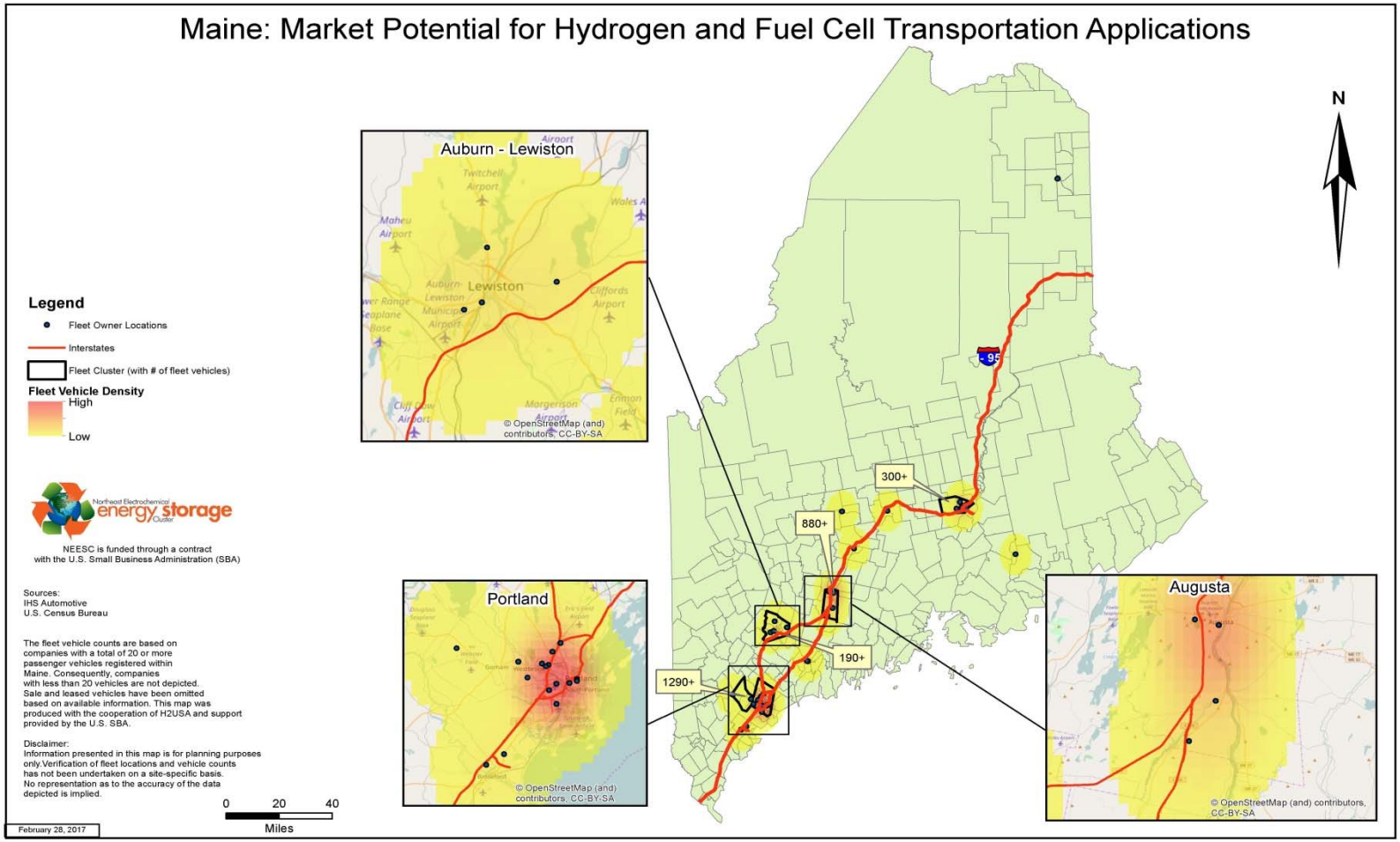

Markets

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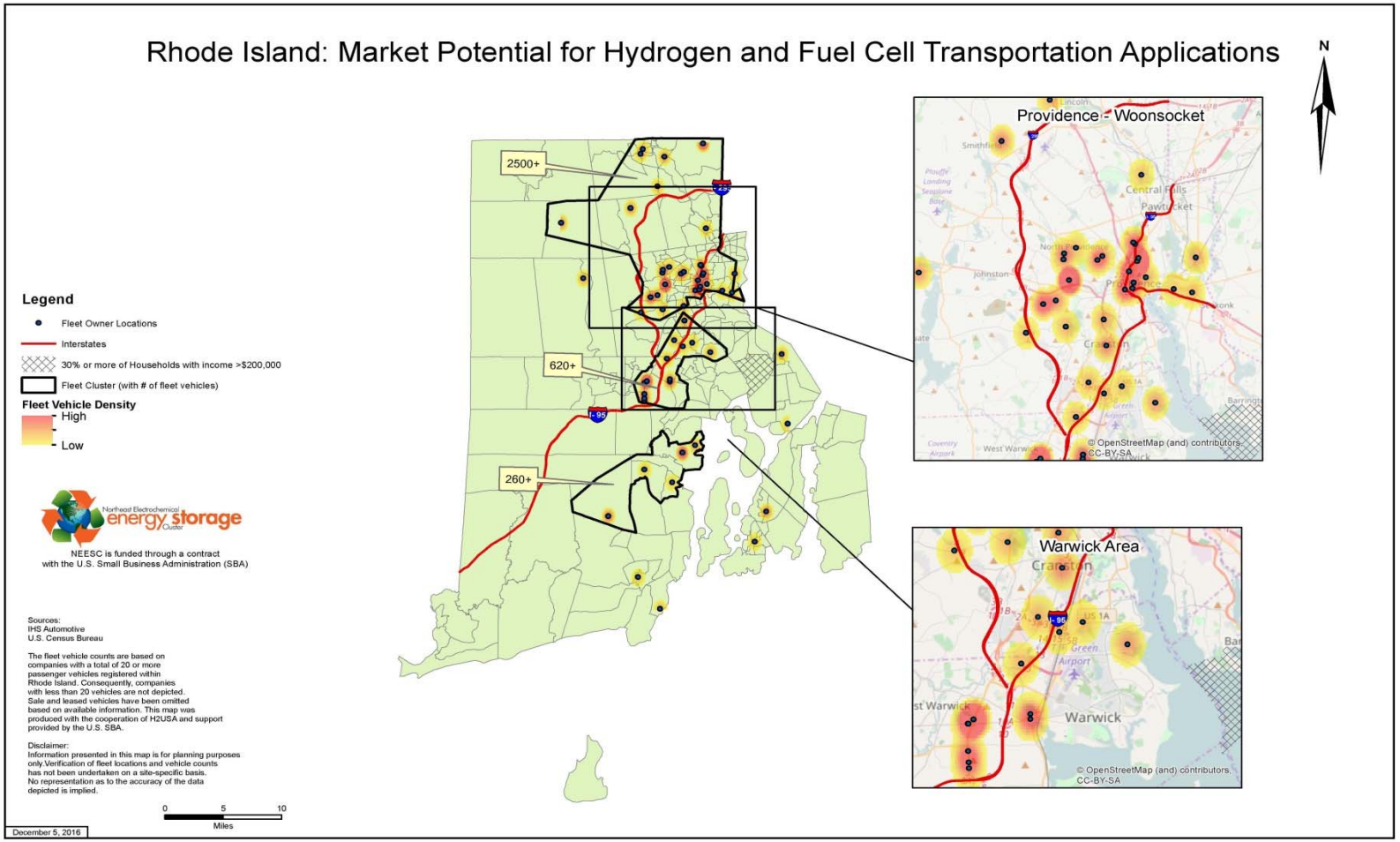
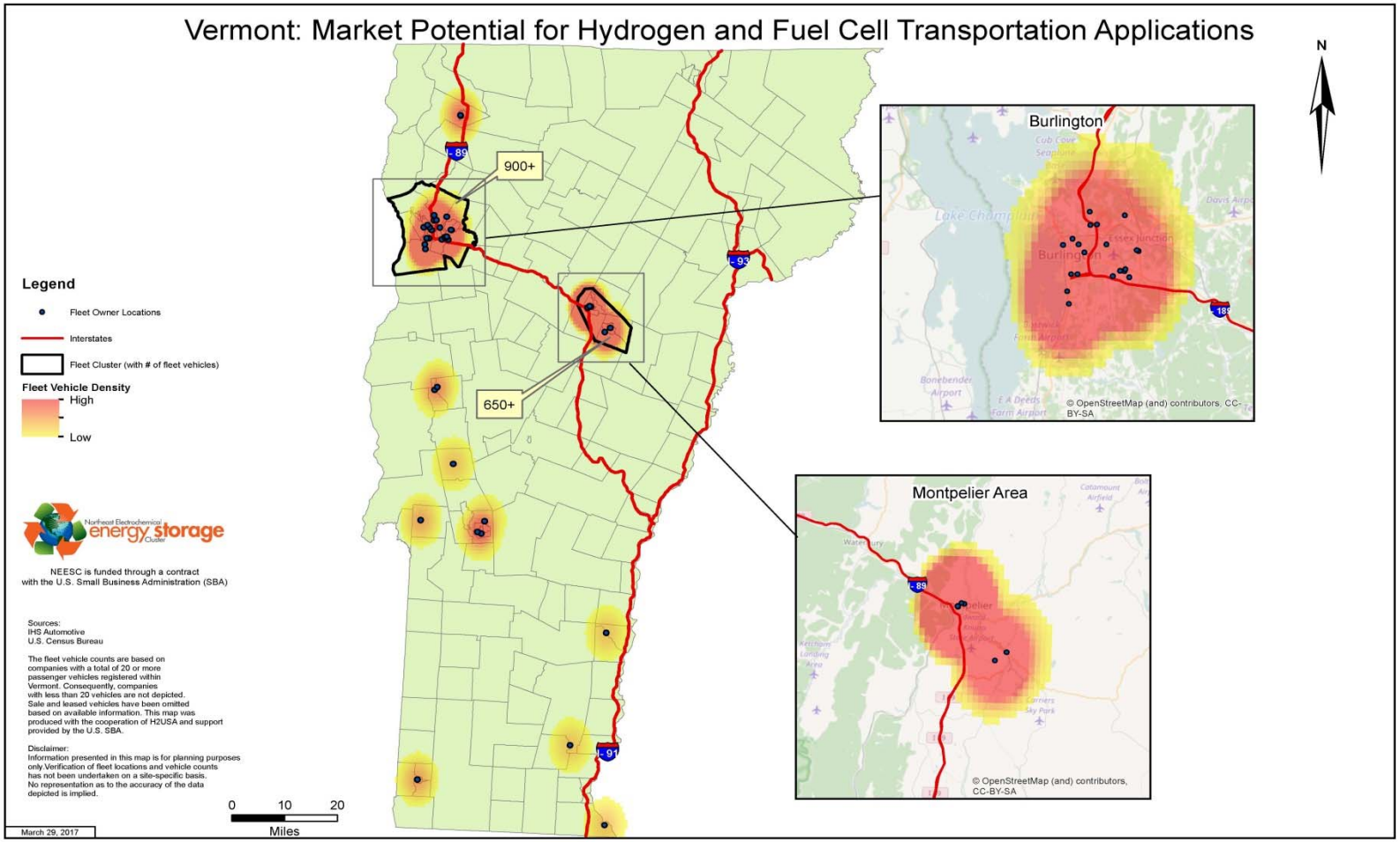


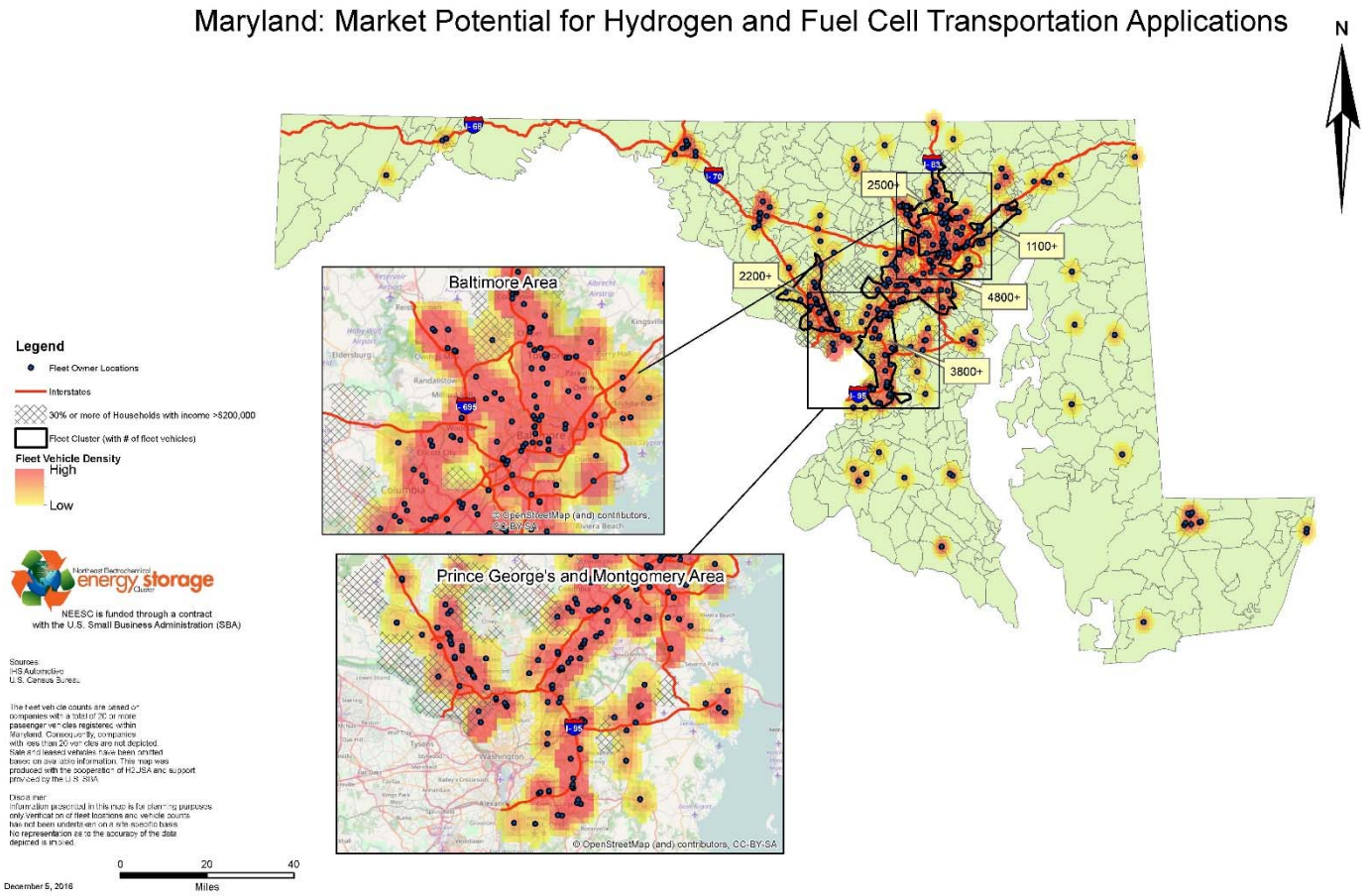
Markets

Regional Transportation Targets



Markets

Regional Transportation Targets



Action

Northeast Fleet Market Opportunities

Regional FCEV and Hydrogen Market Opportunities

State	Total Fleets			Fleet Deployment Goals				Supporting Infrastructure
	Vehicles	State	Buses	Vehicles	State	Buses	Total	
Maine	2,918	6,960	153	67	70	7	144	1 – 2
Connecticut	11,725	4,000	921	508	40	43	591	6 – 7
New York	43,631	18,708	7,458	1851	187	349	2,387	18 – 23
Massachusetts	17,602	10,072	1,796	722	101	84	907	7 – 9
Rhode Island	3,651	2,026	291	151	20	14	185	1 – 2
New Jersey	69,194	13,000	2,970	3102	130	139	3,371	31 – 34
Vermont	1,966	2,030	86	72	20	4	96	1 – 2
New Hampshire	-	2,023	113	-	20	5	25	1 – 2
Maryland	20,551	8,800	1,780	872	88	83	1,043	8 – 10
Region	**171,238**	**67,619**	**15,568**	**7,345**	**676**	**728**	**8,749**	**74 – 89**

- 8,749 Fuel Cell ZEVs (Projected)
  - 7,345 Passenger Vehicles
  - 676 State Passenger Vehicles
  - 728 transit/paratransit buses (FCEB)
- 74 to 89 hydrogen refueling stations

Action

Economy of Scale: Implementation of Roadmap Targets

VW Allocation (2.0L+3.0L)	Allocation for EVSE	CAPEX Application	Cost per Application	Quantity	Cost per state	Subsidy	Cost after Incentives	Cost per State	Cost After Subsidies	Subsidies
	Connecticut	• Transit buses (FCEB)	$1,000,000	43	$43,000,000	85%	$6,450,000	$63,658,400	$21,850,202	$41,808,198
		• FCEV LDV State	$15,800	48	$758,400		$758,400			
		• FCEV LDV Private	$15,800	500	$7,900,000	$5,000	$5,400,000			
$55,721,170	15%	• H_2 Fueling	$2,000,000	6	$12,000,000	23%	$9,241,802			
	Maine	• Transit buses (FCEB)	$1,000,000	7	$7,000,000	85%	$1,050,000	$11,164,600	$4,547,933	$6,616,667
		• FCEV LDV State	$15,800	70	$1,106,000		$1,106,000			
		• FCEV LDV Private	$15,800	67	$1,058,600		$1,058,600			
$21,053,064	15%	• H_2 Fueling	$2,000,000	1	$2,000,000	33%	$1,333,333			
	Massachusetts	• Transit buses (FCEB)	$1,000,000	84	$84,000,000	85%	$12,600,000	$111,003,400	$34,082,711	$76,920,689
		• FCEV LDV State	$15,800	101	$1,595,800		$1,595,800			
		• FCEV LDV Private	$15,800	722	$11,407,600	$2,500	$9,602,600			
$75,064,424	15%	• H_2 Fueling	$2,000,000	7	$14,000,000	27%	$10,284,311			
	New Hamshire	• Transit buses (FCEB)	$1,000,000	5	$5,000,000	85%	$750,000	$7,316,000	$3,066,000	$4,250,000
		• FCEV LDV State	$15,800	20	$316,000		$316,000			
$30,914,841	$0	• H_2 Fueling	$2,000,000	1	$2,000,000	0%	$2,000,000			
	Rhode Island	• Transit buses (FCEB)	$1,000,000	14	$14,000,000	85%	$2,100,000	$18,701,800	$5,950,128	$12,751,672
		• FCEV LDV State	$15,800	20	$316,000		$316,000			
		• FCEV LDV Private	$15,800	151	$2,385,800	$2,500	$2,008,300			
$14,368,858	10%	• H_2 Fueling	$2,000,000	1	$2,000,000	24%	$1,525,828			
	Vermont	• Transit buses (FCEB)	$1,000,000	4	$4,000,000	85%	$600,000	$7,453,600	$3,386,934	$4,066,666
		• FCEV LDV State	$15,800	20	$316,000		$316,000			
		• FCEV LDV Private	$15,800	72	$1,137,600		$1,137,600			
$18,692,130	15%	• H_2 Fueling	$2,000,000	1	$2,000,000	33%	$1,333,334			
	New York	• Transit buses (FCEB)	$1,000,000	349	$349,000,000	85%	$52,350,000	$417,200,400	$104,974,161	$312,226,239
		• FCEV LDV State	$15,800	187	$2,954,600		$2,954,600			
		• FCEV LDV Private	$15,800	1851	$29,245,800	$5,000	$19,990,800			
$127,701,807	15%	• H_2 Fueling	$2,000,000	18	$36,000,000	18%	$29,678,761			
	New Jersey	• Transit buses (FCEB)	$1,000,000	139	$139,000,000	85%	$20,850,000	$252,065,600	$130,340,918	$121,724,682
		• FCEV LDV State	$15,800	130	$2,054,000		$2,054,000			
		• FCEV LDV Private	$15,800	3102	$49,011,600		$49,011,600			
$72,215,805	15%	• H_2 Fueling	$2,000,000	31	$62,000,000	6%	$58,425,318			

Action

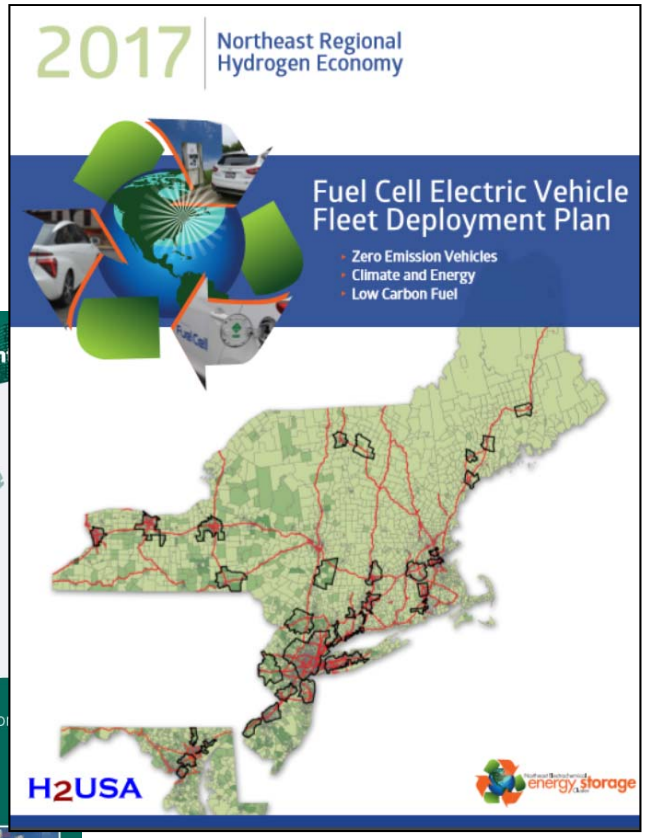
Market Planning: Roadmaps (Updated 2018)

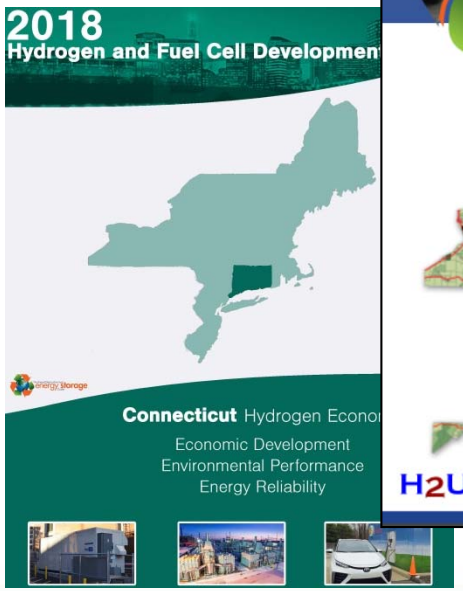
- Economic impacts (jobs, revenue, companies)
- Technology, Applications, and Markets
- Stationary and Transportation Deployment Targets
- Policy and Drivers
  - o Job Development
  - o Energy Reliability
  - o Storm Preparation
  - o Environmental
  - o Carbon Control
  - o Energy Cost

Action

Regional FCEV Deployment

- Consistent with goals of H2USA, NESCAUM, and the 8 State MOU Action Plan
- Developed for 9 states
  - Northeast states including Maryland
- ZEV Deployment Targets
  - Fleets, early market adopters, hydrogen users, hydrogen refueling, proximity to highways, etc
- Hydrogen Infrastructure
- Policy and Drivers
- Plan Expandable to Include:
  - OEM survey data
  - NREL modeling
  - Subset of National Roadmap
  - Additional states
- State Roadmaps (8 states)





Action

Implementation of Fleet Deployment Plan

Analysis

- Economic analyses/modeling for 2018 (state/regional engagement)
- Market projections and guidance (OEMs/DOE)
- Business Case Analysis for FCEBs, FCEVs and hydrogen fueling
- DOT alternative fuel corridor designation
- 8-State “ZEV” MOU (FCEV and H2 refueling)

Financing

- H_2 infrastructure (financing and development models)
- VW Settlement, FTA, EPA DERA, States’ resources

Coordination for Deployment (public/private partnership)

- State RFPs (State Roadmaps)
- Safety Reviews / Education and Awareness (Hydrogen Safety Panel)
- Regional Technical Exchange Centers

Action

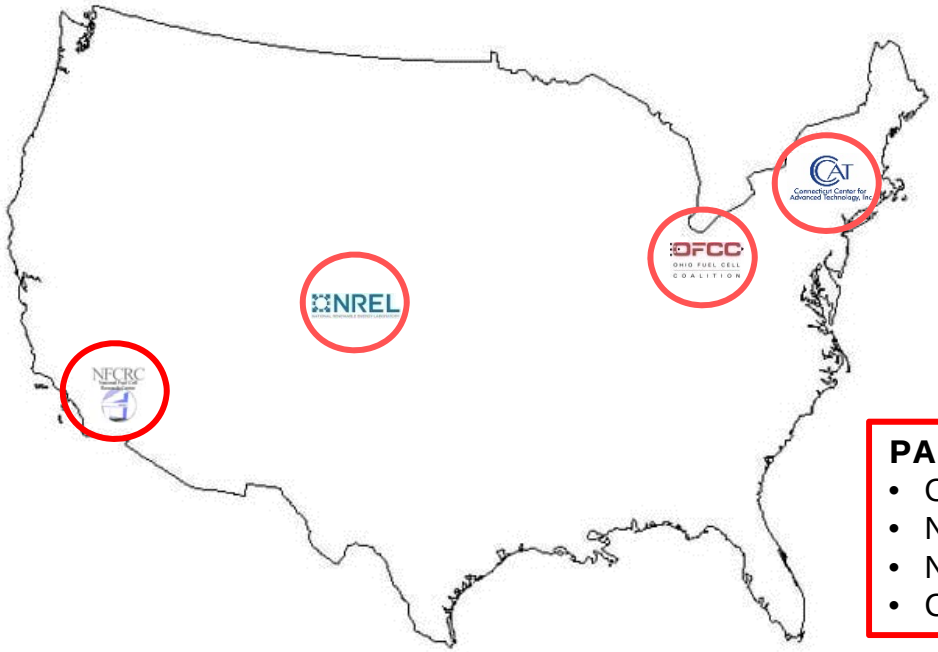
Hydrogen Safety Panel

- Safety reviews
- Safety guidance
- Project design and safety plans
- Safety knowledge and best practices
- Incident investigations

Action

National Technical Exchange Centers

- Supply Chain Database
- Supply Chain Exchange
- Standardization



PARTNERS / COLLABORATORS

- Ohio Fuel Cell Coalition (OFCC)
- National Renewable Energy Lab (NREL)
- National Fuel Cell Research Center (NFCRC) at UC Irvine
- Connecticut Center for Advanced Technology (CCAT)

Policy

States Transportation Policy Summary

State Energy Policy/Incentives for ZEV Transportation	ME	NH	VT	MA	RI	CT	NY	NJ	MD
Zero Emission Vehicle (ZEV) Program (FCEV/H_2 Infrastructure)			■	■	■	■	■		■
ZEV Purchase Target for State Government Fleets (TBD)			■	■	■	■	■		■
Purchase Incentives/"Point-of-Purchase" Rebates				■	■	■	■		■
Fuel Incentives									
Time of Day Rates/Variable Peak Pricing						■			
Public/Private Infrastructure Partnership						■	■		
Fuel Efficiency Standard (Private/State Fleets)			■	■	■	■	■	■	■
Refueling Infrastructure Incentives				■		■	■		
REC Available for Renewable H_2									
Tax Incentives			■		■	■	■	■	■
HOV Lanes and Parking Incentives							■	■	
One Stop Regulatory Approval									
Identified State "Point" Person				■	■	■			

NEESC Development Plan Market Potential	ME	NH	VT	MA	RI	CT	NY	NJ	MD
Stationary Fuel Cell (MW, low/high range)	87	74	58	250	52	170	1,131	214	
Transportation FCEV (near-term number of vehicles)	137	20	92	823	171	548	2,038	3,232	960
Transportation Fuel Cell Electric Bus (near-term number of vehicles)	7	5	4	84	14	43	349	139	83
Refueling Stations (low/high range)	1/2	1/2	1/2	7/9	1/2	6/7	18/23	31/34	8/10

Results

Summary

- Direction/Goals
- Market/Target
- Action/Implementation
- Policy/Incentives
- Results/Public Value

- 16+ stations planned/existing in the Northeast US

25 AFDC; https://www.afdc.energy.gov/fuels/stations_counts.html

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