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| Study of the Transportation of Alternative Fuels in and around Massachusetts |
|  |
| January 2015 |
| Submitted to: |
| Massachusetts Department of Energy Resources  100 Cambridge Street, Suite 1020 Boston, MA 02114 Attn: Stephen Russell |
| Prepared by |
| ICF International  100 Cambridgepark Drive, Suite 500 Cambridge, MA 02140 |



Table of Contents

[1. Introduction 1](#_Toc409536987)

[2. Supply of Alternative Fuels to the Region 2](#_Toc409536988)

[2.1. Ethanol 2](#_Toc409536989)

[2.2. Biodiesel 2](#_Toc409536990)

[2.3. Propane 4](#_Toc409536991)

[2.4. Natural Gas 5](#_Toc409536992)

[2.5. Hydrogen 7](#_Toc409536993)

[2.6. Electricity 8](#_Toc409536994)

[3. Review of Barriers to the Supply of Alternative Fuels in the Region 10](#_Toc409536995)

[3.1. Ethanol 10](#_Toc409536996)

[3.2. Biodiesel 11](#_Toc409536997)

[3.3. Propane 12](#_Toc409536998)

[3.4. Natural Gas 13](#_Toc409536999)

[3.5. Hydrogen 14](#_Toc409537000)

[3.6. Electricity 15](#_Toc409537001)

[4. Review Options for Supply of Alternative Fuel in an Emergency 17](#_Toc409537002)

[5. Recommendations to Overcome Barriers to the Supply of Alternative Fuels in the Region 20](#_Toc409537003)

[5.1. Overarching Recommendations 20](#_Toc409537004)

[5.2. Ethanol 21](#_Toc409537005)

[5.3. Biodiesel 21](#_Toc409537006)

[5.4. Propane 22](#_Toc409537007)

[5.5. Natural Gas 22](#_Toc409537008)

[5.6. Hydrogen 23](#_Toc409537009)

[5.7. Electricity 23](#_Toc409537010)

[List of Abbreviations and Acronyms 25](#_Toc409537011)

List of Exhibits

[Exhibit 1. Biodiesel Production in the Study Region (2013) 4](#_Toc409537012)

[Exhibit 2. New England Natural Gas Pipelines 7](#_Toc409537013)

[Exhibit 3. Alternative Fuel Assessment for Use in an Emergency 18](#_Toc409537014)



# Introduction

This report is the result of a larger grant from the U.S. Department of Energy (DOE) Clean Cities program entitled *Removing Barriers, Implementing Policies and Advancing Alternative Fuels Markets in New England.* The Massachusetts Department of Energy Resources (MassDOER), specifically the Massachusetts Clean Cities Coalition, partnered with five Clean Cities coalitions in the New England area, including Maine Clean Communities, State of Vermont Clean Cities, Granite State Clean Cities, and Ocean State Clean Cities. MassDOER was responsible for coordinating multiple efforts under this grant. ICF International (ICF) supported MassDOER’s efforts by investigating the barriers related to alternative fuel supply, consumption, and use in the region. For the purposes of this scope, the study region includes Massachusetts, New Hampshire, Maine, Rhode Island, and Vermont. The alternative transportation fuels of focus are ethanol, biodiesel, natural gas (compressed and liquefied), propane, hydrogen, and electricity.

The following sections in the report reflect ICF’s research and analysis in several areas:

* **Section 2: Supply of Alternative Fuels to the Region**. This section provides estimates of alternative fuel consumption in the study region, distinguished by a) state and b) fuel type. ICF’s estimates were developed using available information on fuel supply, alternative fuel vehicles, stations, and fuel imports. Furthermore, for each fuel type, ICF provided a brief overview of the supply chain in the study region.
* **Section 3: Review of Barriers to the Supply of Alternative Fuels to the Region**: For each fuel, ICF reviewed regulatory, technical, and economic barriers. In some cases, ICF highlighted attitudinal barriers (i.e., barriers that arise from the perception of stakeholders e.g., fleets and other end users). Where appropriate, ICF identified recent constraints that limited the supply (or consumption) of a particular transportation fuel.
* **Section 4: Review of Options for Supply of Alternative Fuels in an Emergency.** Givenregional concerns related to emergency preparedness during disasters (e.g., Hurricane Sandy, Northeast blackout of 2003, polar vortex of 2014), ICF reviewed the pros and cons of each alternative transportation fuel based on a supply chain assessment. ICF then identified the tradeoffs of relying on each type of alternative fuel in the event of emergency.
* **Section 5: Recommendations to Overcome Barriers to the Supply of Alternative Fuels in the Region**. ICF developed recommendations to help overcome barriers to the supply of alternative fuels in the region based on research and stakeholder outreach. ICF identified what are characterized as overarching recommendations which represent high level solutions to major barriers identified in Section 3. These recommendations represent ICF’s best effort to distill recommendations by fuels and by state. This section also includes more specific recommendations to overcome existing barriers by fuel type.

# Supply of Alternative Fuels to the Region

This section provides an overview of how alternative fuels are supplied to the region, and includes estimates of alternative fuel consumption in the study region, on a state-level basis to the extent possible. ICF’s estimates were developed using available information on fuel supply, alternative fuel vehicles, stations, and fuel imports.

## Ethanol

Ethanol is typically consumed as a low level blend in gasoline (10 percent by volume, E10) or as a high level blend with gasoline (85 percent by volume, E85) for use in flex-fuel vehicles (FFVs).

### Fuel Consumption, Vehicles, Stations and Imports

The table below includes ICF’s estimates of E85 fuel consumption in 2013. The values are presented as a range, reflecting ICF’s best estimates based on research and analysis of publicly available data and interviews with stakeholders. The table also includes ethanol imports to ports in the study region for 2011−2014 (through September); it is more likely that this ethanol is consumed as E10 rather than E85 given that more than 98% of the study region’s motor gasoline is dispensed as E10.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| State | E85 Consumption Estimates (2013) | E85 Stations | Ethanol Imports (million gallons) | | | |
| 2011 | 2012 | 2013 | 2014 |
| Maine | * 81,600−240,000 gallons of E85 | 1 | - | - | - | - |
| Massachusetts | * 730,000−1,800,000 gallons of E85 | 9 | 15.7 | 25.1 | 3.6 | - |
| New Hampshire | * 81,600−240,000 gallons of E85 | 1 | - | - | - | - |
| Rhode Island | none | 0 | 10.4 | 65.6 | 35.1 | - |
| Vermont | * 81,600−240,000 gallons of E85 | 1 | - | - | - | - |
| Notes: ICF assumed an average throughput of 6,800-20,000 gallons per month of E85. This is based on ICF research and data provided through Clean Cities Annual reports. For instance, Dennis K Burke retail station and Gulf Oil/Cumberland Farms stations report 82,000 gallons and 89,154 gallons of E85 dispensed in 2013, respectively. In most cases, ICF believes that E85 consumption in the last several years has been on the lower end of these estimates. | | | | | | |

### Fuel Supply

Ethanol is not produced in the study region. As a result, ethanol arrives via a combination of railcar, barge, and truck from both domestic and international producers. Ethanol typically is shipped to a storage and blending terminal via railcar from the Midwest or barge from the Gulf. After blending with gasoline, the finished fuel is typically distributed to local retail outlets on trucks.

## Biodiesel

### Fuel Consumption, Vehicles, and Imports

The table below includes ICF’s estimates of B20 fuel consumption in 2013. The values are presented as a range, reflecting ICF’s best estimates based on research and analysis of publicly available data and interviews with stakeholders. The table also includes biodiesel imports to ports in the study region for 2011−2014 (through September). Finally, the table also includes notes, where appropriate, on publicly available data on biodiesel consumption e.g., fleets that use biodiesel.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| State | Biodiesel Consumption Estimates (2013) | B20 Stations | Imports (million gallons) | | | |
| 2011 | 2012 | 2013 | 2014 |
| Maine | * 75,000−600,000 gallons of B20 | 3 | - | - | - | 12.6 |
| Massachusetts | * 1.71−2.60 million gallons of B20 | 13 | 2.8 | - | - | 17.7 |
| New Hampshire | * 100,000−800,000 gallons of B20 * Public transit fleet in Nashua uses B20 | 4 | - | 2.4 | - | 10.3 |
| Rhode Island | * 125,000−1,200,000 gallons of B20 * Over 500 vehicles used a total of ~875,000 gallons of fuel, with blends ranging from B5-B99 | 6 | - | - | - | - |
| Vermont | * 25,000-2000,000 gallons of B20 | 1 | - | - | 0.2 | - |
| Notes: ICF estimated B20 consumption assuming a station throughput of 25,000 gallons to 200,000 gallons annually. These values are based on ICF research and data provided in the state-level Clean Cities Annual reports. Biodiesel is consumed as B5, B10, B20, and B100 throughout the study region. ICF normalized the consumption estimates to B20 for the sake of simplicity. ICF believes that biodiesel consumption in the last several years has been on the lower end of these estimates. | | | | | | |

There was a drastic increase in biodiesel imports through September of 2014: Nearly 40 million gallons of biodiesel have landed at ports in the study region, with Irving Oil accounting for about 90% of these imports. While this activity demonstrates the ability of the supply chain to deliver significant volumes of biodiesel to the study region, it is unclear how much of this biodiesel is used as a transportation fuel. Irving Oil is a large distributor of biofuel and petroleum products in the study region, for both transportation fuels and for home heating.

### Fuel Supply

Biodiesel is supplied locally from one major biodiesel producers in the New England area, White Mountain Biodiesel, along with a number of smaller biodiesel facilities as shown in the exhibit below. Biodiesel is also railed and trucked into New England from the Midwest and Ontario or brought in by barge. The normal modes of biodiesel transport are by rail from major production regions (for example the Midwest) into distribution terminals, and from there by barge or truck into smaller terminals. Customers typically receive biodiesel blends by truck delivery from terminals. Based on information gathered from stakeholders, imported biodiesel is likely blended into heating oil or in blend levels under 5% for on-road diesel. Regional producers also sell product to end-users and distributors for use in heating oil and on-road and off-road diesel applications.

Exhibit 1. Biodiesel Production in the Study Region (2013)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| State | City | Company | Production Capacity (MMgal/yr) b | Type of Feedstock a |
| ME | Portland | Maine Standard Biofuel | 0.50 | Multi feedstock |
| MA | Bridgewater | MPB Bioenergy LLC | 0.50 | Yellow Grease |
| Sandwich | Cape Cod BioFuels | 0.50 | Yellow Grease |
| Billerica | Baker Commodities Billerica |  | -- |
| NH | North Haverhill | White Mountain Biodiesel, LLC | 5.50 | Yellow Grease |
| Nashua | Batchelder Biodiesel Refineries | 0.25 | Yellow/Brown grease |
| Grafton | Outpost Biodiesel, LLC |  | Yellow Grease |
| RI | Westerly | Mason Biodiesel LLC | 1.20 | Multi feedstock |
| Newport | Newport Biodiesel, LLC | 0.50 | Yellow Grease |
| Total | | | 8.95 | |
| a Multi feedstock refers to any combination of yellow/brown grease, animal fats, and virgin vegetable oils, such as soy.  b These production capacities were updated based on phone interviews conducted in 2013. | | | | |
| Sources: National Biodiesel Board, 2013; Biodiesel Magazine, 2013; company websites, 2013. | | | | |

## Propane

Propane or liquefied petroleum gas (LPG) is used as a transportation fuel, typically after conversion kits have been installed in medium-duty (e.g., shuttles) and heavy-duty applications (e.g., buses). Propane is typically delivered to refueling stations via truck. Propane can be sourced from refineries or natural gas wells (including from wells using unconventional methods of extraction (e.g., hydraulic fracturing).

### Fuel Consumption, Vehicles, and Fueling Stations

The table below includes ICF’s estimates of LPG fuel consumption in 2013. The values are presented as a range, reflecting ICF’s best estimates based on research and analysis of publicly available data and interviews with stakeholders. The table also includes some notes, where appropriate, on publicly available data on LPG consumption e.g., fleet information.

|  |  |  |
| --- | --- | --- |
| State | Propane Fuel Consumption and Vehicle Information | Propane Stations |
| Maine | * 98,000−280,000 gasoline gallon equivalents (gge) of LPG * 35 Island Explorer shuttle buses in Bar Harbor * 10 Maine School Administrative District No. 6 school buses in Portland | 14 |
| Massachusetts | * 140,000−400,000 gge of LPG * Identified 10 vehicles using LPG 100% of the time | 20 |
| New Hampshire | * 98,000−280,000 gasoline gallon equivalents (gge) of LPG | 14 |
| Rhode Island | * 35,000−100,000 gge of LPG * Buckley Heating and Cooling’s two vehicle fleet used 5,200 gallons of fuel | 5 |
| Vermont | * 14,000−40,000 gge of LPG | 2 |
| Notes: ICF estimated propane consumption assuming a station throughput of 7,000 gallons to 20,000 gallons monthly. These values are based on ICF research and data provided in the state-level Clean Cities Annual reports. In most cases, ICF believes LPG annual consumption in the study region is on the low- to mid-points of the ranges shown above. | | |

### Fuel Supply

No propane fuel supply constraints were identified in New England. Approximately 75% of propane is transported by rail, 10% by ship, and 15% by truck (from New York).[[1]](#footnote-1) This average may change slightly from state-to-state. For example, Maine may have 90% of deliveries by rail. Two states, New Hampshire and Rhode Island, also receive propane deliveries by ship and the fuel is delivered from the port by truck to individual distributors.

There is no propane pipeline in New England. The closest location is in upstate New York where the TEPPCO Pipeline ends. The TEPPCO Pipeline passes through the Marcellus and Utica production regions, and is interconnected with many of the gas processing facilities in this region. As a result, there has been a significant increase in propane available on the Northeastern end of the pipeline. The increase in regional propane production has allowed the TEPPCO system to replace much of the propane that used to come from Mont Belvieu, Texas with local supply.

## Natural Gas

Natural gas is used as a transportation fuel when it is compressed (CNG) or liquefied (LNG). Compression typically occurs on-site at a retail station after being transported via pipeline. There is a growing demand for CNG in the region with about 40 public and private stations at the date of this report. Liquefaction requires a more significant investment, and while it can be liquefied on-site at a station, it is more likely to be liquefied at a large, centralized facility (with access to a pipeline) and delivered via truck. There is currently one LNG station planned for Massachusetts, and Clear Energy had pitched the concept of converting part of a former paper plant in Groveton, NH to a LNG production facility.[[2]](#footnote-2)

### Fuel Consumption, Vehicles, and Fueling Stations

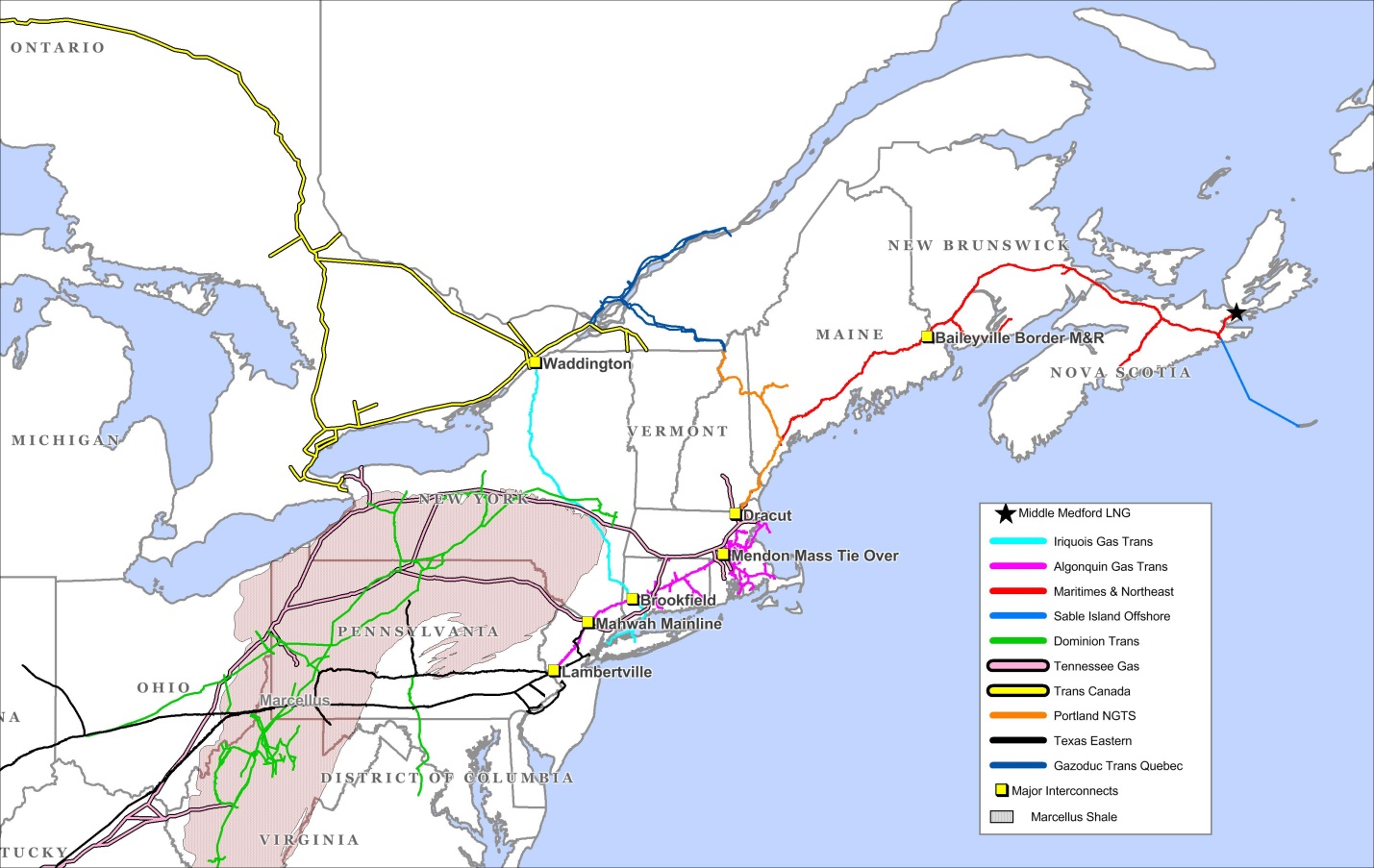
The table below includes ICF’s estimates of CNG consumption in 2013. The values are presented as a range, reflecting ICF’s best estimates based on research and analysis of publicly available data and interviews with stakeholders. The table also includes some notes, where appropriate, on publicly available data on LPG consumption e.g., fleet information.

|  |  |  |  |
| --- | --- | --- | --- |
| State | Natural Gas Consumption and Vehicle Information | NG Stations | |
| CNG | LNG |
| Maine | * 360,000−480,000 gge of CNG | 2 | 0 |
| Massachusetts | * 6.9 million−11.0 million gge of CNG * 831 heavy-duty CNG vehicles used 6.9 million gallons of fuel | 24 | 1 (planned) |
| New Hampshire | * 540,000−720,000 gge of CNG * 40 street sweepers, pick-up, and refuse trucks in Nashua, NH | 3 | 0 |
| Rhode Island | * 1,080,000−1,440,000 gge of CNG | 6 | 0 |
| Vermont | * 540,000−720,000 gge of CNG * 9 Casella refuse trucks with time-fill stations in Williston | 3 | 0 |
| Notes: ICF estimated CNG consumption assuming a station throughput of 15,000−20,000 gallons per month, with some exceptions. For instance, there are data regarding fuel consumption for airport shuttles and other vehicles serving Boston Logan International Airport, indicating that throughput there is upwards of 1 million gge annually. Furthermore, the Massachusetts Bay Transportation Authority (MBTA) reports consuming about 5.6 million gge and operates six CNG stations. These values were included in the estimates for Massachusetts. The throughput assumptions for other stations are based on ICF research and data provided in the state-level Clean Cities Annual reports. | | | |

### Fuel Supply

The majority of natural gas in the New England area is brought in through major pipelines as shown in the exhibit below. Over many decades, pipeline operators in New England have steadily developed an expansive network of interstate pipelines that serve large areas of the region. These systems are interconnected with a network of interprovincial pipelines in Eastern Canada. These pipeline systems link New England, Ontario, and Atlantic Canada gas buyers with gas reserves in every major North American basin, including the Gulf of Mexico, Western Canada, the U.S. Rockies, and Appalachia. In areas with limited or no natural gas access, it is common to deliver compressed gas by truck. In fact, several companies have recently initiated operations with so-called virtual pipelines–including Innovative Natural Gas (Charlestown, MA), NG Advantage (Milton, VT), and Xpress Natural Gas (Boston, MA). These companies deliver compressed natural gas, most frequently to industrial customers

Exhibit 2. New England Natural Gas Pipelines



*Source: ICF International*

The growth in Marcellus production has been accompanied by aggressive midstream infrastructure development over the past few years, a trend that is likely to continue into the future with many pipeline projects under development. While there are a large number of small localized projects, such as Vermont Gas’ expansion project to bring service to southern Vermont, there are also a number of larger gas pipeline projects aimed at increasing gas supply into New England, such as the Atlantic Bridge Project, the Algonquin Incremental Market (AIM) expansion, and the Northeast Energy Direct Project.

## Hydrogen

Hydrogen is consumed in small quantities as a transportation fuel in the region today, with two stations in Massachusetts. Despite the limited commercial availability of hydrogen and hydrogen fuel cell vehicles today, three of the five states included in the region are part of an eight-state group that signed a memorandum of understanding, committing the jurisdictions to a goal of putting 3.3 million zero-emission vehicles (ZEVs) on the road. ZEVs include electric vehicles and hydrogen fuel cell vehicles. Hydrogen is typically produced via steam reformation of methane or electrolysis. Further, it can be produced centrally and distributed to refueling stations or produced on-site. Given the limited number of stations and interest in hydrogen to date, no significant information was available regarding the supply of hydrogen to the region.

### Fuel Consumption, Vehicles, and Fueling Stations

Massachusetts and Rhode Island are the only two states in the study region that have plans in place to advance a hydrogen fueling network. Massachusetts has the only operational hydrogen station in the region, operating by Nuvera Fuel Cells with a 50 kilogram per day production capacity. There is another station under construction by Proton with a planned capacity of 40 kg/day. Stakeholders in Massachusetts plan to install 3–5 additional stations by the end of 2015; whereas in Rhode Island, there are plans to install 1–2 stations in early 2016.

### Fuel Supply

Very limited quantities of hydrogen are currently being trucked into the region or are produced on site using natural gas. Hydrogen fueling infrastructure typically costs about $1 million to $2 million per new station, depending on factors such as capacity and hydrogen delivery method.

## Electricity

Plug-in electric vehicles (PEVs) are expanding their market share in the region’s light-duty passenger vehicle population. As a result, the availability of charging infrastructure has increased rapidly. Because other aspects of electricity’s supply chain are well understood in the region–including production/generation, transmission, and distribution–ICF focused on the supply of electric vehicle charging infrastructure (specifically, electric vehicle supply equipment, EVSE), or the point of fueling.

### Fuel Consumption and Vehicle Information

The table below includes the number of plug-in electric vehicles in each state–distinguished as plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs)–and the number of publicly available charging stations with Level 2 charging and DC fast charging (DCFC) capabilities.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| State | Plug-in Electric Vehicles | | | Public Charging Stations | |
| PHEVs | BEVs | Total | L2 | DCFC |
| Maine | 429 | 59 | 488 | 35 | 3 |
| Massachusetts | 2,125 | 704 | 2,829 | 641 | 15 |
| New Hampshire | 531 | 145 | 676 | 55 | 0 |
| Rhode Island | 200 | 30 | 230 | 132 | 6 |
| Vermont | 446 | 116 | 562 | 85 | 11 |
| Notes: Vehicle registration data were provided by NREL via Polk. These data are for registrations through August 2014. The PHEV populations include estimates for Ford C-Max and Ford Fusion PHEVs that were adjusted for national-level sales rates (i.e., percentages) of PHEVs compared to total hybrid electric vehicles (inclusive of vehicles that do not plug-in). | | | | | |

The amount of electricity as a transportation fuel that is consumed depends on factors such as vehicle miles traveled, vehicle efficiency, and access to charging. For a recent study,[[3]](#footnote-3) ICF estimated that PHEVs consume 1,280 kWh–3,900 kWh annually, depending on the electric range of the vehicle (ranging from 10–40 miles); and BEVs consume about 3,800 kWh annually. Based on these values, ICF estimates that PEVs in the study area consumed about 12.5 GWh in 2014.

### Fuel Supply

Electricity is abundantly available in the study region through a large number of public and municipal electric utilities. Most models of PEVs were available for sale in the study region between 2010 and 2013, including the Ford C-Max, Focus EV, Fusion, and Transit Connect EV, Honda Fit EV, Smart ForTwo EV, Mitsubishi iMIEV, Nissan Leaf, Tesla Model S and Roadster, Fisker Karma, Toyota Prius Plug-In, and Chevrolet Volt. Approximately 4,800 PEVs were registered in the region between 2010 and 2013.[[4]](#footnote-4) The most widely available alternative transportation fuel infrastructure is electric vehicle charging equipment or EVSE. Approximately 948 publicly-accessible Level 2 charging stations and 35 DC Fast Charging stations were available in the study region as of January 2015. Many of these are available through charging networks, such as ChargePoint, SemaCharge, and eVgo. Additional private, workplace, and residential charging locations were also widely available in the region.

# Review of Barriers to the Supply of Alternative Fuels in the Region

The following sub-sections review regulatory, technical, and economic barriers by fuel type. Where appropriate, ICF has highlighted attitudinal barriers (i.e., barriers that arise from the perception of stakeholders e.g., fleets and other end users). Furthermore, ICF has identified recent constraints that may have limited the supply (or consumption) of a particular alternative transportation fuel.

## Ethanol

### Regulatory Barriers

Though there are no specific regulatory barriers in the ethanol supply chain, there is a general unease in certain communities about the transportation of ethanol via rail. For example, in 2011, Global Partners, a large fuels logistics company, proposed to repair and enlarge a rail siding that would enable ethanol rail shipments to one of its storage facilities in Revere, MA (in addition to the barge shipments it received through Chelsea Creek, an industrial port near Boston). The proposal faced significant scrutiny from the surrounding community, which eventually led to the passage of a House bill that would place a moratorium on the project until 2020 and require extensive study by state agencies. As a result, Global Partners announced in July 2013 that it would withdraw the proposal.[[5]](#footnote-5) These types of existing or potential regulatory barriers limit or inhibit the ability of fuel suppliers to reliably supply ethanol to the region.

Other potential regulatory barriers are related to the use of higher blend ethanol products. For example, in 2014, New Hampshire legislators introduced House Bill 1220 that would limit the use of ethanol to 10 percent of the fuel mix in the state, preventing the use of higher blends, such as E15.[[6]](#footnote-6) Though the legislation was not enacted,[[7]](#footnote-7) it reflects a broader concern about the expanded use of ethanol in parts of the region.

### Technical Barriers

Though E10 is a common blend in the study area, there are very few stations providing mid- and high-level blends of ethanol fuels, such as E85. This limits access for commonly available FFVs in the region.

### Economic Barriers

Many stakeholders cited price as a common barrier to higher blends of ethanol consumption. Though E85 is fairly competitively priced with gasoline, users are generally aware of the corresponding fuel economy reduction (attributable to the lower energy content of ethanol compared to gasoline).

### Attitudinal Barriers

Perhaps the largest barrier to ethanol is the lack of interest in the fuel for use as a high-level blend. Generally stakeholders supported the idea of purchasing a domestically-produced fuel over a foreign fuel, but because ethanol is not produced in the study region, stakeholders were less inclined to make necessary infrastructure investments. Some of this may also be motivated by politicians, such as Senator Leahy, that previously expressed concern about a dependence on ethanol and a corresponding increase in the price of food and competition with livestock. In other states, such as Maine, ethanol was blamed for road tax reductions and the state legislature subsequently increased the ethanol tax.

## Biodiesel

### Regulatory Barriers

Massachusetts currently has a 2% biodiesel (B2) blending requirement in law, but it was indefinitely suspended in 2010 by the Energy Secretary of the Massachusetts Department of Energy Resources.[[8]](#footnote-8) There were a number of factors leading to this decision, including the lack of reliable supply, cost, and concerns about fuel quality. This regulation could have led to significant biodiesel consumption in Massachusetts, as well as other New England states given the closely linked fuel supply chain in the region.

Another regulatory barrier is a national standard that does not require terminals to disclose biodiesel blends under 5% on the bill of lading.[[9]](#footnote-9) Any biodiesel blend under 5% is considered petroleum diesel under ASTM International standard D975. This leads to regulatory uncertainty about mandating additional blends of biodiesel. For example, stakeholders had concerns that the Massachusetts blending requirement would lead to biodiesel blends of 7%.

Though not directly related to regulations, some states are unable to use biodiesel through the lack of procurement protocols, such as a master price agreement.

### Technical Barriers

Many stakeholders cited cold weather as a significant barrier for higher blends of biodiesel during the winter months in New England with some instances of cold flow issues. Cold flow issues may be mitigated with proper quality control standards, such as those achieved through BQ-9000 accreditation. BQ-9000 is an accreditation for biodiesel producers and marketers and is designed to ensure that biodiesel fuel is produced and maintained at the industry standard, ASTM D6751. It is cooperative and voluntary program, but requires that producers must pass a rigorous review and inspection of their quality control processes by an independent auditor. Biodiesel producers in New England, including Newport Biodiesel, White Mountain Biodiesel, and Cape Cod Biofuels, are not BQ-9000 accredited. BQ-9000 is a procurement requirement among major biodiesel buyers, such as the City of New York and terminals such as Sprague, and the lack of this accreditation limits the ability of local producers to sell to major end-users.

Another issue is fuel logistics for distributors. Some terminals do not store biodiesel in a separate tank and therefore biodiesel is not available to blend at the rack. If a distributor wanted to blend biodiesel they may need to go to a second location –a time intensive and potentially costly option. To handle this issue, many distributors providing biodiesel have storage and blending infrastructure on-site which significantly limits options for end-users and retailers.

Like many of the other alternative transportation fuels, available fueling infrastructure is in limited supply. Of the infrastructure that does exist, many of the pumps are not publicly-accessible. Furthermore, station owners expressed concerns about converting existing diesel tanks to biodiesel. If they were to add a dedicated biodiesel tank, they may be constrained by space and cost.

Finally, certain terminals, such as Sprague, consistently cite biodiesel supply reliability as a major issue in the region.

### Economic Barriers

The loss of the federal biodiesel blender’s tax credit at the end of 2013 has resulted in significant economic strain for many biodiesel producers. Though the credit was retroactively extended through 2014 at the end of the 2014 calendar year, extensions of that nature may help a biodiesel company in the short-term, but do not allow for new investments in equipment or expansions. Without the tax credit and with oil prices rapidly declining, among other factors, it is difficult for producers to keep prices at or below diesel prices. As a result, biodiesel prices have been a disincentive for the average consumer and fleets.

### Attitudinal Barriers

In the 1990s and early 2000s, certain biodiesel users experienced problems with fuel quality leading to significant engine damage. Though isolated to specific batches of biodiesel, unfortunately the experience soured the desire of certain fleet managers to continue investing and using biodiesel. Some stakeholders also cited instances of fleet managers concerned with using any amount of biodiesel, even B5, during cold weather months.

## Propane

### Regulatory Barriers

The most significant issue for propane fuel is the difficulty of obtaining permits for fueling stations and storage. Specifically, Massachusetts has among the most difficult permit requirements in the region. This is partly because it is a municipal-based permit process, instead of a state-based process.

Another potential barrier is the passage of state regulations that would restrict and regulate hazardous materials shipments via rail, such as propane. For example, proposed legislation in New Hampshire could limit propane rail shipments to major storage locations.

### Technical Barriers

Throughout New England there is a shortage of publicly-available propane fueling locations. Stakeholders cite a lack of interest among alternative transportation fuel funding entities, which direct money towards other types of fueling infrastructure or do not assist with permitting issues.

### Economic Barriers

Though this barrier is not unique to propane vehicles, stakeholders cite the incremental cost of upfitting or converting a propane vehicle as a difficult obstacle for many fleets. Further impacting fleets in the near-term are the depressed prices of gasoline and diesel. Though propane prices tend to track oil prices, the significant price differential seen earlier in 2014 is shrinking. This trend could have a negative impact on fleets that have not yet invested in propane, or reduce the demand and interest in new fueling locations.

## Natural Gas

### Regulatory Barriers

Many stakeholders cited the high costs associated with utility demand charges as a barrier for expanding public natural gas fueling infrastructure, because natural gas fueling infrastructure requires electricity to run the compressors. Demand charges are incurred by commercial electric utility customers for the highest kilowatt (kW) use over a 15 minute period within a billing month. In Vermont these charges are an average of $16/kW. Vermont Gas analyzed the costs of a large public station and determined that the demand charges would average $3,000 per month to power the compressors before the cost of the electricity.[[10]](#footnote-10) State public utility commissions approve utility demand charges. Stakeholders contend that these regulatory entities should approve demand charge exemptions for natural gas and electric vehicle charging infrastructure.

Other citizens are concerned about competing uses of natural gas for electricity and home heating. Although much of the region has reliable access to natural gas for the majority of the year, during the winter months, natural gas supply can be constrained by the demand of natural gas peaking plants, particularly on the coldest days. Regulators may perceive transportation as an unnecessary competitor during these times and potentially limit access to fuel.

In states with limited access to natural gas, such as New Hampshire, trucking gas to fleets is a potential option. However, New Hampshire’s fire marshal requires a venting apparatus for compressed natural gas trucks; this apparatus is not required in other states limiting the ability of out-of-state trucks to provide shipments of gas demonstrating a need for regulatory consistency in the region.

Though new pipelines are under consideration or review for much of the region, some states, such as Maine, have issued a moratorium on new capacity due to environmental concerns.

### Technical Barriers

Public and semi-public infrastructure may be available in certain portions of New England, but not all fleets may have easy access to those stations. For example, Rhode Island has several quasi-public state-owned stations, but the State has not developed a protocol for non-state fleets to obtain accounts to access those stations. Furthermore, some infrastructure was not set-up to easily accommodate the public. For example, a Burlington Department of Public Works (DPW) station in Vermont was developed in part with Clean Cities funding, but does not include a credit card reader. Users must call ahead and pay cash to access the station, unless they establish an account with the DPW. Furthermore, not all public stations are able to absorb additional users. Many will need additional compressors and pump modifications to make the stations more accessible to the public.

Given that many areas in New England are fairly rural, stakeholders cited range anxiety as a challenge among fleets. Some fleets are hesitant to operate with natural gas because of the reduced range of the fuel and the smaller tank size.

Finally, some station owners in the region have not made the necessary repairs and investments in infrastructure to maintain necessary reliability for public and private fleets. For example, one station had broken nozzles for many years causing significant inconvenience for end users. Access to reliable infrastructure is of paramount importance to fleets and can be a major disincentive for alternative fuel adoption.

### Economic Barriers

Similar to the barriers discussed for propane, natural gas will be significantly impacted by lower oil prices in the near-term, leading to a longer return on investment for existing fleets and a significant disincentive for new fleets. Furthermore, natural gas rates are relatively high within the region compared to other parts of the country. Though many fleets may have long-term fuel contracts, those that are forced to purchase fuel from the spot market may experience extremely high prices, particularly in the winter months when natural gas is in high demand.

Additionally, stakeholders cite the incremental cost of upfitting or converting a natural gas vehicle as a difficult obstacle for many fleets. In areas of New England within air quality attainment zones, stakeholders cited a lack of state and federal funding to assist stakeholders with fleet vehicle conversions and infrastructure. They also noted that many states within New England do not have significant incentives for fleets to convert to natural gas or other alternative transportation fuels.

### Attitudinal Barriers

Even though natural gas is not recovered in many parts of New England, there is a deep-seated concern among many residents about hydraulic fracturing in shales, such as the Marcellus and Utica Basins. Residents are concerned about the environmental impacts of recovering natural gas, such as methane gas release and water contamination. States, such as Vermont, have gone so far as to symbolically pass legislation banning hydraulic fracturing. This has led to concerns about the need for new and existing investments in natural gas vehicles and infrastructure.

## Hydrogen

### Regulatory Barriers

Due to the limited number of hydrogen fueling stations currently located in the New England area, there will be a learning curve for regulators, first responders, and end users to permit and cite new facilities. Additionally, some states in the region have a municipal-based permitting process, which requires a more extensive educational process leading to longer permitting times in some jurisdictions.

### Technical Barriers

The lack of available hydrogen infrastructure is a barrier to adoption for individuals and fleets. It is difficult to plan for infrastructure deployment without a better sense of manufacturer plans for deploying vehicles in the region. Though there was a recent announcement by Toyota and Air Liquide to deploy hydrogen fueling infrastructure across the Northeast, there was no indication in the press release about how many Toyota Mirai’s would be available for sale or lease.[[11]](#footnote-11)

Furthermore, when developing utility rates for PEVs, regulators should be mindful of rates for hydrogen fuel vehicles. Hydrogen production, which is primarily derived from hydrolysis and gas reformation, can be energy intensive, and parity with electricity costs is important.

### Economic Barriers

There are currently no on-road fleets in New England using hydrogen. This is largely due to the expense of hydrogen fueled vehicles and infrastructure. To date, federal and state funding has not been issued for projects in the study region. Furthermore, funding that is available in the region for alternative fuels is not being applied consistently to hydrogen fuel cell vehicles and infrastructure. Other non-financial incentives, such as high occupancy vehicle (HOV) lane access and parking incentives, also need to be consistently applied to assist with deployment.

### Attitudinal Barriers

In order to convince vehicle manufacturers to deliver products to the region, states need to implement policies and funding to convey a pro-hydrogen signal. Until then, manufacturers are less likely to direct vehicles to the region, which will delay deployment.

## Electricity

### Regulatory Barriers

There are no known regulatory barriers for electricity as a transportation fuel at this time.

### Technical Barriers

One of the more significant barriers is the lack of available PEV models in the region. For example, at the date of publication, the Chevy Spark EV, Fiat 500-E, and RAV-4 EV were not available for sale in the study area, while others were available in limited quantities.[[12]](#footnote-12)

Though there is a significant quantity of charging locations, many stakeholders cite the lack of publicly-accessible charging infrastructure as a barrier to PEV adoption. Range anxiety is also a concern among many consumers, particularly in the more rural areas of the study region.

Other stakeholders also listed cold weather as a barrier. In extreme cold events there have been instances of PEVs reporting difficulty operating at full range. For example, some stakeholders reported that the Nissan LEAF was limited to 35-40 miles of range. Furthermore, certain types of charging equipment, such as DC fast chargers, have been reported having issues regarding functioning properly in extreme cold.

### Economic Barriers

Many individuals and fleets find it challenging to afford PEVs. Even with federal incentives, there is still an incremental cost for most major models. The majority of states in the study area did not have long-term, sustained state incentive programs for PEV or electric vehicle charging equipment purchases. Many stakeholders expressed a need for additional funding to expand the network of public and workplace charging stations around the study region.

As mentioned above for natural gas, demand charges are also a barrier for charging equipment, particularly for DC fast chargers which use large quantities of electricity in a relatively short amount of time. For example, the Worcester Regional Transit Authority in Massachusetts purchased five all-electric Proterra buses, but the fleet did not report savings over diesel largely because of demand charges.[[13]](#footnote-13)

### Attitudinal Barriers

Another potential barrier to PEV deployment is related to dealer education. Based on information provided by stakeholders, there have been instances where dealers provided misinformation about the vehicles and actively steered consumers away from PEVs. Though this issue is not unique to New England (for example, the University of California-Davis recently published a working paper on PEV dealer satisfaction in California),[[14]](#footnote-14) stakeholders must work closely with dealers and manufacturers to ensure accurate information is conveyed to consumers.

# Review Options for Supply of Alternative Fuel in an Emergency

Given the recent history of extreme weather events that create emergency situations in and around the study region, there is a need to understand the role that alternative fuels can play when petroleum supply chains are negatively impacted. Hurricane Sandy, for instance, is an extreme example of a weather event that led to petroleum shortages, thereby negatively impacting the ability of rescue and evacuation crews to get to stranded citizens or others in need of immediate help. In a less extreme event, but one that was more recent, 195,000 residents in New Hampshire and 100,000 residents in Maine were without power over Thanksgiving in November 2014.

To assess the ability of alternative fuels to play a role in case of an emergency, ICF developed evaluation criteria against which each fuel was measured. ICF employed the following criteria in our evaluation:

* **Fuel supply and availability**: ICF considered factors such as the proximity of fuel production to the study region and the supply chain that delivers the fuel to the study region. Apart from factors like proximity and supply chain, we also considered the ability to supply sufficient volumes in the event that additional fuel is required in an emergency.
* **Physical supply infrastructure**: This criteria focuses on the physical assets or infrastructure along the supply chain such as trucks or barges, pipelines, transmission lines, etc. Further, we considered what physical restrictions may be in place as a result of the physical infrastructure’s vulnerability in an emergency.
* **Fueling infrastructure**: ICF considered the ability to distribute the fuel at retail and private fueling stations in the study region, and how this infrastructure may be impacted in an emergency.
* **Costs for installing infrastructure**: In the event that contingency plans are put in place, ICF considered the costs of installing new infrastructure to supply alternative fuels in the region.
* **Available vehicles**: Outside of infrastructure, ICF considered the availability of vehicles capable of using the corresponding alternative fuel. Our consideration focused on emergency vehicles and those that might be able to support emergency-related activities. These vehicles tend to be in higher weight classes (i.e., medium- and heavy-duty vehicles) rather than light-duty vehicles.
* **Training/ease of use**: Given the importance of readiness and preparedness in an emergency, ICF considered the ability to train emergency responders and other personnel on issues related to each alternative fuel.

ICF developed a simplified qualitative assessment of each fuel’s ability to perform in an emergency across the six (6) criteria outlined above. For each fuel and criteria, we make a red-yellow-green assessment, whereby red indicates that the fuel is not well-suited to provide support in case of an emergency; yellow indicates that the fuel has some limitations that must be considered, but has potential; and green indicates that there are few if any limitations for the fuel in case of an emergency and that it is well suited to fill that role. Each fuel is assigned with an overall rank based on the average of each criterion. The exhibit below illustrates ICF’s findings. Recommendations to enhance the opportunities to use fuels with yellow and red assessments in the event of an emergency may be found in Section 5.

Exhibit 3. Alternative Fuel Assessment for Use in an Emergency

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Fuel | Fuel supply & availability | Physical supply infrastructure | Fueling infrastructure | Vehicle availability | Infrastructure costs | Training /  Ease of use | Overall rank |
| Ethanol |  |  |  |  |  |  |  |
| Biodiesel |  |  |  |  |  |  |  |
| Propane |  |  |  |  |  |  |  |
| Natural Gas |  |  |  |  |  |  |  |
| Hydrogen |  |  |  |  |  |  |  |
| Electricity |  |  |  |  |  |  |  |

* **Ethanol**: E10 is commonly used in the study region, but with limited fueling infrastructure for medium- and high-level blends of ethanol and limited availability of flex-fuel emergency vehicles (particularly for medium- and heavy-duty applications) ethanol has limitations in emergency situations. Ethanol supply and availability, infrastructure costs, and the ease of use are all positive characteristics of ethanol in the study region. Since ethanol is not produced in the study region, but rather transported primarily through rail and barge, depending on the type of emergency, ethanol supplies could be quickly exhausted or interrupted in a manner similar to the petroleum supply chain that is at risk during emergencies.
* **Biodiesel**: With local biodiesel production in the study region and a large number of emergency diesel vehicle options, biodiesel blends are an optimal emergency fuel for the region. Existing infrastructure and minimal training requirements for first responders means that biodiesel could be quickly and easily deployed in an emergency. Potential areas for improvement are related to the physical biodiesel supply infrastructure and available fueling infrastructure. Biodiesel is traditionally transported by vehicles and with limited storage in the region, depending on the type of emergency, supply could quickly be exhausted or interrupted in a manner similar to the petroleum supply chain that is at risk during emergencies.
* **Propane**: Propane fuel is transported by rail, ship, and truck providing a variety of delivery methods in the study region–essential in the event of an emergency. The fuel is also widely available in both cities and rural areas. Fueling infrastructure is also inexpensive and relatively easy to install temporarily or permanently. However, the number of propane fueling stations and propane vehicles are limited. Also, propane fueling requires additional training compared to conventional fueling methods.
* **Natural gas**: Natural gas is widely available, with some exceptions in rural areas of the study region. In many parts of the study region, natural gas fueling infrastructure is common and a variety of medium- and heavy-duty vehicles could be deployed for emergencies. However, infrastructure costs are expensive, limiting deployment to date. Based on stakeholder outreach, ICF found that many of the CNG stations in the region have compressors that can (and have) operated on back-up generators in the event that electrical transmission or distribution lines are down. In some cases, the aforementioned virtual pipelines for natural gas could provide short-term solutions for fueling in the event of an emergency.
* **Hydrogen**: Due to the limited availability of fueling infrastructure and vehicles, hydrogen is not an optimal emergency fuel for the region.
* **Electricity**: PEVs have limited applications for emergency events primarily isolated to light-duty vehicle response teams. Though electricity is abundantly available and fueling infrastructure is relatively inexpensive and easy to deploy, there are a limited number of medium- and heavy-duty PEVs on the roads today that could be deployed in the event of an emergency. Furthermore, many emergency events include the loss of electrical power, thereby severely limiting the potential for PEVs.

# Recommendations to Overcome Barriers to the Supply of Alternative Fuels in the Region

ICF developed the recommendations in the following subsections to help overcome barriers to the supply of alternative fuels in the region. Our first set of recommendations are broad and provide high level solutions to major barriers identified in Section 3 and represent ICF’s best effort to distill recommendations by fuels and by state. Although broader in their scope, these recommendations represent the issues that were brought to the forefront through interviews with stakeholders in the study region and ICF research. Subsequent sub-sections provide more specific recommendations distinguished by fuel type. While ICF recognizes that some state-specific barriers may not be adequately addressed, we note that this report is intended to provide regional-level recommendations.

## Overarching Recommendations

### Regulatory

Streamline permitting. Streamline permitting processes for fueling infrastructure within each state; in states with municipal oversight of permitting process, establish a state resource for information and guidance where needed.

Seek consistency in code development. Establish consistent zoning and building codes and standards for alternative transportation fuel infrastructure between states.

Regulatory review and develop consistency. Review state and regional restrictions on alternative transportation fuel shipments, storage, and distribution infrastructure. Subsequently, the review should lead to identifying options for normalization of regulations and restrictions to provide consistency.

### Policy

Consider low carbon fuel standard. Coordinate with other states in the Northeast to consider options for a low carbon fuel standard that could provide regulatory incentive for obligated parties to blend low-carbon fuels, including alternative transportation fuels. Consider implementing a petroleum reporting requirement to better understand the carbon intensity of fuels used in the region.

Incentivize alternative fuels and alternative fuel vehicles where financially feasible. Where possible, expand High Occupancy Vehicle (HOV) lane access for alternative fuel and advanced vehicles, regardless of the number of passengers. Develop equitable and appropriate incentives for alternative fuel vehicles and infrastructure deployment, including tax incentives, rebates, vouchers, grants, and low- or no-interest loans. Develop vehicle purchase incentives that are consistent with auto dealer sales practices and methodologies.

### Economic

Incentivize alternative fuels. Provide vehicle purchase and infrastructure incentives and funding for consumers and ensure that programs are equitable across a range of alternative fuels and advanced vehicle options.

Identify innovative financing opportunities. Work with alternative fuel industry, including vehicle manufacturers, dealers, utilities, and state agencies, to implement low-cost financing programs for vehicle and infrastructure deployment.

Leverage public-private partnerships. ICF recommends meeting with key industry members to reduce the initial capital investment of infrastructure and vehicle acquisitions and conversions.

Pooling resources for purchasing power. Consider state or regional public and private group purchases of alternative fuel vehicles and advanced vehicles to maximize savings and negotiating opportunities.

### Educational

Industry outreach and engagement. Work with the alternative fuel industry and equipment manufacturers and dealers to ensure that all available alternative fuel vehicles are available for sale in New England and market them in all states to the extent possible.

Dealer education. Incorporate dealer education as part of any vehicle incentive rollout plan to reduce potential consumer misinformation.

General education and outreach. Develop and distribute educational materials specific to New England for policymakers and the general public. Identify and repurpose existing materials on educational websites, such as the Alternative Fuels Data Center, to provide to stakeholders. Use this as an opportunity to educate policymakers and state regulators about the alternative transportation fuels supply chain and potential implications of limiting regulations and laws that would inhibit the availability and reliability of the fuels.

## Ethanol

Develop and provide incentives. ICF recommends prioritizing incentives for mid- and high-level blends of ethanol, including incentives for end-users and infrastructure, such as blender pumps.

Eliminate or prevent restrictions. Some states have considered or have restricted on the quantity of ethanol sold in the state, as well as limitations on the ethanol blend level.

Taxation. Eliminate unnecessary taxation on ethanol.

Educational outreach. There are a variety of misconceptions related to the environmental benefits of ethanol. ICF encourages a concerted effort to educate state policymakers and regulators about the benefits of ethanol.

## Biodiesel

Reinstate blending requirements. ICF recommends re-instating the 2% blending requirement for biodiesel in Massachusetts to expand the biodiesel market in the Northeast.

Improve disclosure of biodiesel content. Require disclosure of any biodiesel content on the bill of lading at the terminal.

Establish procurement protocols. Where necessary, work with local producers to evaluate the opportunities for BQ-9000 certification.

Develop procedures for use of biodiesel in extreme cold weather conditions.

Provide incentives for biodiesel. ICF recommends focusing incentives for biodiesel on critical areas like upstream infrastructure (e.g., storage at terminals), and downstream distribution i.e., retail infrastructure.

Educate stakeholders. ICF recommends engaging with stakeholders on ASTM testing procedures and requirements to ensure biodiesel maintains a high level of fuel quality and consistency.

Ensure regulatory consistency. ICF recommends normalizing the fees levied against biodiesel producers. For instance, ICF outreach indicates that some yellow grease collectors in Massachusetts are being made to pay for sanitation permits in each town for which they operate. These types of fees impact the cost competitiveness of biodiesel.

## Propane

Identify and evaluate regulations related to propane storage, distribution, and consumption. ICF recommends identifying and evaluating potentially restrictive regulations related to propane storage, distribution, and consumption. The evaluation should yield ways to ensure regulatory consistency between states and provide permitting assistance, particularly for propane storage and distribution.

Provide incentives for propane. ICF recommends incentivizing the purchase of propane vehicles and infrastructure, particularly for vehicle acquisitions and retrofits and publicly-accessible fueling infrastructure.

## Natural Gas

Evaluate tariff structures for natural gas fueling infrastructure. Many states in the region charge high tariffs and demand charges of station operators, making it difficult to make a business case for infrastructure expansion. It is important that the tariff structure reflects the cost of service to the utility (including any profit).

Expand natural gas infrastructure. There are significant constraints to natural gas supply in the region, especially during the winter months when the fuel is used for home heating. This has knock-on effects in other industries such as transportation fuels. Moving forward, it will be important to expand natural gas infrastructure and distribution capabilities in the region to minimize disruption. This will require engagement with regulators to ensure fuel access for fleets year-round. At this point, it is unclear how virtual pipelines that are supplying natural gas to rural areas will impact the demand for natural gas as a transportation fuel. These pipelines are unlikely a cost-effective displacement for diesel as a transportation fuel. Further, they may decrease the near-term urgency of increasing the distribution infrastructure in the study region, thereby maintaining existing bottlenecks and contributing to the limited expansion of retail infrastructure.

Ensure regulatory consistency. Regulatory consistency between states is important for sustained alternative fuel growth in the study region and stakeholders should identify and mediate regulatory inconsistencies, such as the New Hampshire fire marshal requirement for a venting apparatus in compressed natural gas distribution trucks.

Provide incentives for natural gas. Target incentives for natural gas vehicles; the increase in demand for natural gas will be met by infrastructure providers. Deploying more natural gas vehicles will do more to improve the business case for natural gas infrastructure deployment than incentives for infrastructure.

Expand public accessibility of existing network. More than half of the existing CNG stations are private stations. To the extent feasible, the region should consider upgrading existing private and semi-private natural gas stations to become publicly-accessible or to increase available fuel supply to existing users. Ensure that existing stations have the tools necessary to maintain reliable supply and equipment to end users.

Education and outreach. Continue to educate fleets about natural gas options to eliminate misinformation and provide accurate information regarding important considerations, including available vehicle options, vehicle performance capabilities, vehicle range, and cost. Educate state policymakers and regulators about the benefits of natural gas, including the environmental benefits (e.g., air quality, greenhouse gas reductions, etc.).

## Hydrogen

Develop a regional plan for hydrogen fueling infrastructure and vehicle deployment. Regional planning can help guide efforts and ensure that the states in the study region stay ahead of the curve. This is particularly important for states in the study region that have signed a memorandum of understanding (MoU) to take specific actions to deploy zero emission vehicles; this includes Massachusetts, Rhode Island, and Vermont. The plan should include targets for deployment to understand infrastructure needs. Coordinate with auto manufacturers to understand plans for vehicle availability in the region.

Cultivate public-private partnerships. Create opportunities for public/private partnerships to leverage capital and resources for infrastructure deployment.

Provide incentives for hydrogen. ICF recommends focusing incentive support on providing base-level funding to deploy a minimum number of hydrogen stations that are targeted in areas of anticipated high demand. This will help seed the market for fueling infrastructure. Further, ICF recommends extending any vehicle incentive programs to include hydrogen fuel cell vehicles.

Streamline the permitting process. Develop permitting process for hydrogen infrastructure; in states with municipal oversight of permitting process, establish a state resource for information and guidance where needed.

Identify go-to contacts. Each state, or the region collectively through groups such as the Clean Cities coordinators, should seek to identify individuals that stakeholders can contact for assistance and to resolve conflicts.

## Electricity

Education and outreach. Institute PEV educational opportunities for consumers and dealers, particularly as it relates to vehicle options, range anxiety, vehicle performance in cold weather, and incentives.

Provide incentives for electric vehicles. Extend funding for, or initiating funding for vehicle purchase incentives.

Develop and execute PEV readiness actions. PEV readiness actions cut across multiple planning and policy areas. For instance, ICF generally recommends that states require EVSE pre-wiring for new and renovated parking garages and multi-family dwellings. Similarly, ICF encourages states to adapt model ordinances to establish EVSE requirements within municipal codes for multi-family dwellings, commercial buildings, and parking garages.

Utility engagement. Coordinate with in-state utilities and public service commissions to design PEV rates and minimize utility demand charges for EVSE.

Reduce regulatory burden for infrastructure providers. Establish exemptions where necessary for EVSE providers, or others providing electricity for vehicles, so that they are not defined as a public utility under state law.

Evaluate opportunities to install EVSE at non-residential locations. ICF recommends identifying multi-family dwellings and workplace charging locations to ensure adequate opportunities for charging outside of the home.

Support public-private partnerships. ICF recommends establishing public-private partnerships to deploy public and workplace EVSE, including fast charging to facilitate long-distance travel and for those without dedicated home charging options.

# List of Abbreviations and Acronyms

|  |  |
| --- | --- |
| B20, B5 | biodiesel blend levels (i.e., 20% biodiesel, 5% biodiesel) |
| BEV | battery electric vehicle |
| CNG | compressed natural gas |
| DCFC | direct current fast charging |
| DOE | U.S. Department of Energy |
| DPW | Department of Public Works |
| E85, E10 | ethanol blend levels (i.e., 85% ethanol, 10% ethanol) |
| EV | electric vehicle |
| EVSE | electric vehicle supply equipment |
| FFV | flex-fuel vehicle |
| GGE | gasoline gallon equivalent |
| HOV lanes | high occupancy vehicle lanes |
| kW, kWh | kilowatt, kilowatt-hr |
| LPG | liquefied petroleum gas (propane) |
| LNG | liquefied natural gas |
| MassDOER | Massachusetts Department of Energy Resources |
| MoU | memorandum of understanding |
| PEV | plug-in electric vehicle |
| PHEV | plug-in hybrid electric vehicle |
| ZEV | zero-emission vehicle |

1. Phone interview with Joe Rose, Propane Gas Association of New England, December 5, 2014. [↑](#footnote-ref-1)
2. Despite some early optimism about the proposed facility in March 2014, more recent information (July 2014) indicates that the facility is “on hold” due to unspecified reasons and is unlikely to move forward. See for instance the article online here: <http://bit.ly/1zuXTYT>. [↑](#footnote-ref-2)
3. ICF International, California Transportation Electrification Assessment, Phase 1, prepared for the California Electric Transportation Coalition. Available online at: http://www.caletc.com/wp-content/uploads/2014/09/CalETC\_TEA\_Phase\_1-FINAL\_Updated\_092014.pdf [↑](#footnote-ref-3)
4. R.L. Polk National Vehicle Population Profile database, March 31, 2014. [↑](#footnote-ref-4)
5. Oil Price Information Service, April 29, 2014, “Massachusetts Ethanol Rail Amendment Revived,” accessed on December 29, 2014 at <http://www.chelseacollab.org/news/press/massachusetts-ethanol-rail-amendment-revived>. [↑](#footnote-ref-5)
6. New Hampshire Business Review, May 5, 2014, ‘N.H. Senate ponders limits on corn-based ethanol,’ accessed on December 29, 2014 at <http://www.nhbr.com/May-16-2014/NH-Senate-ponders-limits-on-corn-based-ethanol/>. [↑](#footnote-ref-6)
7. See House Bill 1220 status at <http://legiscan.com/NH/text/HB1220/id/997119>. [↑](#footnote-ref-7)
8. MassDOER Program Announcement: DOER Suspends Formal Requirements, Establishes Voluntary Program, Jun 2010. Available online at: http://www.mass.gov/eea/docs/doer/renewables/biofuels-mandate-announcement-jun302010.pdf [↑](#footnote-ref-8)
9. The bill of lading is a legal document providing the driver details of the contents of the freight. [↑](#footnote-ref-9)
10. Phone interview with Owen Brady, Vermont Gas Systems, November 26, 2014. [↑](#footnote-ref-10)
11. Air Liquide, November 17, 2014, ‘Air Liquide plane network of new hydrogen filling stations in the United States,’ accessed December 29, 2014 at <http://www.us.airliquide.com/en/air-liquide-plans-network-of-us-hydrogen-filling-stations.html>. [↑](#footnote-ref-11)
12. NESCAUM, October 23, 2014, ‘Multi-State ZEV Task Force: Presentation to the California Air Resources Board.” [↑](#footnote-ref-12)
13. Phone interview with Steve Russell, Massachusetts Clean Cities Coalition, December 3, 2015. [↑](#footnote-ref-13)
14. University of California-Davis, October 2014, ‘New Car Dealers and Retail Innovation in California’s Plug-In Electric Vehicle Market.’ Accessed December 29,2014 at <http://www.its.ucdavis.edu/research/publications/publication-detail/?pub_id=2353>. [↑](#footnote-ref-14)