

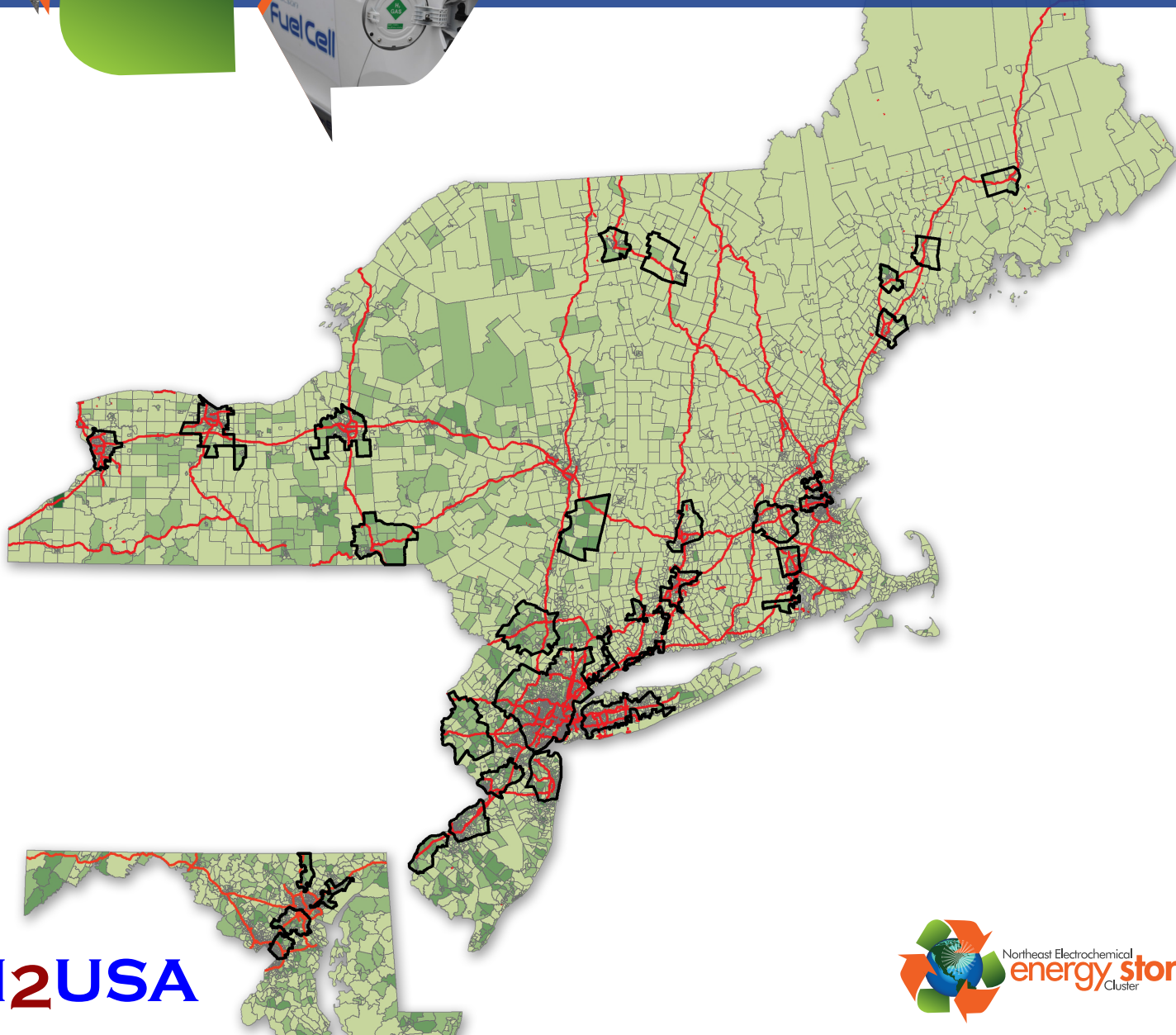
2017

Northeast Regional Hydrogen Economy



Fuel Cell Electric Vehicle Fleet Deployment Plan

- ▶ Zero Emission Vehicles
- ▶ Climate and Energy
- ▶ Low Carbon Fuel



H₂USA



2017 Northeast Regional Hydrogen Economy Fuel Cell Electric Vehicle Fleet Deployment Plan

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Table of Contents

<i>Executive Summary</i>	3
<i>Introduction</i>	4
Drivers.....	5
Barriers.....	6
Policy	6
Economic Impact	7
FCEV Potential Market.....	7
Fleets	9
Bus Transit	9
Specialty Vehicles.....	9
Hydrogen Infrastructure.....	10
Costs and Development	11
<i>Conclusion</i>	11
 <i>Index of Figures</i>	
Figure 1 – Fuel Cell Operation ³	4
 <i>Index of Tables</i>	
Table 1 – Hydrogen and Fuel Cell Drivers	5
Table 2 – Hydrogen and Fuel Cell Barriers	6
Table 3 – Northeast’s Hydrogen Fuel Cell Policy	6
Table 4 – 2015 Hydrogen Fuel Cell Industry	7
Table 5 – Transportation Targets	7
Table 6 – FCEV Advantages	8
Table 7 – Regional ZEV Fleet Transportation Market Opportunities (Initial to 2025)	9
Table 8 – FC Material Handler Advantages	10
Table 9 – Criteria for Deployment.....	10
Table 10 – Policy/Incentives for FCEV Deployment	11



Executive Summary

This 2017 Fleet Deployment Plan has been developed by the Northeast Electrochemical Energy Storage Cluster (NEESC) and H₂USA to identify opportunities, barriers, and actionable steps necessary for long-term deployment of zero emission fuel cell electric vehicles (FCEVs) and hydrogen infrastructure for fleets in the Northeast region and Maryland.

FCEVs could replace existing conventional vehicles in the Northeast region starting with **8,021 passenger vehicles** primarily in fleet clusters; **728 buses** primarily within transit fleets; and specialty vehicles including forklifts that are already being converted to use fuel cell technology for prolonged work in enclosed warehouse space. These FCEVs and fuel cell electric buses (FCEBs), fueled by hydrogen, could reduce annual carbon dioxide (CO₂) tailpipe emissions by approximately **95,000 to 134,000 metric tons** per year. To accommodate these vehicles, **74 to 89 hydrogen refueling stations** must be developed.

This guidance document recommends the following market opportunities for FCEV deployment and supporting hydrogen infrastructure development to meet economic, energy, and environmental needs:

- **8,021 FCEVs (676 FCEVs for State fleets) passenger fleet vehicles**
- **728 transit/paratransit FCEBs**
- **74 to 89 hydrogen refueling infrastructure sites (to support FCEV/FCEB deployment)**

Regional FCEV/FCEB Transportation Market Opportunities for Fleet Deployment

State	Vehicles (FCEV)	Buses (FCEB)	Total	Supporting H2 Infrastructure
Maine	137	7	144	1 – 2
Connecticut	548	43	591	6 – 7
New York	2,038	349	2,387	18 – 23
Massachusetts	823	84	907	7 – 9
Rhode Island	171	14	185	1 – 2
New Jersey	3,232	139	3,371	31 – 34
Vermont	92	4	96	1 – 2
New Hampshire	20	5	25	1 – 2
Maryland	960	83	1,043	8 – 10
Region Total	8,021	728	8,749	74 – 89

The deployment of hydrogen and fuel cell technology will reduce the region's dependency on oil; improve air and water quality; help meet carbon and zero emission vehicle (ZEV) requirements; utilize clean and renewable energy from indigenous sources, such as biomass, wind, and photovoltaic (PV) power; and increase the number of energy sector jobs within the Northeast. FCEVs are also convenient for consumer use; powerful with no voltage drop after use; easily refueled in 3 to 5 minutes, consistent with conventional refueling; and have a range of 300+ miles to avoid refueling anxiety. Barriers include: 1) vehicle cost, which is expected to be competitive with conventional and/or other advanced propulsion technology vehicles after mass manufacturing; and 2) development of refueling infrastructure to support deployed FCEVs. This plan provides links to relevant information to help assess, plan and initiate hydrogen FCEV fleet deployment and hydrogen refueling infrastructure development to help meet the economic, energy and environmental goals of the Northeast region.

Policies and incentives that support hydrogen and fuel cell technology will increase deployment and create additional jobs throughout the hydrogen fuel cell supply chain. As deployment increases, manufacturing costs will decline and hydrogen and fuel cell technology will be in a position to compete more effectively in a global market without support from incentives. Policies and incentives can be coordinated regionally to maintain this cluster as a global exporter for long-term growth and economic development.



Introduction

This 2017 *Northeast Regional Hydrogen Economy Fuel Cell Electric Vehicle Fleet Deployment Plan* was created for the Northeast Electrochemical Energy Storage Cluster (NEESC) regional states² and Maryland, with support from the United States (U.S.) Small Business Administration (SBA) and the U.S. Department of Energy (DOE) supported H₂USA Initiative to increase awareness and facilitate the deployment of hydrogen and fuel cell technology. NEESC is a network of industry, academic, government and non-governmental leaders working together to provide energy storage solutions. The network focuses on the innovative development, production, promotion and deployment of hydrogen and fuel cell technologies. H₂USA is a public-private partnership that promotes the development of hydrogen infrastructure to support a widespread adoption of hydrogen fueled fuel cell electric vehicles (FCEVs) across America. H₂USA's mission is to "address hurdles to establishing hydrogen fueling infrastructure, enabling the large scale adoption of fuel cell electric vehicles." The intent of this guidance document is to make available information regarding the economic value and deployment opportunities to increase environmental performance and energy reliability using hydrogen and fuel cell technologies.

A fuel cell is a device that uses hydrogen and oxygen to create an electric current. Fuel cells occupy a technology platform that when coupled with electric drivetrains can replace the internal combustion engine (ICE) in vehicles. Fuel cells are used commercially to provide power for transportation, stationary, and portable power applications, such as the grid, businesses, forklifts, automobiles, trucks, buses, military electronics, laptop computers, and cell phones.

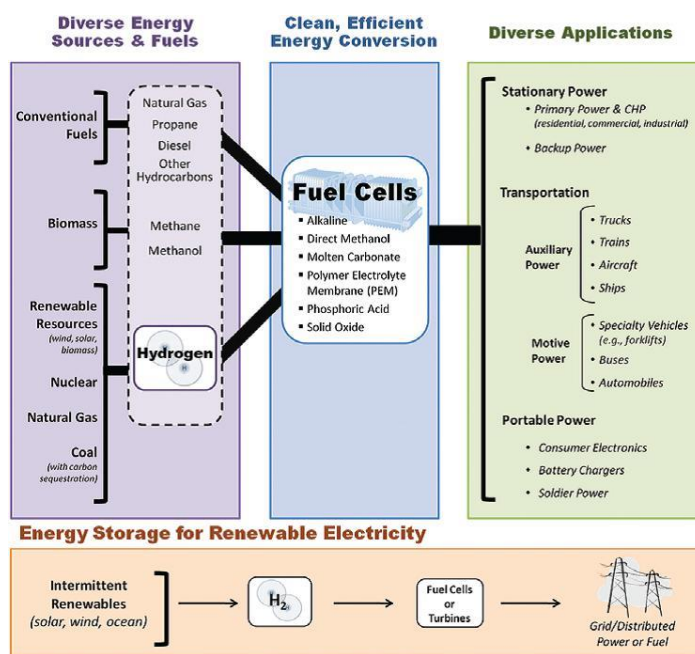
FCEVs derive energy from the most plentiful element in the known universe: hydrogen.

The powertrain of these vehicles have fewer moving parts, which means less maintenance may be required. This is not to say FCEVs will be maintenance free, or that failure will never occur with the fuel cell or vehicle battery; however, with fewer moving parts, there may be less likelihood for friction related failures.

FCEVs emit no harmful criteria pollution tailpipe gases into the environment, the only byproduct of the hydrogen fuel cell is water. In addition, fuel cells can reduce the need for heavy electric vehicle (EV) batteries when compared to battery electric vehicles (BEV), cut down on recharging/refueling time (3 to 5 minutes), and provide a driving range of 300+ miles on a single refueling.³

Hydrogen can be produced using a wide variety of resources found here in the U.S. Hydrogen can be renewable and produced from waste, biomass, wind, solar, tidal, wave, and geothermal. Production technology includes electrolysis of water, steam reforming of natural gas, coal gasification, thermochemical production, trigeneration, and biological gasification.⁴

Figure 1 – Fuel Cell Operation³



² The NEESC region states include Connecticut, Vermont, New Hampshire, Massachusetts, Rhode Island, Maine, New York, and New Jersey.

³ U.S. DOE; "Hydrogen Delivery;" <http://energy.gov/eere/fuelcells/hydrogen-delivery>; October 2016.

⁴ Hydrogentrade.com; "Hydrogen Production;" <http://www.hydrogentrade.com/production/>; October 2014.

Production of hydrogen from natural gas may be favored initially because it has the highest hydrogen-to-carbon ratio of any energy source and because of the availability associated with mature steam methane reforming (SMR) processes and facilities already in use for petrochemical and industrial applications.⁵ Furthermore, natural gas is generally available throughout the Northeast region, is relatively inexpensive, and is primarily a domestic energy source.

Because hydrogen is considered an “energy carrier” that produces clean power, both its production and consumption would be carbon-free if generated by renewable energy sources. There has been continuous research focused on developing advanced technologies for producing hydrogen from domestic renewable energy resources that minimize environmental impacts. For example, the electric energy generated by solar panel arrays can be used to power the electrolysis of water, which produces hydrogen fuel and oxygen as a byproduct. The SunHydro solar-powered refueling station located in Wallingford, Connecticut generates hydrogen using Proton OnSite’s enhanced proton exchange membrane (PEM) technology that derives hydrogen from renewable solar energy and water.⁶ In Hempstead, New York a 100 kilowatt (kW) wind turbine operates specifically to provide clean renewable power to an electrolyzer that produces hydrogen for a vehicle refueling station.⁷

Drivers

Hydrogen-powered FCEVs offer documented benefits required for a sustainable, clean energy future that will improve the country’s energy and economic security, significantly reduce greenhouse gas emissions, and create jobs in the United States. FCEVs have already been introduced into the US market in California and more will be introduced into other regions likely starting with the Northeast states through 2025. In addition, eight states have signed a Memorandum of Understanding (MOU), which establishes a collective goal and imposes a mandate on the original equipment manufacturers (OEMs) to deploy at least 3.3 million zero emission vehicles (ZEVs) by 2025.^{8,9}

Table 1 – Hydrogen and Fuel Cell Drivers

- Emissions Reduction
- Economic Development
- Global Demand for Low Carbon Power
- Energy Storage
- Energy Security

The Northeast hydrogen and fuel cell industry, while still emerging, currently has an economic impact exceeding \$1.4 billion in total revenue and investment. The Northeast region also benefits from approximately 6,550 direct, indirect, and induced jobs from this industry.^{10,11} Furthermore, the Northeast has a definitive and attractive economic development opportunity to greatly increase its participation in the hydrogen and fuel cell industry as this collective industry strives to meet global demand for clean, low

⁵ Go with Natural Gas; “Natural Gas and Hydrogen;” <http://www.gowithnaturalgas.ca/operating-with-natural-gas/fuel/natural-gas-as-an-energy-source/natural-gas-and-hydrogen/>; February 2014.

⁶ SunHydro; “SunHydro and Proton Energy Systems Open First-of-Its Kind, Solar-Powered Hydrogen Fueling Station in Connecticut;” <http://www.sunhydro.com/sunhydro-and-proton-energy-systems-open-first-of-its-kind-solar-powered-hydrogen-fueling-station-in-connecticut/>; October 15, 2010.

⁷ NYSERDA; “Town of Hempstead Hydrogen and H2/CNG Blend Refueling Station (ST10152-1);” <https://www.nyserda.ny.gov/Cleantech-and-Innovation/Research-Project/Research-Projects/Research-Project-Search-Results/Project-Information?p=3266>; June 2016. Personal communication with Tara Schneider, Town of Hempstead, Oct. 4, 2016.

⁸ Zero emission vehicles include fuel cell electric vehicles (FCEV), battery electric vehicles (BEV), and plug-in hybrid electric vehicles (PHEV).

⁹ Mass.gov; “State Zero-Emission Vehicle Programs: Memorandum of Understanding;” <http://www.mass.gov/eea/docs/dep/air/priorities/zev-mou-final.pdf>; October 24, 2013.

¹⁰ Indirect impacts are the estimated output (i.e., revenue), employment and labor income in other business (i.e., not-OEMs) that are associated with the purchases made by hydrogen and fuel cell OEMs, as well as other companies in the sector’s supply chain. Induced impacts are the estimated output, employment and labor income in other businesses (i.e., non-OEMs) that are associated with the purchases by workers related to the hydrogen and fuel cell industry.

¹¹ Economic impact derived from an IMPLAN Economic Financial Model, Todd Gabe; NEESC; January 2016. This analysis assesses the direct, indirect, and induced values of the Northeast region’s hydrogen and fuel cell industry.



carbon power. The Northeast region’s biomass, wind, and photovoltaic (PV) power production industries could be further enhanced with energy storage provided by hydrogen and used within the transportation sector. These drivers (see Table 1) will become more important as users turn to sustainable energy sources in place of fossil fuels.

Barriers

There are economic and technological barriers (see Table 2) that may temporarily impact the use of hydrogen for transportation. Economic barriers include the cost of hydrogen production and distribution, cost of materials and components, and competition with current fossil fuels. Codes and standards concerning refueling infrastructure including hydrogen storage, distribution networks, and integration of new technology are technological barriers which are currently being addressed for successful integration of hydrogen as a transportation fuel. Educating consumers and product developers about the capabilities and accomplishments of hydrogen and fuel cell technologies may be the first step to the mass adoption of ZEVs. Also, symbiotic ZEV markets and competing conventional ICE vehicle markets must be fully examined to project FCEV deployment. Coordinating the development of convenient and cost effective hydrogen refueling infrastructure for FCEV users as a result of the mandated ZEV rollout will also be necessary.

Table 2 – Hydrogen and Fuel Cell Barriers

- Cost of Production
- Production/Distribution
- Cost of Materials/Components
- Competing Markets
- Hydrogen Storage Technology
- Distribution Networks
- Technology Integration
- Uniform Codes and Standards
- Education

Policy

The Northeast’s high cost of electricity, concerns over regional air quality, available federal tax incentives for renewable power, and legislative policy for climate control have resulted in renewed interest in the development of efficient and cost effective vehicles powered by renewable energy. Specific policies in the region supporting FCEV deployment and hydrogen refueling infrastructure development may include the purchase of state-owned passenger vehicles, “point-of-purchase” rebates, hydrogen fuel rebates, incentives to support the development of refueling infrastructure, tax incentives, infrastructure partnerships, and high occupancy vehicle (HOV) lanes/parking incentives (See Table 3 and Appendix III – State Energy Policy/Incentives for Stationary Fuel Cells and Hydrogen Transportation).

Table 3 – Northeast’s Hydrogen Fuel Cell Policy

- Multi-State ZEV Action Plan
- Renewable Greenhouse Gas Initiative
- ZEV Purchase Incentives
- Renewable Fuel Incentive Rebates
- Refueling Infrastructure Incentives
- Tax Credits

Recent research suggests that the type of policy mechanisms with the strongest relationship to alternative fuel vehicle (AFV) adoption per capita include grant or rebate policies, discount policies, and exception policies. Understanding which policies best support and promote the use of AFVs and alternative fuels will allow states to realize the important economic, environmental, and efficiency benefits related to increased adoption of AFVs.¹²

¹² Clean Energy Coalition; “Alternative Fuels: A State Policy Analysis;” <http://cec-mi.org/wp-content/uploads/2014/08/Policy-Paper-Final-v2.pdf>; July 2014.



Economic Impact

In 2015, the hydrogen and fuel cell supply chain had a significant bearing on the region's economy, contributing nearly \$1.4 billion in revenue and investment, more than 6,550 direct, indirect and induced jobs, and labor income of approximately \$620 million.

Information on the age distribution of hydrogen and fuel cell companies in the Northeast is suggestive of a substantial

expansion in the sector, with recent growth of several small businesses. Analysis of the employment growth of the hydrogen energy and fuel cell companies in the Northeast indicates that a greater percentage of businesses grew than declined between 2011 and 2015, and 17 companies (with data available for both periods) had a combined employment growth rate of approximately 16 percent.¹³ The growth of jobs related to the deployment of FCEVs and other hydrogen equipment may reduce some jobs in traditional sectors; however, there will be a net increase in job creation. Economic data for the NEESC region is provided in Table 4.

Table 4– 2015 Hydrogen Fuel Cell Industry	
	NEESC Regional Economic Data
Supply Chain Members	1,194+
Direct Revenue & Investment (\$M)	497
Direct Jobs	1,806
Direct Labor Income (\$M)	279
Indirect Revenue & Investment (\$M)	504
Indirect Jobs	2,192
Indirect Labor Income (\$M)	192
Induced Revenue & Investment (\$M)	419
Induced Jobs	2,560
Induced Labor Income (\$M)	148
Total Revenue & Investment (\$M)	1,420
Total Jobs	6,558
Total Labor Income (\$M)	620

FCEV Potential Market

Government and industry are now advancing the use of hydrogen and renewable energy as a replacement of hydrocarbon fuels in the transportation sector, which accounts for approximately 31 percent of the Northeast region's total energy consumption.¹⁴ As these hydrogen system sizes and applications increase, efficiency will increase, resulting in more favorable economics and enhanced reliability. Targets for FCEV deployment and hydrogen infrastructure development include public/private fleets, bus transit, and specialty vehicles (see Table 5). FCEVs have advantages (see Table 6) over conventional ICE technology and can reduce price volatility, decrease dependence on oil, improve environmental performance, and provide greater efficiencies, as follows:

Table 5 – Transportation Targets

- Public/Private Fleets
- Bus Transit
- Material Handling
- Ground Support Equipment
- Auxiliary Power Units
- Ports

- Fuel cell electric vehicles can achieve up to 60 percent efficiency¹⁵, which is substantially greater than the 30 percent efficiency of conventional vehicles or 40 percent efficiency of most hybrid vehicles.¹⁶
- FCEVs operating on hydrogen produced from renewable resources virtually eliminate all GHG emissions compared to conventional fossil fuel-powered vehicles. Passenger car tailpipe emissions of CO₂ are reduced by 4.75 metric tons CO₂E/vehicle/year.^{17,18}

¹³ NEESC; "Economic Profile of the Northeastern U.S. Hydrogen Energy and Fuel Cell Industry;" Todd, Gabe; January 2016.

¹⁴ U.S. Energy Information Administration (EIA); "U.S. Overview - Energy Consumption by End-Use Sector, 2014"; <http://www.eia.gov/state/>; October 2016.

¹⁵ U.S. DOE; "The Fuel Cell Electric Vehicle (FCEV);"

http://energy.gov/sites/prod/files/2015/07/f24/fcto_fcev_infographic_0.pdf; September 2016.

¹⁶ U.S. DOE; "Where the Energy Goes"; <https://www.fueleconomy.gov/feg/atv.shtml>; September 2016.

¹⁷ GHG emissions include carbon dioxide, methane, and nitrous oxide, all expressed as carbon dioxide equivalents.

¹⁸ U.S. EPA; "Greenhouse Gas Emissions from a Typical Passenger Vehicle;" <https://www.epa.gov/sites/production/files/2016-02/documents/420f14040a.pdf>; September 2016.



- Fuel cell electric buses (FCEBs) had an average fuel economy of 5.47 miles per kilogram of hydrogen, which equates to 6.18 miles diesel gallon equivalent.¹⁹ The average fuel efficiency of conventional diesel transit buses is approximately 3.6 miles per gallon.²⁰ These results indicate that the FCEBs have an average fuel economy that is approximately 42% higher than that of the diesel buses.
- Fuel cells offer significant GHG reduction opportunities for transit buses. A bus powered by hydrogen fuel cell technology operated on hydrogen from renewable resources could displace 79 to 131 metric tons CO₂E/vehicle/year of diesel bus emissions.^{21, 22,}

Table 6 – FCEV Advantages

- Quiet Operations
- Zero/Near Zero Emissions
- Domestic Fuel Supply
- Price Volatility Reduction
- Energy Security
- Higher Efficiency
- Range: 300+ Miles
- Fast Refueling: 3-5 Minutes
- Safe, Convenient and Affordable

Automakers are now making plans to comply with ZEV goals. Eight (8) states have committed and signed a Memorandum of Understanding (MOU), which establishes a collective goal to deploy at least 3.3 million ZEVs by 2025. Automakers have already begun to announce pricing structures for their 2017 FCEV model.²³ Six (6) of the eight (8) states that have signed the Eight (8) State MOU are located in the Northeast region and have the potential of deploying approximately 639,000 FCEVs/BEVs by 2025. If all the Northeast states were to adopt the MOU, the result could be more than 800,000 FCEVs/BEVs by 2025.²⁴ The expected result of this deployment will be high efficiency vehicles that require less fuel and produce very low or zero tailpipe emissions.

Potential initial deployment of 3.3 million ZEVs by 2025 is aggressive and based on the availability of infrastructure. This Fleet Deployment Plan uses a conservative step-by-step approach to capture a significant but realistic share of the projected market opportunities in the Northeast by applying the Eight (8) State MOU goals to the total registered vehicles to derive 4.675 percent of registered vehicles that may be registered as ZEV, and then applying this percentage to fleet vehicles as conservative early market opportunities (see Table 7 for more information).²⁵ This approach will build a foundation to begin deployment of FCEVs through the replacement of existing conventional fleet vehicles in the Northeast, starting with 8,021 vehicles that could provide an annual carbon dioxide (CO₂) emissions reduction of approximately 95,000 to 134,000 metric tons per year.^{26, 27}

¹⁹ NREL; “Zero Emission Bay Area (ZEBA) Fuel Cell Bus Demonstration Results: Fifth Report;” <http://www.nrel.gov/docs/fy16osti/66039.pdf>; September 2016.

²⁰ U.S. DOE; “Average Fuel Economy of Major Vehicle Categories;” <http://www.afdc.energy.gov/data/10310>; September 2016.

²¹ On average, transit buses travel approximately 34,000 miles annually. <http://www.afdc.energy.gov/data/10309>.

²² U.S. EPA; “Vocational Vehicle CO₂ Standards for 2014-2016 Medium-Heavy (20,000 lbs. -33,000 lbs.) equals 234 g/ton-mile;” <https://www3.epa.gov/otaq/climate/documents/vocational-only-presentation.pdf>; August 2012.

²³ Toyota Motors Corporation; “Toyota Announces 2017 Mirai Pricing;”

<http://toyotanews.pressroom.toyota.com/releases/toyota-announces-2017-mirai-pricing.htm>; September 2016.

Los Angeles Times; “Honda Clarity Fuel Cell coming -- at a price;” <http://www.latimes.com/business/autos/la-fi-hy-honda-clarity-fuel-cell-price-20160121-story.html>; Sept 2016.

²⁴ FCEV deployment derived from a DOE projection of California ZEV (FCEV and BEV) and 2011 registered vehicle data. Based on the DOE projection and Eight State MOU Connecticut, Massachusetts, New York, Vermont, Maryland, and Rhode Island have the potential to deploy approximately 565,000 FCEVs/BEVs; Connecticut, Massachusetts, New York, Vermont, Maryland, Rhode Island, New Hampshire, New Jersey, and Maine have the potential to deploy more than 800,000 FCEVs/BEVs by 2025.

²⁵ U.S. DOE; “Fact #771 March 18, 2013 California Zero-Emission Vehicle Mandate is Now in Effect;” <http://energy.gov/eere/vehicles/fact-771-march-18-2013-california-zero-emission-vehicle-mandate-now-effect>; October 2016.

²⁶ Analyses conducted by the Connecticut Center for Advanced Technology (CCAT) based on the ZEV eight-state MOU and R. L. Polk vehicle 2013 data for NY and IHS Automotive 2016 data for ME, VT, RI, MA, CT, NJ, and MD. Eight (8) State MOU projection of 3.3 million and total registered vehicles (NY 2013 and CT, ME, MA, RI, NJ, MD 2016) were used to derive 4.675 percent of registered vehicles that may be registered as ZEVs; this calculated value was then applied to fleet vehicles as a conservative early projection.



Fleets

There are over 171,000 passenger fleet vehicles classified as non-leasing or company-owned vehicles in the Northeast.²⁸ Passenger fleet vehicles at transportation hubs are good candidates for replacement by FCEVs because they mostly operate on fixed routes or within fixed districts and can be fueled from a centralized hydrogen station. As shown in Appendix I – Figures 1 - 9, “Potential Hydrogen and Fuel Cell Applications for Transportation,” a significant number of fleet vehicles are clustered primarily in the New York City, New York; the southwest and Hartford areas in Connecticut; and Boston, Massachusetts metropolitan areas. Additional clusters of fleet vehicles are located in Albany, New York; Portland, Maine; Moorestown, New Jersey; Providence, Rhode Island; and Baltimore, Maryland.²⁹

Table 7 – Regional ZEV Fleet Transportation Market Opportunities (Initial to 2025)

State	Total Fleets ²⁸			Fleet Deployment Goals ²⁹				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

Bus Transit

There are approximately 15,570 buses that provide public transportation services in the Northeast Region, including approximately 12,875 buses that are either diesel or diesel hybrid vehicles.³¹ Although the efficiency of conventional diesel buses has increased, these buses, which typically achieve fuel economy performance levels of 3.6 miles per gallon, have the greatest potential for energy savings by using high efficiency fuel cells. A fuel cell transit bus funded by the Federal Transit Authority’s (FTA) National Fuel Cell Bus Program (NFCBP) will be in service at the Massachusetts Bay Transportation Authority (MBTA) by 2017, along with a hydrogen refueling station provided by Nuvera Fuel Cells.³²

Specialty Vehicles

²⁷ CO₂ emission reduction = 4.75 metric tons CO₂E /vehicle/year*8,021 (FCEVs) + 79 to 131 metric tons CO₂E /vehicle/year*728 (FCEB) = 95,612 to 133,468 metric tons CO₂E /vehicle/year.

²⁸ Vehicle Fleet data provided by R. L. Polk & Co. for NY 2013 and IHS Automotive for CT, ME, MA, RI, NJ, MD 2016; “State” data obtained from GSA 2010 Federal Fleets by State; “Buses” data obtained from NTD Date, “TS2.2 - Service Data and Operating Expenses Time-Series by System”, <http://www.ntdprogram.gov/ntd> ; October 2016.

²⁹ The data used in calculating “Total Fleets” in Table 7 are based on the 2016 IHS Markit (Polk) Fleet Owner Location Data for fleets in the states of Maine, Connecticut, Rhode Island, Massachusetts, Vermont, New Jersey and Maryland. For New York, the 2013 IHS Markit (Polk) Fleet Owner Location Data was used. Data records for “New and Used Car Dealerships”, “Used Car Dealerships”, “lease” or “leasing” companies, and national/regional fleet accounts were excluded. Companies with duplicate location entries and companies with non-physical address entries such as post office boxes were also excluded. This refinement is intended to best reflect the total number and locations of fleet vehicles and potential market opportunities for fuel cell electric vehicles in the Northeast region.

³⁰ “Vehicles” and “Buses” Market Opportunities are estimated by multiplying Total “Vehicles” and “Buses” Fleets by 4.675 percent. A conservative one percent of Total State Fleets is used for State Deployment Goals.

³¹ National Transit Database; “2014 Annual Database Revenue Vehicle Inventory,” <https://www.transit.dot.gov/ntd>; October 2016.

³² MBTA; “Massachusetts Bay Transportation Authority - Sustainability,” http://www.mbta.com/about_the_mbta/environment/default.asp?id=26033; October 2016. Personal Communications with Nuvera Fuel Cells.



Specialty vehicles, such as material handling equipment, airport tugs, street sweepers, and wheel loaders are used by a variety of industries, including manufacturing, construction, mining, agriculture, food sales, retailers, and wholesalers. Batteries that currently power some equipment for indoor use are heavy and take up significant storage space while only providing up to six hours of run time. Fuel cell powered equipment has zero emissions, a lower annual cost of ownership, and almost twice the estimated product life than battery powered equipment. Fuel cell powered lift trucks can be operated indoors, can operate up to eight hours before refueling, can be refueled quickly (2-3 minutes), and eliminates the need for battery storage and charging rooms (see Table 8). Fuel cell powered material handling equipment is already in use at dozens of warehouses, distribution centers, and manufacturing plants in North America. Large corporations that are currently using or planning to use fuel cell powered material handling equipment include: Central Grocers, FedEx Freight, Sysco Foods, and Walmart.³³

Table 8 – FC Material Handler Advantages

- Lower total cost of ownership
- 80% lower refueling/recharging labor cost
- 75% less space required for refueling
- Improved Net Present Value (NPV)
- Zero Emissions

Hydrogen Infrastructure

Hydrogen refueling infrastructure is necessary and will be required to support FCEVs including light duty passenger vehicles, buses and material handling equipment. Hydrogen refueling can be developed privately or publicly depending on usage. While costs for hydrogen refueling infrastructure typically range from \$1,000,000 - \$3,260,000 per station³⁴, it is possible that construction of these stations could be backed by private sector financing or developed publicly in conjunction with deployment of high efficiency ZEV fleets. Consistent with OEM plans for deployment of FCEVs, H₂USA and Northeast States for Coordinated Air Use Management (NESCAUM) are currently developing models for hydrogen infrastructure financing and development to serve projected FCEVs. This plan complements those efforts to help coordinate the initial development of hydrogen refueling infrastructure to improve the value of FCEVs to customers that will enable growth and distribution of ZEV technology into the market place. Potential sites for development include existing conventional refueling stations and new sites where hydrogen may be offered with other alternative fuels.³⁵ For example, Proton OnSite's sister company, SunHydro, has indicated a willingness to develop hydrogen refueling infrastructure on sites along the east coast.³⁶ Appendix I – Figures 1 - 9 “Potential Hydrogen and Fuel Cell Applications for Transportation,” depicts potential locations for hydrogen refueling infrastructure with fleet clusters, early market adopters, and other factors.

Table 9 – Criteria for Deployment

- High Population Density
- Support and Policies for Clean Energy Technology
- NEESC and H₂USA Activities
- Strong Hydrogen and Fuel Cell Industry
- Areas with Early Market Adopters
- Areas with Hydrogen Production and Use
- Areas with Alternative Refueling Stations

³³ U.S. DOE, “Early Markets: Fuel Cells for Material Handling Equipment;” http://www.energy.gov/sites/prod/files/2014/03/f9/early_markets_mhe_fact_sheet.pdf; October 2016.

³⁴ California Air Resources Board; Joint Agency Staff Report on Assembly Bill 8: Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California; December 2015; CEC-600-2015-016. Does not include station costs for 100 percent renewable hydrogen.

³⁵ There are approximately 13,905 retail fueling stations in the Northeast region. U.S. Census Bureau; http://thedataweb.rm.census.gov/TheDataWeb_HotReport2/econsnapshot/2012/snapshot.html?STATE=ALL&COUNTY=ALL&IND=%3DCOMP%28%28C4*C4%29%2FC4%29&x=62&y=7&NAICS=447; 2012. There are approximately 3,400 public and/or private fueling stations within the region that provide one or more alternative fuels such as biodiesel, compressed natural gas, propane, liquefied natural gas, and/or electricity for alternative-fueled vehicles. U.S. DOE; “Alternative Fuels Database;” http://www.afdc.energy.gov/fuels/stations_counts.html; September 2016.

³⁶ Hartford Courant; “First Stop On The 'Hydrogen Highway;” http://articles.courant.com/2010-10-27/news/hc-cl-macpherson1027_1_hydrogen-stations-hydrogen-powered-cars-hydrogen-suppliers; September 2016.



Initial deployment of FCEVs in the Northeast region is expected to occur in fleet clusters with high vehicle density. These fleet clusters are well suited for deployment of hydrogen infrastructure and FCEVs based on criteria listed in Table 9. In considering locations for the development of hydrogen refueling infrastructure, it would also be advantageous to accommodate public transit, public and private early market adopters, and other commercial and private vehicles traveling from fleet cluster to fleet cluster between Maine and Maryland along an East Coast Hydrogen Highway.

Costs and Development

A variety of hydrogen generation technologies, such as steam reformation, electrolyzers, and trigeneration, are available to provide hydrogen for vehicle refueling. The hydrogen may be produced onsite or transported to the refueling station as a gas or liquid. The most common method to produce hydrogen today is through steam methane reformation (SMR), which typically requires an industrial production facility and uses tube trailer trucks to deliver hydrogen to refueling stations. The total cost for a 180 kg/day hydrogen station with delivered gaseous hydrogen is estimated to be just over \$2 million at present, while the total installed costs for a hydrogen station with delivered liquid hydrogen is estimated to cost approximately \$2.8 million. Electrolyzers and onsite SMR are typically used for onsite production of gaseous hydrogen. These stations with onsite production typically produce between 100 to 200 kg of hydrogen per day and cost between \$2.5 million to \$3.35 million each to develop. The electricity and fuel needed to produce hydrogen can be generated with renewable resources such as PV, wind turbines, and biogas; however, production of hydrogen with renewable resources may have higher initial costs than hydrogen produced with traditional resources or through steam reformation.³⁷ Trigeneration is a process whereby a stationary fuel cell generates electricity and heat for an onsite facility, while also producing hydrogen for transportation and other applications.³⁸ Trigeneration is in the developmental stage and could potentially cost between \$3 million and \$5 million per unit.

Table 10 – Policy/Incentives for FCEV Deployment

- ZEV Program
- Purchase of State Passenger Vehicles
- “Point-of-Purchase” Rebates
- Tax Incentives
- Infrastructure Partnerships
- HOV Lanes/Parking Incentives

Conclusion

Hydrogen and fuel cell technology provides significant opportunities for fleet deployment of ZEVs, more efficient use of cleaner energy, job creation, and economic development. If newer/emerging hydrogen and fuel cell technology were to gain momentum, the number of companies and employment for the industry could grow substantially. Hydrogen and fuel cell technology provides an opportunity for the region to more fully utilize its renewable energy industry using hydrogen and fuel cells for transportation, energy storage, and use at consumer sites. Rapid refueling (3 to 5 minutes) consistent with conventional refueling, 300+ mile range, and power with no voltage drop are some benefits that FCEVs will provide to the consumer market.³⁹

Manufacturing/development costs, hydrogen production/distribution, competing markets, and technology integration are economic and technological barriers that must be addressed in order to effectively deploy hydrogen as a reliable transportation fuel. This plan identifies the potential to deploy 8,749 hydrogen fueled ZEVs to “jump-start” the market in fleet clusters. This jump start will establish the foundation to collectively move the stakeholders towards overcoming the initial barriers, as a requisite for enabling

³⁷ California Air Resources Board; “CEC-600-2015-016,” <http://www.energy.ca.gov/2015publications/CEC-600-2015-016/CEC-600-2015-016.pdf>; 2015 .

³⁸ U.S. DOE; Tri-Generation Success Story; https://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/tri-generation_fountainvalley.pdf; September 2016.

³⁹ U.S. DOE; “Hydrogen Deliver;” <http://energy.gov/eere/fuelcells/hydrogen-delivery>; October 2016.



long-term transition to clean and sustainable transportation. This is a conservative assessment of the initial market potential for FCEV fleet deployment and has not been tied to a particular time. If the Eight (8) State MOU goals are achieved and 3.3 million ZEVs and/or hybrids are deployed by 2025, the use of hydrogen and fuel cell technologies for the transportation sector could make the Northeast a consumer leader for renewable energy, GHG emission reductions, and job creation.

Transformation requires vision, commitment and action to overcome challenges associated with the deployment of FCEVs and the construction of supporting hydrogen infrastructure. Policies to facilitate deployment of fuel cell technology may include the purchase of state owned passenger vehicles, “point-of-purchase” rebates, hydrogen fuel rebates, incentives to support the development of refueling infrastructure, tax incentives, infrastructure partnerships, and high occupancy vehicle (HOV) lanes/parking incentives (See Table 10). Hydrogen refueling infrastructure to support FCEVs will require planning and investment by public and private entities. This support will be necessary to achieve the desired societal benefits which can be translated into a positive payback and long-term productivity (Appendix III – State Energy Policy/Incentives for Stationary Fuel Cells and Hydrogen Transportation).

As summarized below, state/federal investments for infrastructure development and vehicle deployment could provide a solid framework to capture a significant share of the market opportunities for 8,021 passenger fleet vehicles, 728 transit/paratransit buses, and 74 to 89 hydrogen refueling stations.

- ***8,021 Fuel Cell Electric Passenger Fleet Vehicles (676 FCEVs for State fleets)***
- ***728 Fuel Cell Transit/Paratransit Buses***
- ***74 to 89 stations for supporting H₂ Infrastructure***

The market opportunity for 74 to 89 hydrogen refueling stations and 8,749 hydrogen fueled ZEVs within fleets is for initial deployment before 2025 to help the market engage and is generally consistent with the market projection from the National Renewable Energy Laboratory (NREL).⁴⁰ The approach to focus on fleet clusters is one strategy to accelerate potential deployment of FCEVs (see Appendix IV for more information). Coordination of other strategies and hydrogen and fuel cell related plans underway in the Northeast region will further lead to market and economic development opportunities. Partnerships between the U.S. DOE, NEESC, NESCAUM, H₂USA, industry OEMs, and the hydrogen industry will also increase opportunities for phased development of hydrogen refueling infrastructure and deployment of FCEVs. Supporting efforts to develop uniform codes and standards will further strengthen deployment opportunities.

To facilitate the execution of this plan, each state in the region will need to provide policy and provisions for funding, financing, and a schedule for market opportunity implementation. Participating states should recognize the need for public support, set goals for long-term productivity, and assist with the development of public/private partnership(s) necessary to share risk and facilitate sustainable market opportunities. Support for this vision from government is appropriate and justified given the public benefit in reducing local air pollution, transition to a low GHG economy, and providing collective economic social benefits.

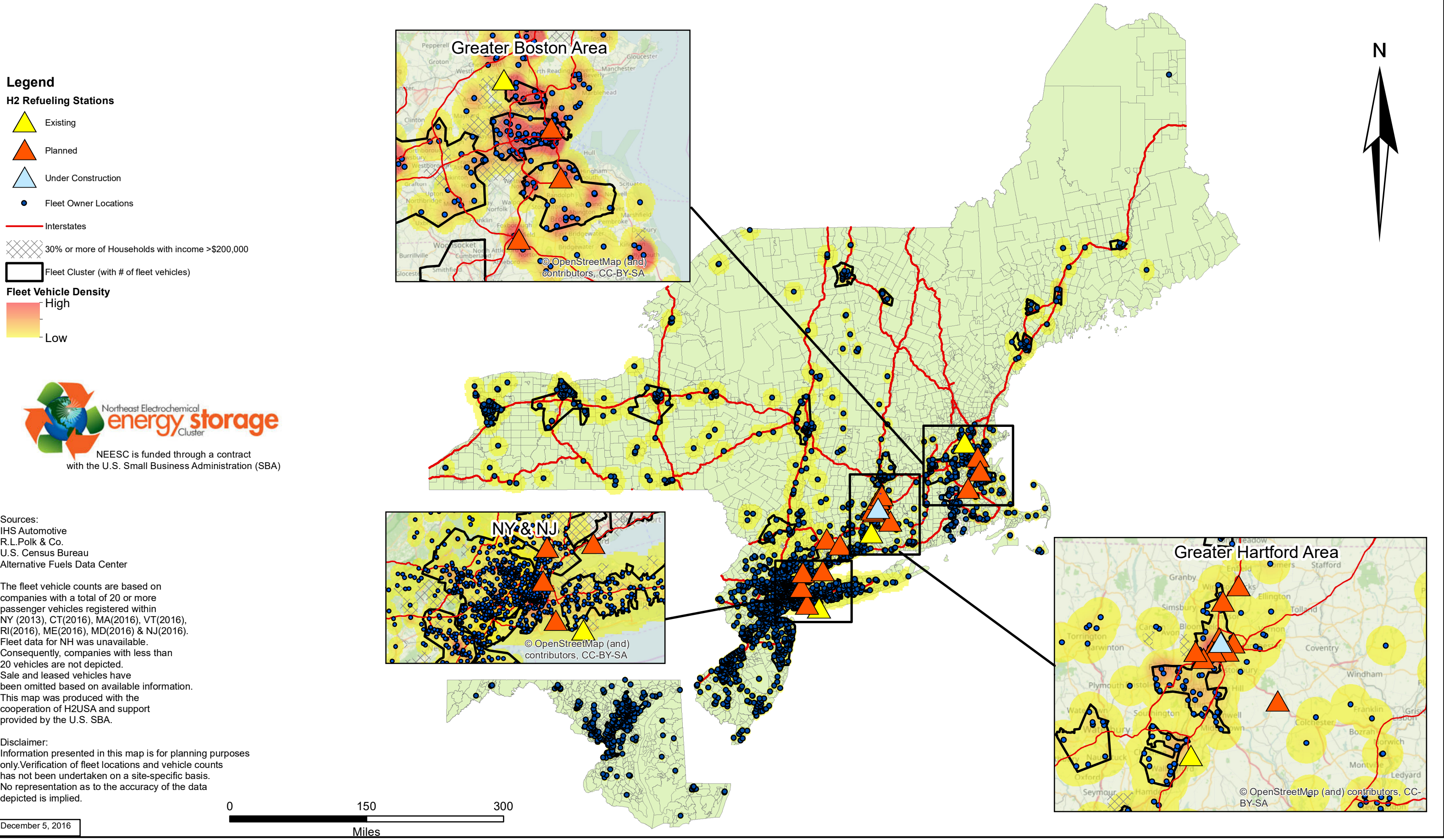
⁴⁰ “Siting Refueling Stations in the Northeast;” draft factsheet, developed by the National Renewable Energy Laboratory; October 2016



APPENDICES

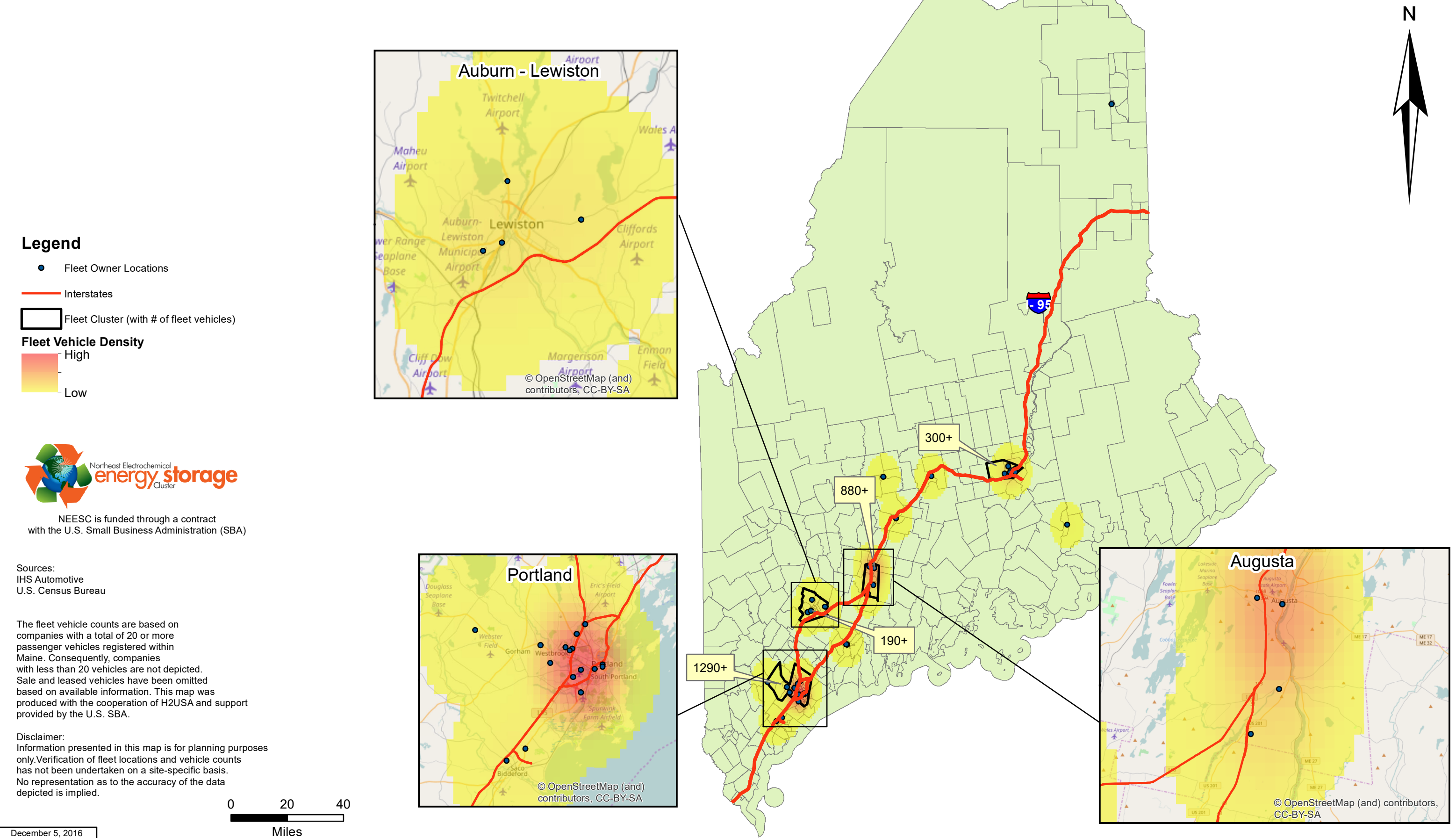


Northeast Region: Market Potential for Hydrogen and Fuel Cell Transportation Applications



APPENDIX I --- Figure 2

Maine: Market Potential for Hydrogen and Fuel Cell Transportation Applications



Connecticut: Market Potential for Hydrogen and Fuel Cell Transportation Applications



Legend

H2 Refueling Stations

- Existing
- Planned
- Under Construction
- Fleet Owner Locations
- Current Hydrogen Users

- Interstates
- 30% or more of Households with income > \$200,000
- Fleet Cluster (with # of fleet vehicles)

- Fleet Vehicle Density**
- High
 - Low

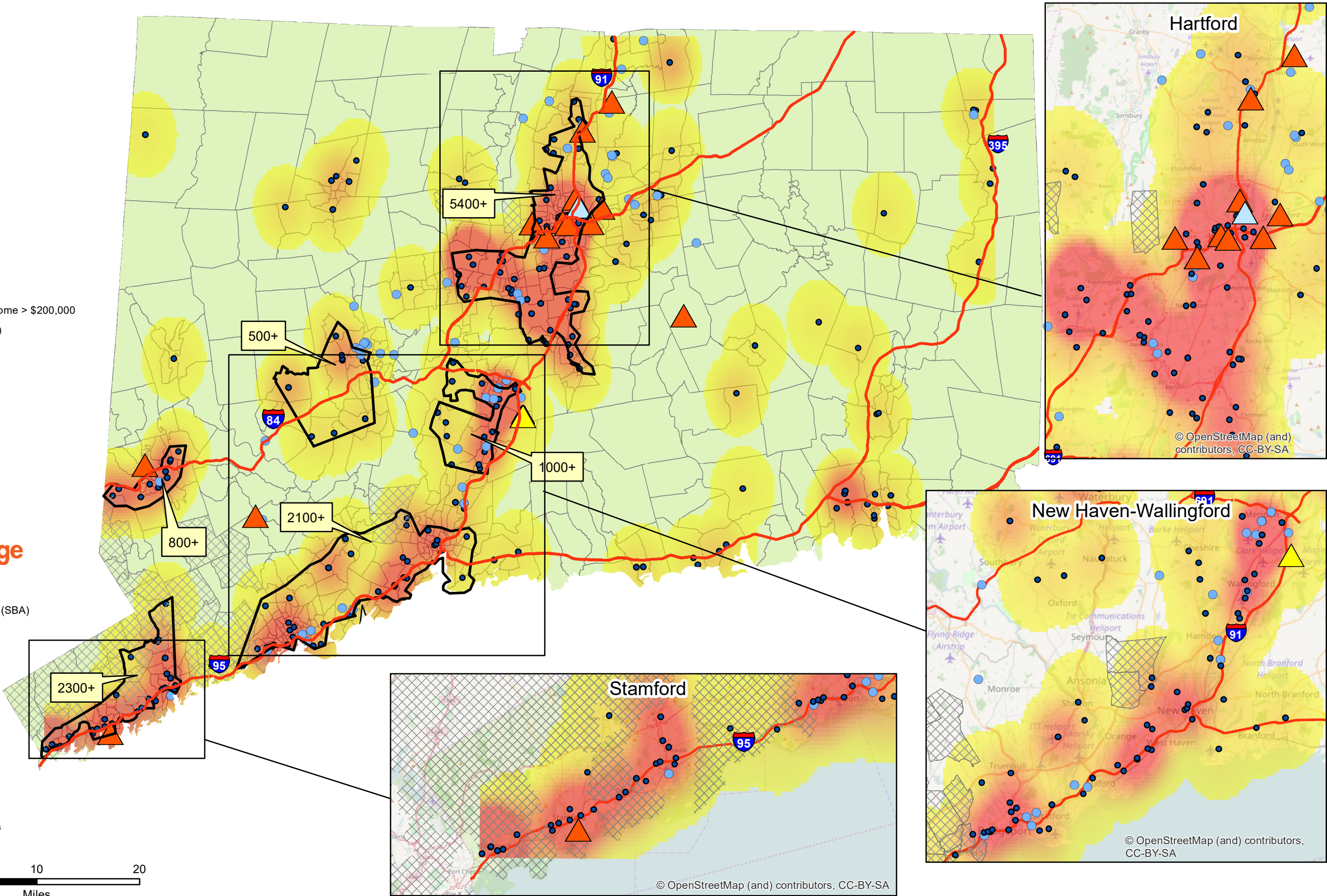
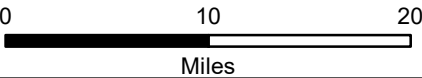


NEESC is funded through a contract with the U.S. Small Business Administration (SBA)

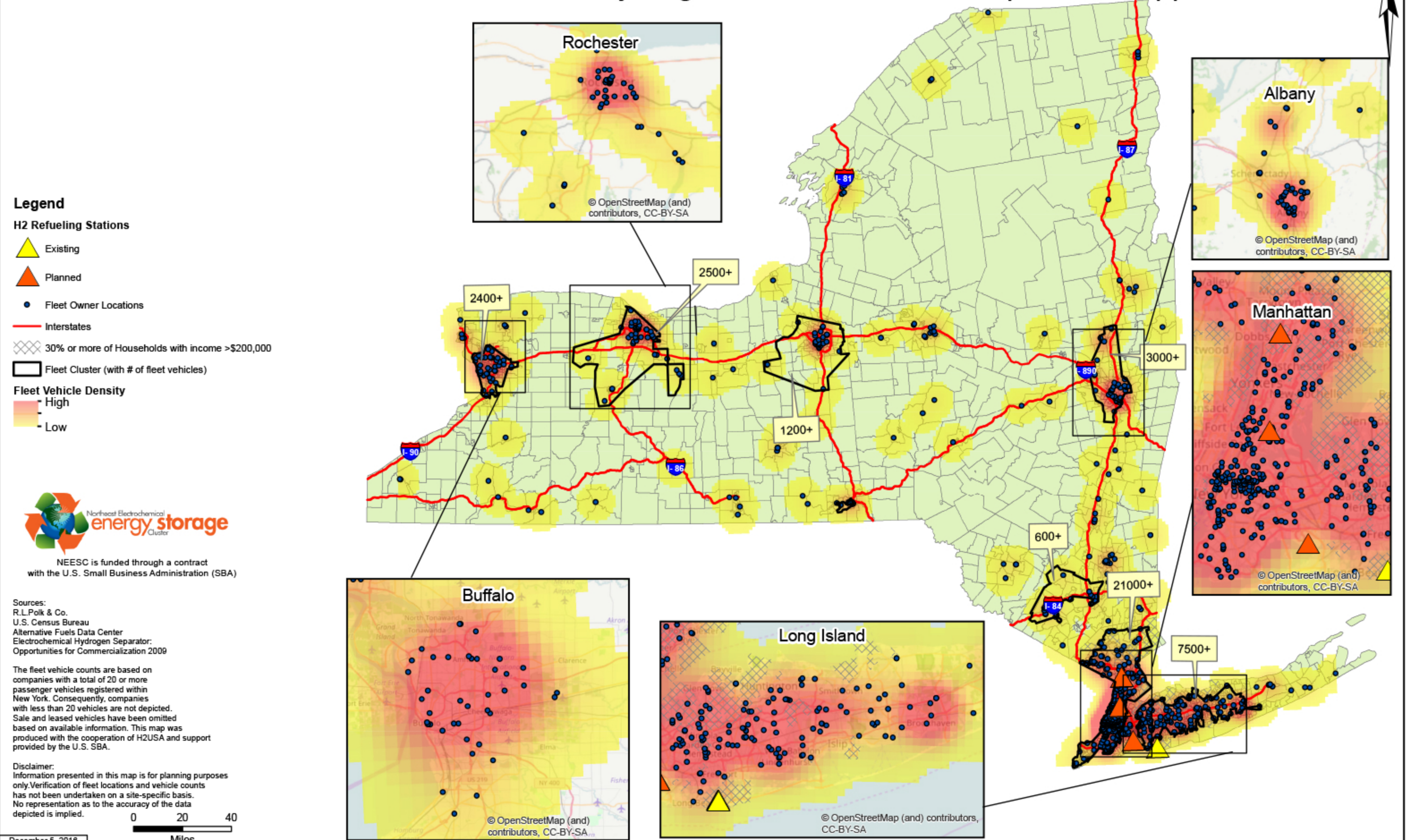
Sources:
IHS Automotive
U.S. Census Bureau
Alternative Fuels Data Center
Electrochemical Hydrogen Separator:
Opportunities for Commercialization 2009

The fleet vehicle counts are based on companies with a total of 20 or more passenger vehicles registered within Connecticut. Consequently, companies with less than 20 vehicles are not depicted. Sale and leased vehicles have been omitted based on available information. This map was produced with the cooperation of H2USA and support provided by the U.S. SBA.

Disclaimer:
Information presented in this map is for planning purposes only. Verification of fleet locations and vehicle counts has not been undertaken on a site-specific basis. No representation as to the accuracy of the data depicted is implied.



New York: Market Potential for Hydrogen and Fuel Cell Transportation Applications



Massachusetts: Market Potential for Hydrogen and Fuel Cell Transportation Applications



- Legend**
- H2 Refueling Stations**
- Existing (Yellow triangle)
 - Planned (Orange triangle)
- Fleet Owner Locations**
- Fleet Owner Locations (Blue dot)
- Interstates**
- Interstates (Red line)
- 30% or more of Households with income > \$200,000**
- 30% or more of Households with income > \$200,000 (Cross-hatched pattern)
- Fleet Cluster (with # of fleet vehicles)**
- Fleet Cluster (with # of fleet vehicles) (Black outline)
- Fleet Vehicle Density**
- High (Red)
 - Low (Yellow)

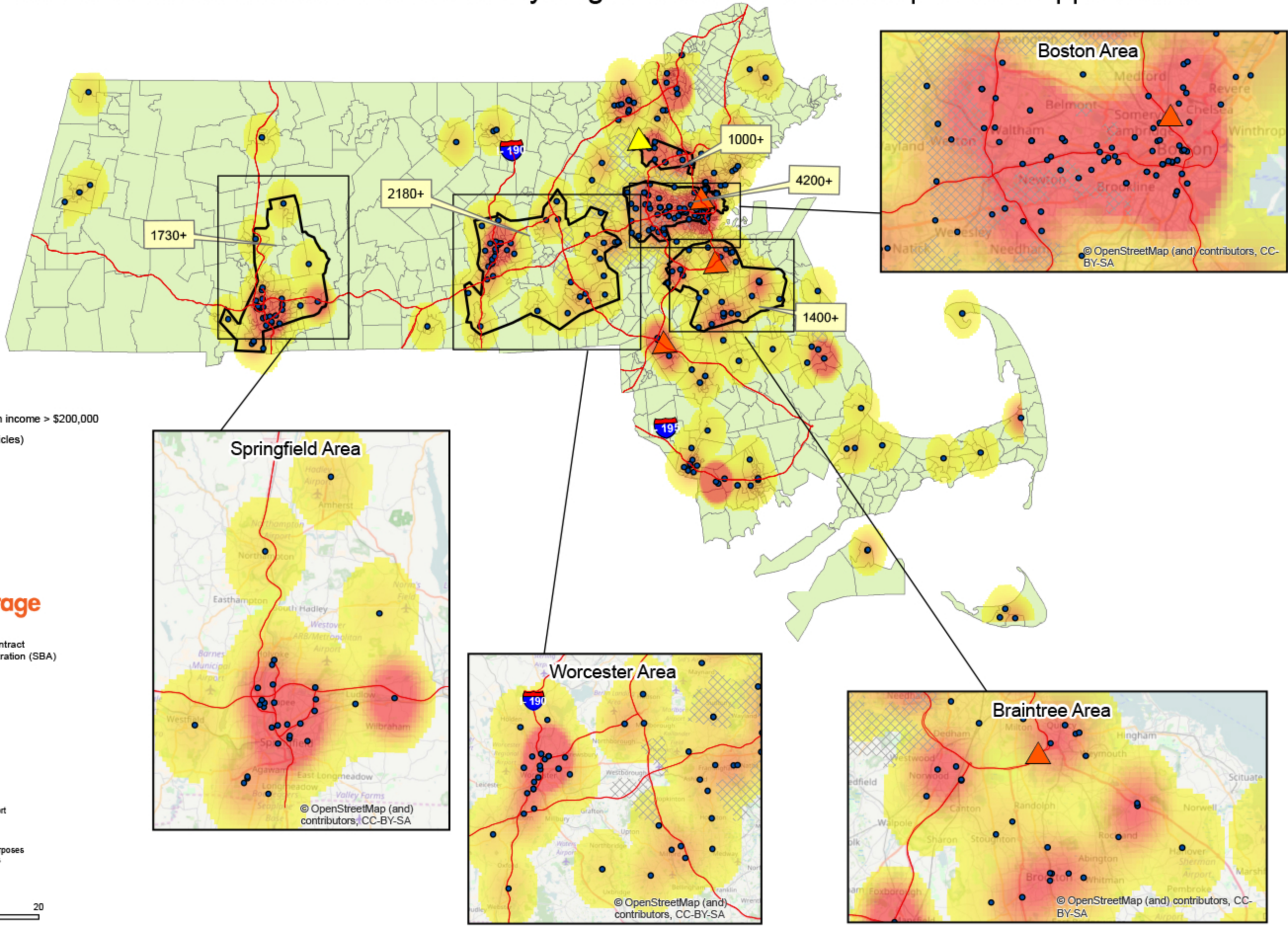
 Northeast Electrochemical energy storage Cluster

NEESC is funded through a contract with the U.S. Small Business Administration (SBA).

Sources:
IHS Automotive
U.S. Census Bureau
Alternative Fuels Data Center

The fleet vehicle counts are based on companies with a total of 20 or more passenger vehicles registered within Massachusetts. Consequently, companies with less than 20 vehicles are not depicted. Sale and leased vehicles have been omitted based on available information. This map was produced with the cooperation of H2USA and support provided by the U.S. SBA.

Disclaimer:
Information presented in this map is for planning purposes only. Verification of fleet locations and vehicle counts has not been undertaken on a site-specific basis. No representation as to the accuracy of the data depicted is implied.



Rhode Island: Market Potential for Hydrogen and Fuel Cell Transportation Applications



Legend

- Fleet Owner Locations
- Interstates
- 30% or more of Households with income >\$200,000
- Fleet Cluster (with # of fleet vehicles)
- Fleet Vehicle Density**
- High
- Low

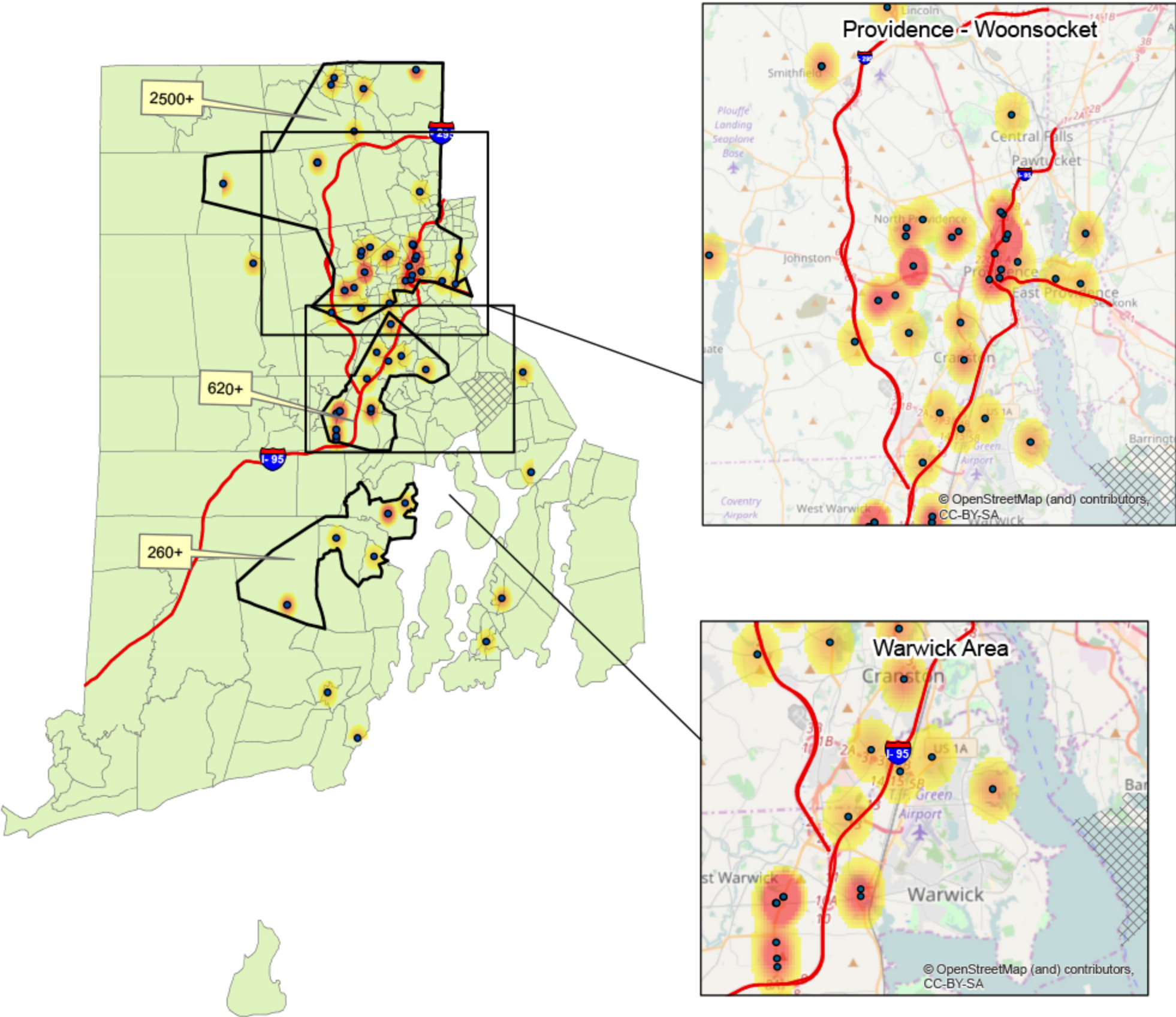


NEESC is funded through a contract with the U.S. Small Business Administration (SBA)

Sources:
IHS Automotive
U.S. Census Bureau

The fleet vehicle counts are based on companies with a total of 20 or more passenger vehicles registered within Rhode Island. Consequently, companies with less than 20 vehicles are not depicted. Sale and leased vehicles have been omitted based on available information. This map was produced with the cooperation of H2USA and support provided by the U.S. SBA.

Disclaimer:
Information presented in this map is for planning purposes only. Verification of fleet locations and vehicle counts has not been undertaken on a site-specific basis. No representation as to the accuracy of the data depicted is implied.



New Jersey: Market Potential for Hydrogen and Fuel Cell Transportation Applications

N

Legend

● Fleet Owner Locations

— Interstates

30% or more of Households with income > \$200,000

□ Fleet Cluster (with # of fleet vehicles)

Fleet Vehicle Density

High

Low



NEESC is funded through a contract with the U.S. Small Business Administration (SBA)

Sources:
IHS Automotive
U.S. Census Bureau

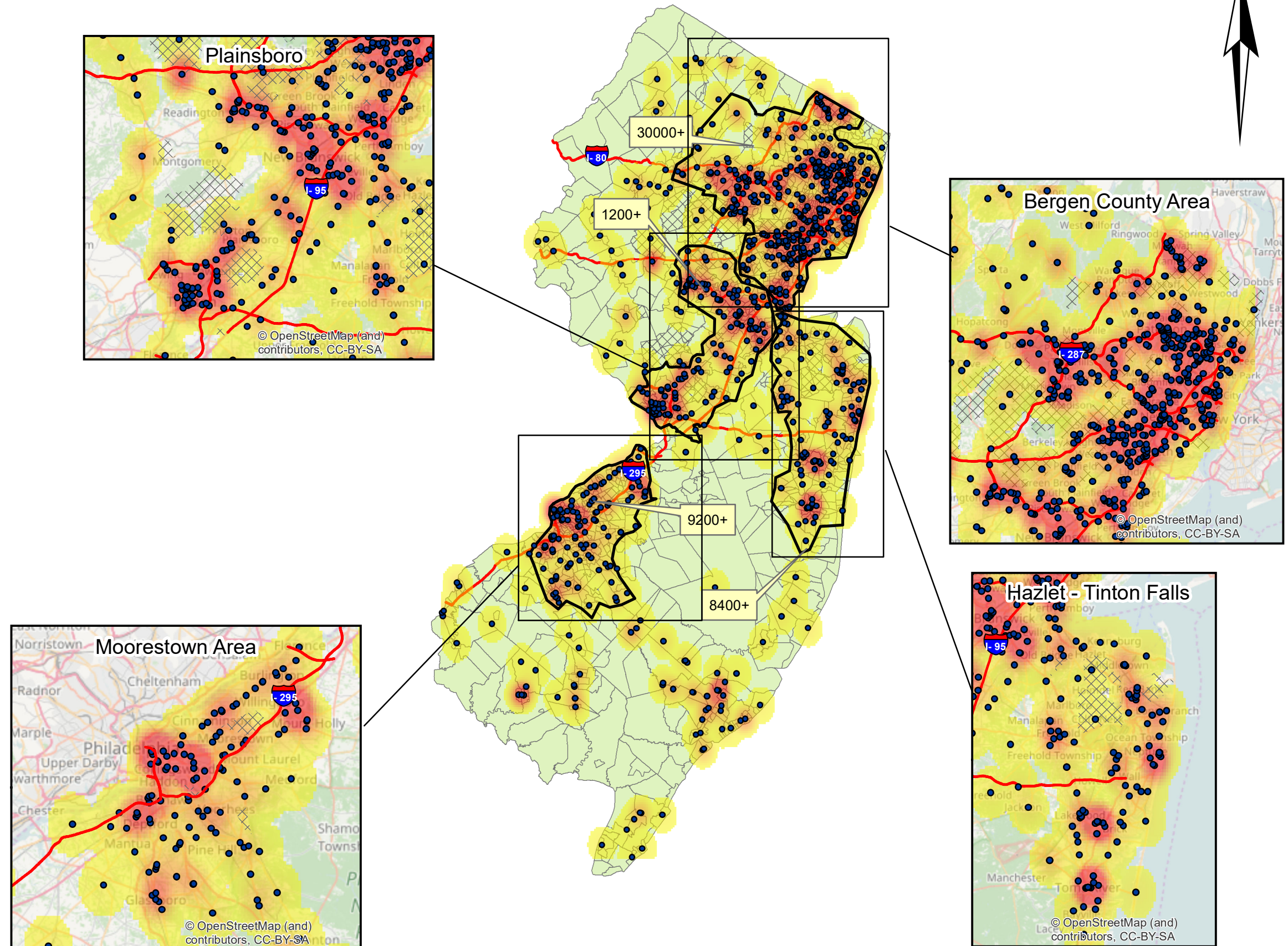
The fleet vehicle counts are based on companies with a total of 20 or more passenger vehicles registered within New Jersey. Consequently, companies with less than 20 vehicles are not depicted. Sale and leased vehicles have been omitted based on available information. This map was produced with the cooperation of H2USA and support provided by the U.S. SBA.

Disclaimer:
Information presented in this map is for planning purposes only. Verification of fleet locations and vehicle counts has not been undertaken on a site-specific basis. No representation as to the accuracy of the data depicted is implied.

0 20 40

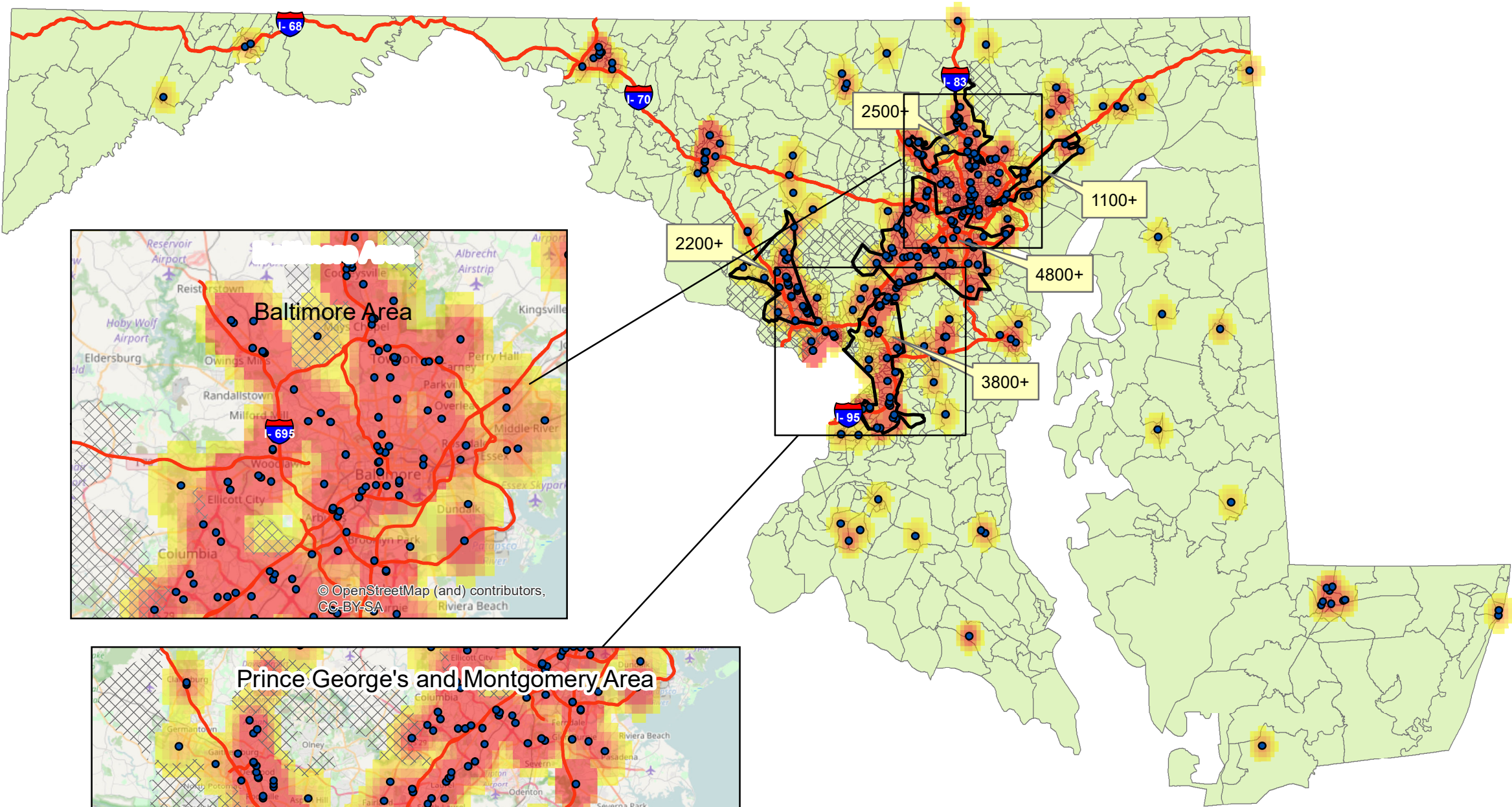
Miles

December 5 2016





Maryland: Market Potential for Hydrogen and Fuel Cell Transportation Applications



Legend

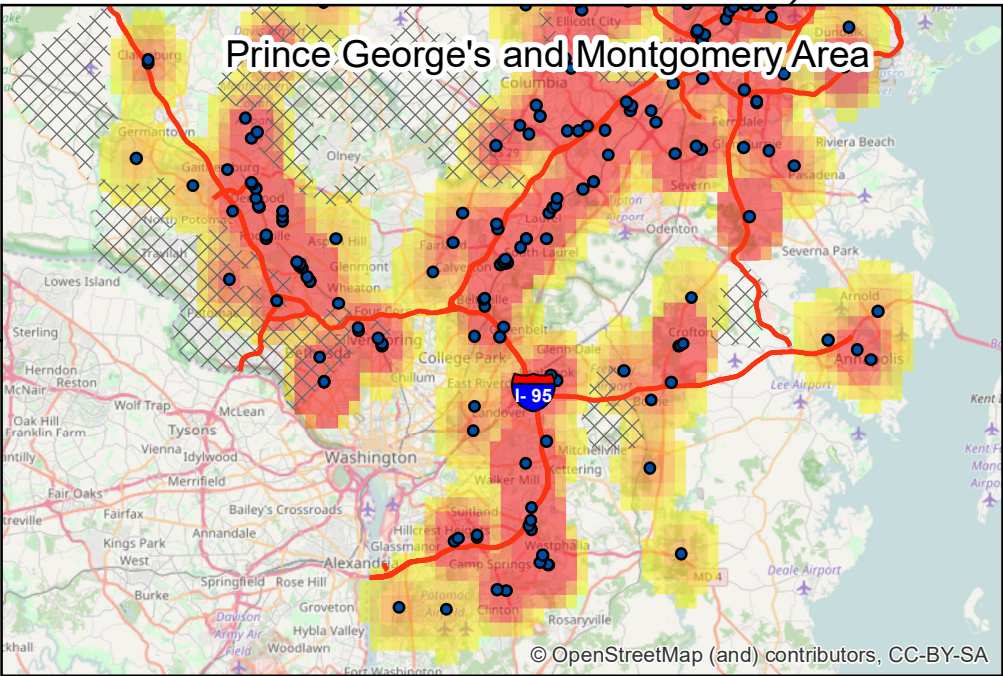
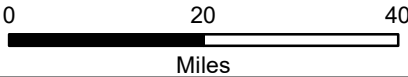
- Fleet Owner Locations
- Interstates
- 30% or more of Households with income >\$200,000
- Fleet Cluster (with # of fleet vehicles)
- Fleet Vehicle Density**
High
Low


NEESC is funded through a contract with the U.S. Small Business Administration (SBA)

Sources:
IHS Automotive
U.S. Census Bureau

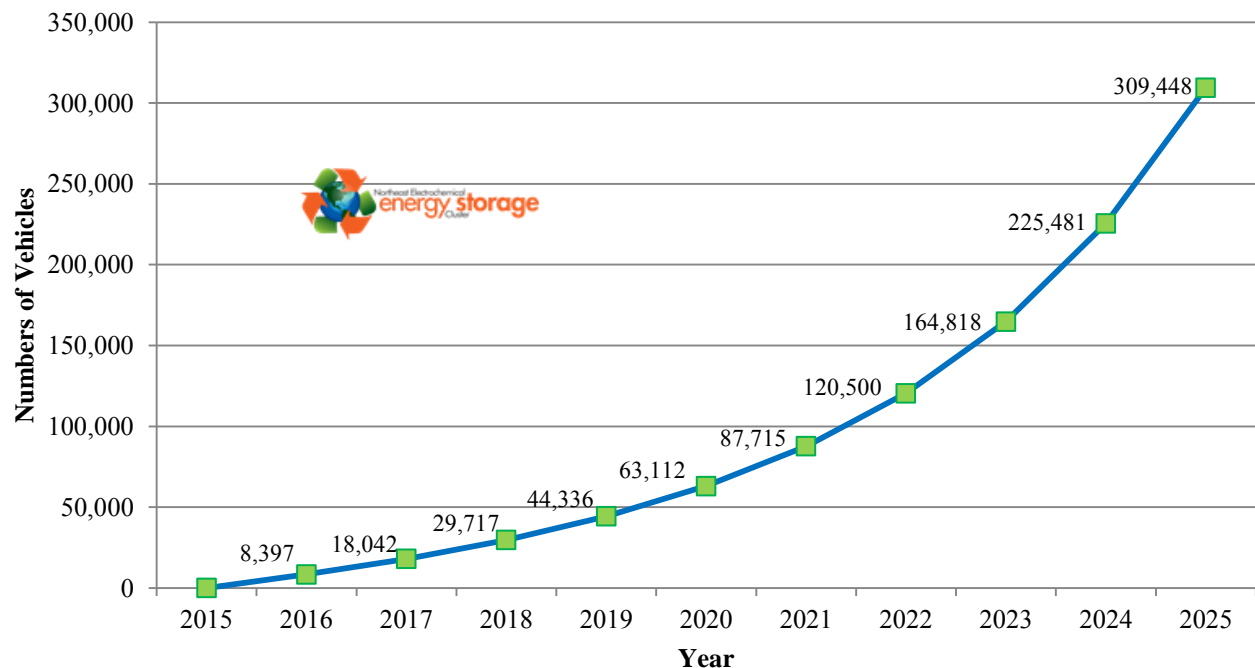
The fleet vehicle counts are based on companies with a total of 20 or more passenger vehicles registered within Maryland. Consequently, companies with less than 20 vehicles are not depicted. Sale and leased vehicles have been omitted based on available information. This map was produced with the cooperation of H2USA and support provided by the U.S. SBA.

Disclaimer:
Information presented in this map is for planning purposes only. Verification of fleet locations and vehicle counts has not been undertaken on a site-specific basis. No representation as to the accuracy of the data depicted is implied.



APPENDIX II – Eight (8) State MOU Projections for FCEVs⁴¹.

	Eight (8) State MOU			Projections for FCEVs per each MOU State ⁴²							
	Total ZEV Sale Requirements	Total FCEV/BEV Sales Requirements	FCEV ⁴³	CA	CT	MA	NY	RI	VT	OR	MD
2015	0	0	0	0	0	0	0	0	0	0	0
2016	89,543	33,587	8,397	3,595	545	1,008	1,860	167	91	467	662
2017	192,402	72,168	18,042	7,725	1,172	2,167	3,998	360	195	1,003	1,423
2018	316,902	118,866	29,717	12,724	1,930	3,569	6,584	592	321	1,652	2,344
2019	472,806	177,344	44,336	18,984	2,879	5,325	9,824	883	479	2,465	3,497
2020	673,031	252,446	63,112	27,023	4,099	7,580	13,984	1,258	682	3,509	4,977
2021	935,407	350,860	87,715	37,558	5,696	10,535	19,435	1,748	948	4,878	6,918
2022	1,285,032	482,001	120,500	51,596	7,826	14,472	26,699	2,401	1,302	6,701	9,503
2023	1,757,645	659,272	164,818	70,572	10,704	19,795	36,519	3,284	1,781	9,165	12,998
2024	2,404,566	901,925	225,481	96,547	14,643	27,081	49,960	4,493	2,436	12,538	17,782
2025	3,300,000⁴⁴	1,237,792 ^{45, 46}	309,448	132,500	20,096	37,165	68,565	6,166	3,344	17,208	24,404



⁴¹ Data provided is an averaged projection that does not account for different market drivers and/or incentives/barriers that could substantially change the deployment ratios between state and the delivery of different ZEV/hybrid vehicles.

⁴² Derived from applying 4.675 percent to FCEVs to total 2011 registered vehicles. The 4.675 percent was calculated by comparing 8-State MOU data to 2011 registered vehicles by state. This data assumes a conservative 25 percent of all FCEVs and BEVs/FCEVs.

⁴³ This data assumes a conservative 25 percent of all FCEVs and BEVs will be FCEVs.

⁴⁴ California Environmental Protection Agency Air Resources Board; “8 state alliance releases plan to put 3.3 million zero emission vehicles on the road.” <http://www.arb.ca.gov/newsrel/newsrelease.php?id=620>; October 24, 2013.

⁴⁵ Derived from a DOE projection of California ZEV (FCEV and BEV), California transitional ZEV (plug-in hybrids), and California total ZEV sales (FCEV, BEV, and PHEV). These projections were applied to the other seven (7) states’ 2011 registered vehicle data to estimate potential ZEV vehicle requirements.

⁴⁶ U.S. DOE; “Fact #771 March 18, 2013 California Zero-Emission Vehicle Mandate is Now in Effect;”

<http://energy.gov/eere/vehicles/fact-771-march-18-2013-california-zero-emission-vehicle-mandate-now-effect>; October 2016.



APPENDIX III – State Energy Policy/Incentives for Stationary Fuel Cell and Hydrogen Transportation

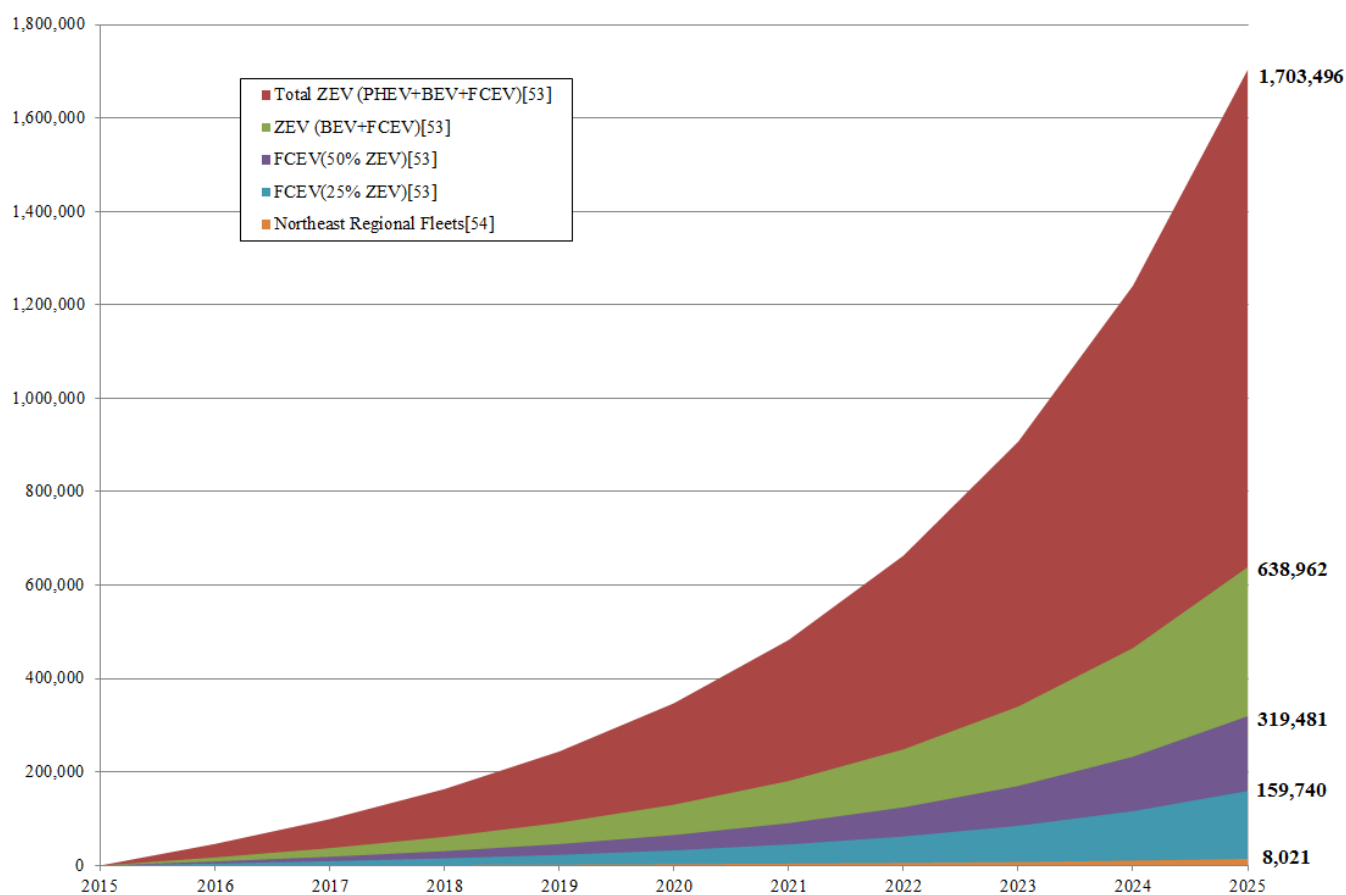
	ME	NH	VT	MA	RI	CT	NY	NJ	MD
State Energy Policy/Incentives for Stationary Fuel Cells									
Mandatory Renewable Portfolio Standard (RPS)	Eligible	Eligible if Renewable	Eligible if Renewable	Eligible if Renewable	Eligible if Renewable	Eligible	Eligible	Eligible	Eligible
Net Metering	Eligible	Eligible if Renewable	Eligible if Renewable	Eligible	Eligible if Renewable	Eligible	Eligible	Eligible	Eligible
Public Benefits Fund	Eligible		Eligible	Eligible	Eligible if Renewable	Eligible	Eligible	Eligible	
Performance-Based Power Purchase	Eligible					Eligible	Eligible		
Utility Ownership/Incentives (Rebate Programs)					Eligible if Renewable	Eligible	Eligible	Eligible	Combined Heat & Power
State Grant Program		Eligible if Renewable			Eligible				Combined Heat & Power
State Loan Programs			Eligible if Renewable		Combined Heat & Power	Eligible			
Microgrid Reliability Program				Eligible		Eligible	Eligible	Eligible	
Property Tax Incentive (Commercial)			Eligible if Renewable			Eligible		Eligible	
Sales Tax Incentive			Eligible if Renewable						
Property-Assessed Clean Energy (PACE) Financing					Eligible if Renewable	Eligible	Eligible		
One Stop Regulatory Approval						Eligible			
Identified State "Point" Person									
State Energy Policy/Incentives for Hydrogen Transportation									
	ME	NH	VT	MA	RI	CT	NY	NJ	MD
Zero Emission Vehicle (ZEV) Program (FCEV/H ₂ Infrastructure)			Eligible	Eligible	Eligible	Eligible	Eligible		Eligible
ZEV Purchase Target for State Government Fleets (TBD)			Eligible	Eligible		Eligible	Eligible		Eligible
Purchase Incentives/"Point-of-Purchase" Rebates				Eligible	Eligible	Eligible	Eligible		Eligible
Fuel Incentives									
Public/Private Infrastructure Partnership						Eligible	Eligible		
Fuel Efficiency Standard (Private/State Fleets)			Eligible	Eligible	Eligible	Eligible	Eligible	Eligible	Eligible
Refueling Infrastructure Incentives				Eligible		Eligible	Eligible		
REC Available for Renewable H ₂									
Tax Incentives			Eligible		Eligible		Eligible	Eligible	Eligible
HOV Lanes and Parking Incentives							Eligible	Eligible	
One Stop Regulatory Approval									
Identified State "Point" Person				Eligible	Eligible	Eligible			
NEESC Development Plan Market Potential									
	ME	NH	VT	MA	RI	CT	NY	NJ	MD
Stationary Fuel Cell (MW, low/high range)	54/73	45/61	15/20	234/312	37/49	131/175	543/724	254/339	
Transportation FCEV (near-term number of vehicles)	80	21	80	1,818	142	445	2,808	5,455	2,705
Transportation Fuel Cell Electric Bus (near-term number of vehicles)	3	4	2	49	11	32	364	173	53
Refueling Stations (low/high range)	1/2	1/2	1/2	18/19	2/3	4/5	27/32	55/60	26/27
<div>Eligible</div> <div>Eligible if Renewable</div> <div>Combined Heat & Power</div>									



APPENDIX IV – Northeast ZEV Deployment Range (VT, RI, CT, NY, MA, MD)⁴⁷

Year	Total ZEV (PHEV+BEV+FCEV) ⁴⁸	ZEV (BEV+FCEV) ⁴⁹	FCEV (50% ZEV) ⁴⁹	FCEV (25% ZEV) ⁴⁹	Northeast Regional Fleets ⁴⁹
2017	99,320	37,254	18,627	9,313	468
2018	163,588	61,360	30,680	15,340	770
2019	244,068	91,547	45,773	22,887	1,149
2020	347,426	130,315	65,158	32,579	1,636
2021	482,867	181,118	90,559	45,279	2,274
2022	663,347	248,814	124,407	62,203	3,123
2023	907,315	340,323	170,162	85,081	4,272
2024	1,241,263	465,584	232,792	116,396	5,845
2025	1,703,496	638,962	319,481	159,740	8,021

Northeast ZEV Deployment Range (VT, RI, CT, NY, NJ, MA, MD)



⁴⁷ Excludes California, Oregon, New Hampshire, and Maine.

⁴⁸ Based on California, NESCAUM, and Department of Energy projections.

⁴⁹ Bases on 4.675% of fleet vehicles.

