Regulatory Barriers to Development of Vehicle Alternative Fuel Infrastructure in New England – MA, ME, NH, RI & VT

Prepared by the Hydrogen Energy Center

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This report is delivered as one component of a comprehensive, two-year project, *"Removing Barriers, Implementing Policies and Advancing Alternative Fuel Markets in New England"*, undertaken by the Clean Cities programs in the states of Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. Funding for this project is provided by the U.S. Department of Energy.

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INTRODUCTION and ISSUES SUMMARY

The U.S. Department of Energy's Clean Cities Program is addressing the challenges that exist to transitioning the US Northeast from petroleum-based vehicle fuels to fuels which have lower impacts and can be sourced closer to home.

This report is delivered as one component of a comprehensive, two-year project undertaken by the Clean Cities programs in the states of Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. The project is called, "Removing Barriers, Implementing Policies and Advancing Alternative Fuel Markets in New England".

The project sought to answer the question: "What regulatory, permitting, approval and administrative policies and procedures by governments and private standards organizations are creating impediments to the implementation of fueling cars and trucks with non-petroleum "alternative" fuels, and what measures can be taken to minimize or remove these obstacles?"

The six categories of alternative fuels studied for this project are: biodiesel, compressed natural gas (CNG), electric vehicle charging, hydrogen, liquified natural gas (LNG), and propane (LPG). The nature of challenges found to impede the adoption of these six fuels varied widely. Following is a list of issues covered by this study:

1. **Local and state-level** permitting, zoning and approval;
2. Permitting and regulation of **gaseous fuels;**
3. Permitting and regulation of **electric vehicle charging;**
4. **Equipment and facilities** codes, standards and regulations,
5. **Conversion** of vehicles to alternative fuels;
6. Regulations related to **weights, measures and fuel quality**;
7. **Taxation** of alternative fuels;
8. Property, equipment and casualty **insurance;**
9. State-level **public utilities'** rules, regulations and policies;
10. **Federal rules** impacting state regulations on infrastructure development and
11. **Incentives** to facilitate adoption of alternative fueling.

METHODOLOGY

Researchers used a 4-step process for this analysis:
Step 1 – For each of the 6 alternative fuel types covered by this project, researchers conducted interviews with supply companies, advocacy organizations and government agencies to ask what obstacles are causing problems or delays for fueling systems roll-out. From these interviews, 56 key issues were identified.

Step 2 – For each issue, a list of relevant government and business entities and their contact details was compiled, to provide sources for information regarding suggestions for and status of any resolution efforts.

Step 3 – Researchers contacted the list of entities compiled in step 2 in order to clarify the importance of each issue and to learn the status of efforts, policies, regulatory changes etc. that might eliminate these obstacles to alternative fueling.

Step 4 – Researchers identified corrective measures that could eliminate the key obstacle issues, based on the findings of step 3. In cases of complex policy, regulatory or taxation issues, multiple

corrective measures were considered. A list of recommendations for corrective measures and/or further analysis was produced.

The completed research work for the 5-state project area included identification of 152 relevant agencies, interest and technology groups as the “issues constituency” for alternative fuel system implementation and permitting improvements in the 5-state project region. The research for preparation of statutory, regulatory and codes process changes has included direct interviews with approximately one-third of these constituent entities. These are the entities with prime responsibility for regulatory, permitting, and codes process changes to deal with the identified alt fuels infrastructure development issues covered by HEC in this project.

Through an extensive outreach process the constituents of primary importance were contacted to accomplish the following:

1. Confirm whether the responsible entities agree that changes are needed to accommodate new fuels.
2. Determine whether changes to deal with these issues are already being developed or considered by the entities closest to these issues.
3. From the responsible entities' involvement and expertise, compile possible changes to the regulatory process.
4. Determine whether the evolving regulations and supporting codes need enhancements, assistance or modifications
5. Determine how this project can assist or augment the evolving measures to enable successful development of alt fueling/charging infrastructure in the 5-state project area.

REPORT FORMAT AND ISSUES SUMMARY

The format and contents of this project final report are as follows --

Key Issues: an explanatory list of the 55 key issues identified in step one of this project.

Findings and Recommendations: the most important research findings, conclusions and recommended actions, policy changes, codes and standards upgrades and training for or each of the 55 issues.

Appendices (1 & 2): backup data and research findings, a detailed list of business firms, key government agencies, private research and standards organizations, alternative fuel advocacy organizations and individuals who comprise a stakeholder network for alternative fuels implementation in the five New England states and nationally – also, additional research findings and notes plus a summary of key codes and standards related to fueling technologies and installations.

The following is a summary of issues findings. The main body of the report contains further explanations and recommendations related to these 55 issues.

In the summary below and in the main report, the issues descriptions written in RED are felt to be the priority issues for action and/or solutions.

1: General local and state-level permitting, zoning, and approval

1.11 With energy technologies changing rapidly, local permitting procedures do not necessarily incorporate codes for new fuels fast enough. This includes adoption of permitting standards and procedures, incorporation of new industry-accepted codes and staff training to deal with the new issues associated with these new fuels.

1.12 In some local communities, permitting/approval processes for alternative fueling facilities do not currently require adherence to specific codes and standards that are professionally recognized as necessary rules for construction and operation of such facilities.

1.13 It is widely felt that sufficient codes and standards exist to control fuel dispensing installations and that the biggest challenge is in getting local authorities fully informed and trained to use them.

1.14 In some municipalities, zoning officials do not have clear rules, models, training or experience to guide them in deciding whether fueling facilities that use gaseous fuels should be permitted within retail and commercial zones.

1.15 Due to lack of decision-maker familiarity with alternative fuels and fueling equipment, infrastructure permitting for these fuels usually becomes a time-consuming, one-off process. That adds cost and risk burdens to the development process in comparison to the more familiar gasoline and diesel fueling.

1.16 Local permitting and enforcement do not have “best practices” designs for alt fueling.

1.17 In some localities officials choose to not adopt new versions of codes as the basis for review/permitting, and this suggests possible further involvement by state fire marshals.

2: Permitting and regulatory issues specific to gaseous fuels

2.11 Variations in the physical properties of the many liquid and gaseous fuels are not always reflected in the criteria used by local municipalities for land-use, fire and environmental reviews & approvals of fueling facilities.

2.12 Propane fueling station developers in particular recommend state-issued model regulations for propane station approval based on relevant codes to prevent what they feel are arbitrary local government approval conditions not based in accepted codes and standards.

2.13 In the case of natural gas or propane, many local authorities' primary familiarity with these fuels is in the context of usage in homes and industry – not for dispensing to vehicles.

2.14 Because only a handful of commercial hydrogen fueling facilities have been built in New England, most local officials have not yet been faced with the need to understand hydrogen codes, physical properties, risks and differences from other gaseous and liquid fuels.

2.21 Unlike gasoline and diesel fueling or electric charging, dispensing systems for gaseous alternative fuels such as CNG, LNG and hydrogen can involve on-site processing at the dispensing site causing facilities permitting for these fuels to be treated more like industrial process facilities than retail vending operations.

2.22 Gaseous hydrocarbon alternative fuels are, in some cases, treated as “hazardous materials”, perhaps making infrastructure development approvals more cumbersome than necessary.

2.23 Building codes and the related approval/inspection procedures are sometimes applied to gaseous fueling system applications when no buildings are involved.

2.24 As opposed to building permits, construction permits may, in some cases, be a better tool and process for initial permitting point of contact, but does the "construction permit" exist in most towns?

2.31 For reasons that vary by fuel and by state, alternative fuels may not be allowed to be dispensed by the “public” -- i.e., by vehicle owners and drivers.

2.32 Public response to propane and CNG (and LNG and hydrogen?) fueling facilities in some cases focuses on visual aesthetic impacts when objections are actually rooted in general public discomfort with new and relatively unfamiliar fuel types in local communities.

2.33 The public has become comfortable with unseen underground fuel tanks with gasoline stations. Above-ground tanks for alternative fuels draw opposition based on aesthetic objections and perceived safety risk.

2.34 Unlike gasoline and diesel, gaseous fuels do not leach damaging liquid hydrocarbons into soil and water resources. Approval criteria and processes should recognize this difference and be modified accordingly.

2.41 With respect to fire suppression requirements, there are contentions that the regulations should be different and in some respects more stringent for gasoline in comparison to CNG.

2.42 Equipment is being introduced to the market for compressing natural gas and fueling vehicles in homes. Approval authority and processes, standards and codes for installation of this equipment are not clear for homeowners and building construction/renovation contractors.

3: Permitting and regulatory issues specific to electric vehicle charging

3.11 A large amount of charging station electrical services will be needed to energize the volume of PEVs required to make significant energy and environmental impacts. The current population of power service and equipment installers do not have sufficiently clear instructions on how to install this equipment according to the confusing range of relevant codes, standards and local regulations.

3.12 Local government can plan better and adjust zoning and permitting to enable communities to accommodate demand for ZEV charging (PEV) and fueling (hydrogen) stations.

3.21 Updates may be needed to the National Electric Code (ANSI/NFPA 70) to accommodate rapid development/installation of level 2 and level 3 (DC fast charge) vehicle charging.

3.22 Building codes have not evolved to fully handle electrical system requirements associated with installation of level 2 PEV charging systems in homes and businesses.

4: Equipment and facilities codes, standards and regulations

4.11 Diesel exhaust fluid is a new substance in diesel fueling station design and permitting, and it may add complexity to the process – the implications for biodiesel are not clear.

4.21 Codes do not deal with safety issues and facility designs where one or more alternative fuels – plus gasoline and/or diesel - are all dispensed at the same facility site.

5: Conversion of vehicles to alternative fuels

5.11 There is confusion regarding design standards and codes for indoor storage and maintenance of gaseous fuel vehicles – indoor risks that are very different among the various gaseous fuels which in turn are all very different from gasoline risks.

6: Alternative fuels issues related to weights, measures and fuel quality regulations

6.11 With respect to hydrogen, electric charging, CNG and LNG, states have not finalized the rules for measuring the dispensed amounts of these fuels.

6.12 With respect to hydrogen, electric charging, CNG and LNG, states are not fully prepared to inspect measurement equipment and to apply fuel measurements in calculating fuel taxes (under the current fuel excise tax systems).

6.21 There is no batch control to enable quality control measures to be applied to natural gas delivered specifically for vehicle fueling, and the quality controls on natural gas delivered by gas utilities are not geared toward vehicle fueling requirements.

6.22 Fuel quality controls and quality issues for bio-generated or landfill-generated methane gas differ from natural gas, but no firm fuel quality standards are applied to these bio-sourced gases.

6.23 It is unclear what (if any) quality standards are required in/by the New England states for propane used as vehicle fuel – as opposed to propane used for home heating and cooking and for industrial processes.

6.24 Fuel quality control has been an issue for biodiesel suggesting the need more stringent requirements that Biodiesel meet the industry's BQ9000 standards as a minimum with a likely need to apply standards that deliver a higher level of quality to the customer than BQ9000.

6.25 The hydrogen production and fuel cell manufacturing industries have published explanations of quality issues and guidelines but not a universally applied fuel quality standard for hydrogen used as vehicle fuel.

6.26 Quality requirements covering natural gas used for fuel cell vehicles are different than for use in internal combustion engines, yet the gas quality standards for fuel cell use are unclear or not applied.

7: Alternative fuels issues related to fuels taxation

7.11 Plug-in electric vehicles (PEVs) and plug-in hybrids currently are not paying fuel excise (highway usage) tax on the electric power consumed. For the other alternative fuels, there are various problems of non-acceptance of fuel taxation methods.

7.12 Regardless of problems with alternative fuels taxation, the entire highway funding and taxation system looks likely to be substantially revised by states and the feds, and alternative fuels (and electric charging) will have to be built into the revisions.

7.13 When LNG is taxed as a liquid fuel on a per-gallon basis the customer pays approximately 70% more tax than for an equivalent diesel fuel energy value. This is viewed as a disincentive to convert trucks from diesel to LNG.

7.14 In the cases of CNG, hydrogen, LNG and electric charging, non-batch fuel delivery methods and on-site fuel processing, make it difficult or impossible for taxing entities to use the current, relatively efficient mode of taxing fuel at the wholesale, bulk delivery level where the taxes are passed to the retail level within product prices.

7.15 In the case of LNG fuel taxation, the fact that LNG is very likely to be used almost exclusively in long-haul trucks means that the current IFTA system for taxation on interstate and international trucking is likely to complicate (or possibly be facilitated by) revision of the highway funding system.

8: Policies and issues related to property, equipment and casualty insurance

8.11 Property and casualty insurers generally do not have (and thus do not use) full and accurate assessments of risk associated with alternative fueling facilities. This appears to result in higher than necessary insurance costs for alternative fueling facilities owners.

8.12 Compared to the insurance situation for gasoline and diesel fueling stations, few insurers provide coverage for CNG facilities, and this may also be the case for propane, hydrogen and LNG.

8.13 In many respects, dispensing of gaseous alternative fuels may involve lower risk than is the case with gasoline, but insurance risk assessments and rates do not reflect this.

8.14 Accurate risk assessments and appropriate insurance pricing may be hampered by lack of "best practices" models for alternative fuels dispensing stations.

9: State-level public utilities rules, regulations and policies

9.11 State public utilities regulations limit who can sell electricity on the retail market. This appears likely to interfere with the ability of business entities to sell electric charging services and to establish pricing for this product/service.

9.12 Depending on the rate structure of the particular electric utility involved, DC fast charging stations may incur spikes in electric power consumption that will incur substantial demand charge costs in addition to power consumption and supply fees. This will increase the cost of vehicle charging services.

9.13 In order to make full use of the smart grid energy storage capabilities of plug-in and fuel cell electric vehicles, state and regional (ISO) electric services regulators and energy agencies need to define the terms for supplying energy from vehicle storage to the grid.

9.14 Electricity-supplying utilities may need data regarding planned and permitted electric charging stations – especially level 3 stations at the planning stage -- so the utilities can adjust power availability to the station sites or notify the proposing entity that power cannot be made available.

10: Federal rules impacting state regulations on infrastructure development

10.11 There is some confusion within the fuel facilities and vehicle conversion industries due to the existence – and use by states – of two sets of air emissions approvals – EPA and CARB. Vehicles converted to run on alternative fuels such as CNG or propane require one of the other or both of these approvals.

10.12 It is unclear how (and whether) the EPA's regulations on air impacts of vapor emissions from fueling (vapor recovery systems requirements) will be applied to alternative fuels, especially gaseous fuels using totally sealed fueling and storage technologies.

10.13 “State Implementation Plans” (SIPs) for EPA-mandated air quality standards at the state level are in some cases/respects unclear as to to how vapor (or gaseous) escape will be handled in the processes of both vehicle filling and filling of on-site storage units with alternative fuels.

10.21 OSHA regulations - regarding human exposure to fuel substances – may come into play with respect to handling of the chemical substances of alternative fuels, and fuel system developers appear to be somewhat unprepared for these impacts.

11: Incentives to facilitate adoption of alternative fueling

11.11 Alternative fuel vehicle registration data should be made available so fuel supplying entities – electric utilities, private fuel suppliers, station developers – can plan energy-supply infrastructure, and vehicles using alternative fuels should be clearly labeled to guide first responders.

11.12 The federal Renewable Identification Number (RINS) system for tracking renewably-sourced fuels that account for credits toward the EPA-administered Renewable Fuel Standard (RFS) does not allow renewably-sourced electrical power to be tracked for this purpose, and this removes an economic incentive to use of electric vehicle (plug-in or fuel cell) powering in place of fossil fuel vehicle power.

DETAILS: ALTERNATIVE FUEL BARRIER ISSUES AND RECOMMENDATIONS

1: General local and state-level permitting, zoning, and approval

1.1 Streamlined permitting infrastructure:

1.11 With energy technologies changing rapidly, local permitting procedures do not necessarily incorporate codes for new fuels fast enough. This includes adoption of permitting standards and procedures, incorporation of new industry-accepted codes and staff training to deal with the new issues associated with these new fuels.

Explanation of this issue:

Equipment and system layout designs and operational processes for some alternative fuel storage and dispensing systems are still evolving through the learning stage and have not yet become fully standardized for fast, efficient planning, approval and setup.

Approvals, codes,and standards that are relevant here fall primarily into the realms of fire and building codes, equipment design certifications, zoning and land-use permitting and facilities construction performance requirements. The challenges for effective facilities approvals fall into two categories: First is the adequacy of codes, standards and other technical specifications. Second is the degree to which permitting officials and other “authorities having jurisdiction” (AHJs) have updated knowledge of and skills in applying these new and constantly changing rules.

Relatively new codes and standards governing fueling and charging facilities are spread out over a confusing range of organizations and jurisdictions resulting in very few decision-makers and AHJs – especially at the local level -- being trained at this point to know the full range of regulations that pertain to these facilities. Conflicting requirements, inconsistent application of codes and gaps make approval of facilities uncertain, time-consuming and potentially risky for approval authorities as well as for facilities developers.

Crucial aspects of all fueling system infrastructure review and approval are fire and building codes. The National Fire Protection Association (NFPA – see NFPA.org) is the primary source relied on by all levels of government for the fire risk and human safety components of fuel facilities permitting. However, there is substantial variation among fire and building codes and approval processes among the 5 project states and especially among municipal jurisdictions within each state. This is partly due to local governments' powers to enact rules on their own while conforming to general state requirements and industry-accepted standards. It is also partly due to substantial differences among

municipalities in terms of their abilities to pay the costs for constant updating of permitting authorities' knowledge and skill levels.

As distinct from system equipment and facilities permitting, siting and zoning approval issues for alternative fuel dispensing facilities are focused on perceived safety concerns, property rights issues, availability of power and water services, access and usage rights, traffic impacts, noise levels, other land-use conflicts, protection from vandalism and equipment damage and aesthetic impacts.

For both building/fire safety approvals and land-use/zoning issues, industry-accepted codes and standards are what local and state officials rely on. With alternative fueling technologies now evolving rapidly, the codes and standards organizations are highly challenged to maintain rules that control design, installation and operation of these new facilities. However, most stakeholders see the biggest challenge as training and skills updates on the part of AHJs.

In summary, changes in fueling/charging equipment technology are outstripping the abilities to keep codes, standards, ordinances, and technical skills up-to-date. This is especially the case with facilities for electric vehicle (EV) charging, liquified natural gas (LNG) and hydrogen fueling. With respect to new fueling technologies, this creates expensive delays, design variations and uncertainty that is reported by the fuel facilities industry to be limiting the feasibility of alternative fuel facilities implementation.

Entities that favor faster adoption of alternative fuels and vehicles feel that the process toward best practices and predictable regulatory criteria needs to be pushed by state-level regulations that require faster and safer levels of fuel facility approval where local authorities have a clear base of state rules on which they can rely for confident decision-making.

Options for changes – effectiveness and feasibility:

Possible measures have been suggested for addressing this issue. These options vary in terms of likely effectiveness and feasibility:

1. Enhance state-level fire and building codes to specify review and approval criteria, permitting procedures and approval timing requirements for development of all public, commercial and fleet fueling and charging facilities. Legislation would be required in each of the five project states followed by administrative rules and specifications to be administered and enforced by the agencies/offices in each state that are responsible for fire codes, building codes, zoning and land-use controls. Municipal control and local power traditions in each of the project states make such measures politically unlikely.
2. Establish building, fire, zoning and land-use permitting model statutes in each state that give set clear state-level permitting criteria under which municipalities must function. Such models should lay out suggested – not mandated – ordinance terms that give towns a consistent, legally defensible and administratively efficient base to guide fueling/charging facilities development of all types – conventional gasoline and diesel as well as the newer gaseous, biofuel and electric energy facilities to serve all vehicles.
3. Establish in each state an enhanced local code enforcement training function that is required for all local and state enforcement agencies. The five project states vary somewhat in terms of current

codes training, but in all of these states, local officials and fueling/charging facilities developers agree that decision-makers and authorities having jurisdiction are unable to stay on top of what is needed to substantiate confident, safe approval decisions for all fuels. (For details regarding training programs see issue 1.16.)

Recommendations:

Perhaps the clearest need that had been identified by this project is for establishment of land-use and zoning model ordinances plus model changes to local fire and building codes. These changes are needed so local officials can make confident decisions regarding the design, location, installation, and operation of all types of fueling stations and electric charging facilities. Guidelines, standards and enabling legislation governing land-use, zoning, building and fire regulations are similar enough among the 5 states that a single set of models should be possible, needing only minor modifications by each state.

Contents for these models are suggested below.

Primary industry-recognized codes and standards for these purposes are listed in Appendix 2.

Adoption of these models by relevant authorities in each state should be accompanied by a rigorous training program required of all local Authorities Having Jurisdiction (AHJs) for these local rules and approval procedures.

The overall goal should be to enable the public's safety and well-being to be fully protected using review, approval, administration and enforcement processes for all fuels with terms and processes throughout the region that are equally or more effective, protective, predictable and efficient as is the case for conventional vehicle fuels such as gasoline and diesel.

This project has identified, for each of the project states, the primary, state-level entities appropriate for developing or administering such model codes.

Model codes and ordinances for local officials must be based upon industry-recognized codes and standards (see Appendix 2) where such rules have been fully developed by rigorous and accepted procedures. It is generally felt that the codes necessary for alternative fueling facilities are in place, but that they have not been reflected in local laws and officials' capabilities. As this model development process will identify gaps in codes and standards, the standards organizations have expressed interest in incorporating suggested changes that are viable and substantiated.

The model codes must cover the following in addition to other elements that will be cited by state and local officials as key to public safety and welfare:

- Fuel/energy delivery, transportation and transfer equipment and procedures.
- Fuel/energy storage specifications
- Dispensing equipment design, operation and maintenance
- Clearance distances between system components and from components to other situations that can impact safety and human health.

- Specific distance requirements between dispensing and storage facilities for different types of fuels – example: distances between electric charging and gaseous fueling.
- Specifications for heat, chemical, noise, light and other discharges.
- Ventilation requirements
- Buffer zones with codes-based specifications for distances and performance
- Performance standards specific to various land-use contexts
- Traffic and transportation impacts
- Utility requirements – electricity, water, gas, communication etc.
- Emergency process specifications
- Surface water, groundwater and surface runoff impacts
- Impermeable surface specifications
- Specifications for air emissions and odors from transport, storage and dispensing
- Fire emergency procedures and required emergency equipment
- Operator training and qualifications
- Insurance requirements to cover property and injury liabilities
- Bonding requirements to ensure performance and protection from community loss
- Procedures for public review and input
- Standards for the time required for permitting review, analysis and decisions
- Procedures and criteria for appeal of permitting decisions – appeals by developers and by other interested parties with standing

In each state, the model statute/codes/ordinance development process should be overseen by a committee of individuals representing skills, technical expertise and experience in the areas of –

- Fire protection and codes related to fuels and energy systems
- Construction and building codes related to commercial facilities and handling of energy and chemical substances and situations
- Zoning enabling legislation and state laws and standards governing local zoning and land-use permits
- Codes enforcement processes and standards
- Fuel-related discharge issues and requirements – federal, state and local
- Aesthetics and related facilities design
- General public interest input

1.12 ***In some local communities, permitting/approval processes for alternative fueling facilities do not currently require adherence to specific codes and standards that are professionally recognized as necessary rules for construction and operation of such facilities.***

1.13 ***It is widely felt that sufficient codes and standards exist to control fuel dispensing installations and that the biggest challenge is in getting local authorities fully informed and trained to use them.***

Explanation of these issues:

Local ordinances and review/installation codes in the 5-state study region vary significantly and many do not contain - with legally defined authority – requirements to apply the codes that are generally considered necessary for proper installation of alternative fueling equipment and facilities. A model list might be prepared – for use by all five states - specifying - for each fuel type - all industry-accepted codes and standards that are expected to be used by local authorities for review, permitting and inspection functions (land-use planning, fire and building permits, code enforcement etc.)

Looking ahead, engineering codes will change with rapidly evolving equipment designs, equipment-vehicle interfacing and facilities siting and layout standards. Interaction between the technology developers and standards organizations is happening most effectively in early adoption areas for alternative vehicle fuels/energy – areas such as California and parts of Europe. New England needs to monitor the technology changes and related codes/standards modifications happening world-wide so New England states can keep up with the rest of the world in new fuels utilization and with requirements of public safety and environmental protection. In addition, codes updates need to be linked to on-going training commitments to keep local and state approval/inspection people up to date on rules for facilities design and installation.

Vehicle fuel facilities regulation has been a stable system based simply on gasoline and diesel fueling that – justifiably or not – the public and regulator have become comfortable with. To the extent that vehicle energy changes to some or all of the fuels covered by this report (or others), the system will be less stable and more dynamic. If processes are not put in place to regulate effectively through this dynamic change period, either the move to better fuels will be unnecessarily delayed or the public's safety and well-being will be jeopardized.

Important to permitting of fueling facilities is the concept of the AHJ -- Authority Having Jurisdiction - i.e., jurisdiction over the permitting process and primary authority over the approval decision. That is the official who is in the strongest position to direct the complete process of evaluating and approving or denying permits for construction. In New England, local fire chiefs, fire inspectors or code enforcement directors are usually the AHJs for fuel service facilities and other energy infrastructure projects. This is for good reasons – fire and explosion risks. Although permit processes and other approvals branch off into realms such as planning boards at the local level and to environmental approvals at the state level, and despite local fire code enforcement being under State Fire Marshals' terms (to degrees that vary among the states), the local code enforcement and fire inspection officials seem to be the "gatekeepers" who direct the developer to all agencies and criteria relevant to an energy project's approval process. If these key individuals are not fully versed in alternative fueling substances, technologies, codes and standards -- or these people are faced with a highly confusing mixture of rules -- the facilities approval process is likely to become inefficient, costly and inaccurate.

Options for changes – effectiveness and feasibility:

There are four components to possible solution of this issue:

1. Enable codes officials (state and local) to become proficient and comfortable with the codes and standards that already have been industry-accepted for regulation of all six of the fuel/energy sources covered by this project – compressed natural gas (CNG), propane ("autogas"), liquified natural gas (LNG), biodiesel, hydrogen and electric vehicle charging.
2. Establish enforceable, state-level requirements that local and state AHJs maintain updated certification on facilities design, installation and operation for the fuels used in their states.
3. Enable (staff and fund) the building codes and/or fire codes oversight entities in each state to maintain updated enforcement manuals for AHJs.
4. Staff and fund statewide training programs that certify AHJs for vehicle energy permitting, inspections and enforcement. This training would most logically be offered in conjunction with broader AHJ training for industrial and commercial facilities.

Feasibility of these measures will mostly be questions of political acceptance, funding and staffing. Staffing should be an expansion of existing training programs especially for fire protection personnel. Funding would logically come from permitting and inspection fees channeled centrally for efficient provision of training on a state-wide basis.

Recommendations:

Implementation of all four options cited above.

1.14 *In some municipalities, zoning officials do not have clear rules, models, training or experience to guide them in deciding whether fueling facilities that use gaseous fuels should be permitted within retail and commercial zones.*

Explanation of this issue:

With respect to zoning -- vehicle fueling facilities tend to be allowed in commercial or industrial zones when designed, installed and operated according to codes and standards that are either referenced by the zoning ordinances or that are the basis for state and local regulations for fire protection, safety or environmental impact. Because gasoline fueling station facilities are familiar to both the public and government decision-makers, zoning regulations have evolved in most New England government jurisdictions to direct such facilities rather predictably to particular land-use zones with performance specifications that have become comfortably familiar for relatively quick permitting by government officials. In this zoning approval context, new, "alternative" fuels differ from this comfortable decision-making model, especially in the cases of CNG, LNG, propane and hydrogen.

Zoning - which designates precise areas in which specified business and residential activities can take place - relies to some degree on fire, plumbing, electrical and mechanical equipment codes and standards to determine the design and operational details of how allowable activities must be carried out in the zones where those activities are permitted. For new, "alternative" fuels, local authorities do not have clear "roadmaps" laying out the specific rules to apply and clear standards on which to base approval decisions, performance requirements and inspections.

In the case of hydrogen, for example, most local zoning does not deal with hydrogen handling as a retail fueling station commodity and process. Hydrogen handling codes and standards have evolved mostly in the context of industrial processes and equipment that is located in industrial zones. Therefore, local zoning and land-use approval authorities do not have rules to apply quickly and predictably to retail hydrogen fueling operations.

The same is true, but perhaps to a lesser extent, for CNG, LNG and propane ("autogas"). In many local municipalities, zoning officials simply do not have either clear rules, experience or models and examples to guide them in deciding whether fueling facilities that use these gaseous fuels should be permitted within retail commercial zones. This makes the development process involving these fuels cumbersome, unpredictable, time-consuming, potentially expensive and thus risky for both the fuel system developers and the local government officials.

Options for changes – effectiveness and feasibility:

Model zoning codes and approval processes might be developed to guide towns on the technical and performance standards under which fuel-dispensing equipment can be deployed without delays caused by exceptions, variances, ad-hoc restrictions, zoning ordinance modifications, local codes changes etc.

Recommendations:

See the recommendations under issues 1.12 and 1.13.

1.15 Due to lack of decision-maker familiarity with alternative fuels and fueling equipment, infrastructure permitting for these fuels usually becomes a time-consuming, one-off process. That adds cost and risk burdens to the development process in comparison to the more familiar gasoline and diesel fueling.

1.16 Local permitting and enforcement do not have "best practices" designs for alt fueling.

Explanation of these issues:

When approached from the perspective of permitting and codes, the key individual responsible for approval of fueling facilities siting and construction is known as the "AHJ" – the "authority having jurisdiction" -- usually the fire code inspector or codes enforcement officer (CEO). Alternative fuel facilities are new and relatively unfamiliar to many AHJs at the local level, so these local officials often feel the need to get detailed, one-off engineering analysis of system components and designs, sometimes requiring that design submissions include engineering drawings stamped by a professional engineer. This customized process increases the project cost, the risk that costs will increase, the risk that the project will be rejected and the developer's time and expenses for project preparation.

These obstacles are less common in the familiar realm of conventional gasoline and diesel fueling station siting, thus they create a barrier to alternative fuels expansion in comparison to conventional fuels.

Options for changes – effectiveness and feasibility:

This suggests creating relatively standardized fueling facilities specifications and best practices facilities design requirements for each fuel type – specifications that are easily accepted and permitted based on certified conformance to accepted best practices rather than time-consuming, expensive and risky project-by-project engineering analyses.

How can this be done and what entity might take on the task? Agencies of state government come to mind as entities to undertake this improvement, however that appears unlikely. Private, non-profit organizations can push for standardized facilities designs based on defined best practices keyed to each fuel type. This work would benefit all regions of North America – and beyond - not just the New England states.

To the extent that fueling system design standardization is happening, it is evolving within the firms that manufacture and sell or install the fueling equipment. This is driven by the simple need to reduce total-system costs for success in the competitive market.

Several direct stakeholders have the most to gain from fueling system design standardization based on defined best practices:

- The business development and lobbying organizations representing the fuel systems companies who manufacture, sell and/or deliver each of the alternative fuel/energy types – CNG, propane, LNG, hydrogen, bio-diesel and electric charging.
- Fueling station developers.
- Local and state government planning, permitting and code enforcement officials, and local municipalities.
- Private entities that develop and maintain the relevant codes and standards – National Fire Protection Association (NFPA), International Codes Council (ICC), National Assocation of State Fire Marshals, Society of Automotive Engineers (SAE), American Society of Mechanical Engineers (ASME), Underwriters Laboratories (UL) etc.
- Government agencies tasked with replacing gasoline and petroleum diesel vehicle fuels.

Recommendations:

A government entity, the U.S. Department of Energy Clean Cities program (sponsor of this research) has the scope and purpose to induce appropriate stakeholders (examples listed above) for production of standardized fueling facilities designs based on accepted standards and best practices keyed to each alternative fuel/energy type. The U.S. Department of Energy initiated work in 2012 to identify codes and standards obstacles to adoption of some vehicle alternative fuels – notably hydrogen. Sandia Labs has also undertaken some work in this area. The California Air Resources Board (CARB), The National Fire Protection Association (NFPA), Underwriters Laboratories (UL), or the International Codes Council (ICC) are other entities that might lead the process toward development of model regulations/ordinances. However, only Clean Cities and its parent

organization – USDoE, or Sandia Labs appear to have the scope of interest to push action on the full scope of zoning, land use, and fire and building codes for all six of the fuel types covered here.

Once initiated by Clean Cities, USDoE, or others, the process will likely evolve on its own for each of the fuel types. As alternative fuel technologies and economics change, some fuel types may advance rapidly in the marketplace while others decline. This will sort out the priorities for development of best practices and standardized facilities.

1.17 *In some localities officials choose to not adopt new versions of codes as the basis for review/permitting, and this suggests possible further involvement by state fire marshals.*

Explanation of this issue:

For propane and CNG (potentially for other gaseous fuels such as LNG and Hydrogen as well), some localities use older versions of codes and standards ostensibly out of concern that automatic adoption of updated codes & standards will add administrative burdens or because local officials are not convinced that a new standard is necessarily a valuable improvement. For example, states allegedly use outdated versions of NFPA 58, so some are using standards that are not based on current technologies and knowledge.

Options for changes – effectiveness and feasibility:

Further information is needed to determine which – if any - of the 5 project states require local authorities to adopt specific codes and standards versions related to fuel systems permitting. For each state, it should also be determined whether the State Fire Marshal – and other state-level permitting oversight agencies - require adoption of specific codes and code versions by municipal fire and code enforcement authorities. This information can be used to determine whether fueling facilities permit approvals (aside from zoning) can become the sole responsibility of state fire and health/safety authorities in cases where local agencies lack adoption of required codes and standards versions or where local officials lack the required level of training on the pertinent transportation fuel technologies.

Of course in New England, shifting authority from the local level to the state level - for virtually any issue - is generally resisted quite strongly.

Recommendations:

In states where the State Fire Marshal can preempt unprepared local authorities, and where the Fire Marshal has the authority to require adherence to specific codes and training levels by local AHJs, Fire Marshals should have the resources and authority to maintain updated versions of codes and standards required for local permitting and to maintain and enforce training requirements for local AHJ officials.

In states where the Fire Marshal does not have the power to preempt inadequate local permitting, legislatures should examine whether the state is prepared to adequately protect the public as new vehicle fueling and energy technologies come into the marketplace. This may reveal the need for changes in statutes specifying the responsibilities of Fire Marshals in some states. The process will also identify situations where new allocations of staff and funding are needed.

2: Permitting and regulatory issues specific to gaseous fuels

2.1 Streamlined permitting for fueling infrastructure

2.11 Variations in the physical properties of the many liquid and gaseous fuels are not always reflected in the criteria used by local municipalities for land-use, fire and environmental reviews & approvals of fueling facilities.

2.12 Propane fueling station developers in particular recommend state-issued model regulations for propane station approval based on relevant codes to prevent what they feel are arbitrary local government approval conditions not based in accepted codes and standards.

Explanation of these issues:

Permitting or zoning approvals sometimes put overly conservative restrictions onto fueling equipment layouts and operations in order to protect from risks when decisions lack information, knowledge or guidance. This adds delay, risk and expense to the infrastructure roll-out for alternative fuels.

As an example – natural gas (primarily methane), propane and hydrogen are all gaseous fuels but in leakage situations they behave entirely differently. Without updated codes-based local regulations and training, inappropriate, costly and potentially dangerous design requirements may be applied to these gaseous fueling facilities by local officials sometimes as a result of public hearing input that lacks familiarity with the differences among relatively new fuels.

At the national level, the propane (autogas) fuel system development industry has encountered propane-specific responses to fueling station development permits at the local level that they judge to be arbitrary requirements in conflict with what the industry considers reasonable fueling station layout standards in conformance with applicable standards such as NFPA 58. The propane industry feels that there often is no factual basis behind local authorities' distance requirements for placement of system components relative to one-another and relative to property boundaries.

Similar opinions are stated by the CNG developers and voiced as a concern by hydrogen fueling station development interests although the hydrogen developers have not yet had as much experience with the local permitting process.

Options for changes – effectiveness and feasibility:

The suggestion has been made that in order to enable efficient predictability for standardized alternative fuel station designs and to prevent what the industry feels are unnecessary, unsubstantiated and expensive permit specifications, states should issue required or model regulations for use by local authorities that are based on rigorous CNG, propane, LNG and hydrogen testing and analysis. Such analysis has been conducted, reviewed and vetted through the rigorous processes of the National Fire Prevention Association (NFPA) and other relevant standards organizations. It is also suggested that state rules be enacted to prevent local jurisdictions from imposing stricter restrictions when the AHJs are insufficiently trained on the varying characteristics of different gaseous fuels.

Recommendations:

Appropriate and sufficient for these issues are the options and recommendations cited for issues 1.12, 1.13, 1.15, 1.16 and 1.17.

2.13 *In the case of natural gas or propane, many local authorities' primary familiarity with these fuels is in the context of usage in homes and industry – not for dispensing to vehicles.*

Explanation of this issue:

As with many of the other issues cited here, this barrier is a function of newness and unfamiliarity with gaseous vehicle fuels, lack of available state and local funds and staff time for training on codes and for updating of permitting criteria based on evolving codes and standards, lack of standardized fueling system equipment and facilities configurations.

The history of inspection criteria for natural gas facilities has evolved in the context of gas usage in residential, commercial and industrial buildings, with equipment configurations and installations being handled by facilities professionals - licensed plumbers or employees of the local natural gas distribution company (NGDC). This means that codes enforcement is oriented toward buildings and non-public use – not toward vehicle fueling. This can result in codes administration and controls that do not fit the fuel dispensing situation, possibly allowing dangerous circumstances or, conversely, applying restrictions that unnecessarily hinder facilities development. This tends to also rule out self-service fueling by the public. (See issue 2.31)

Options for changes – effectiveness and feasibility:

Permitting process changes can be made to shift gaseous fueling facilities away from being treated as gas-handling industrial building permit issues and toward the same permitting treatment given to conventional gasoline or diesel fueling stations.

Once local permitting is sufficiently informed and trained to demand clear and consistent facilities configurations for alternative fuels – especially gaseous fuels - fueling station proposals should be treated with relatively straight-forward and standard procedures & criteria. For fuel types that thrive in the New England marketplace, this necessary transition should be able to happen smoothly. Those fuels (if any) that meet with less market acceptance will not matter.

Recommendations:

This report recommends measures for model ordinance development, training of local and state AHJs, and development of best-practices for standardized fueling systems. (See issues 1.12 – 1.16) These measures should include explicit treatment of gaseous fueling facilities as simply a variation of vehicle fueling based on gaseous materials as opposed to liquid gasoline and diesel fuel. However, this shift requires complete, updated and informed adoption of facility design and operation rules tested through the vetting process of the professional codes and standards organizations.

For a list of codes related to each of the alternative fuels, see Appendix 2. An initial task of the model ordinance development process will be to make this codes and standards list comprehensive for all alternative fuels active in the New England market.

2.14 *Because only a handful of commercial hydrogen fueling facilities have been built in New England, most local officials have not yet been faced with the need to understand hydrogen codes, physical properties, risks and differences from other gaseous and liquid fuels.*

Explanation of this issue:

The need for local officials training applies to propane, CNG and LNG as well as to hydrogen although for propane and CNG local codes enforcement and fire inspection personnel are likely to be more familiar with the pertinent codes and standards than is the case with hydrogen which is a rather new ballgame for both state fire marshals and local AHJs. (Also, the degree of local codes familiarity or training in LNG fueling system design specs, standards and codes is not clear.)

Hydrogen's present regulation situation is largely in the realm of industrial gases and industrial operations. Retail fueling systems for hydrogen use technologies that are very different from industrial gas handling, and codes are being evolved to handle such retail dispensing systems, but those codes and related inspection/approval methods have not been explained to most code enforcement personnel.

NFPA 2, 50 A&B, 400 & 495 and others (ASME, CGA, IFC, SAE etc.) collectively form a basis for hydrogen fueling facility approvals by local fire and codes authorities. However, most local codes and fire inspection departments & personnel have not been given any comprehensive process or criteria to follow nor have they been trained on how to apply this series of codes and standards for quick and confident approvals.

A guide to hydrogen fueling station design and inspection is needed from the H2USA program (Fuel Cell and Hydrogen Energy Association) along with a training program on that system for local codes personnel throughout New England (and throughout the U.S.) The U.S. northeast including southern New England) is evolving as the second U.S. market focus area for the initial generation of mass-produced fuel cell cars from OEMs such as Toyota and Hyundai. Therefore, model ordinances (see issues 1.12 and 1.13) and related training for hydrogen are important for New England.

Recommendations:

The clear option for this issue is comprehensive compilation of accepted rules for hydrogen fueling facilities plus incorporation of those rules into state-level standards for state and local fire, building code, environmental and land-use controls. This also requires that the training programs for local officials (see issues 1.12-1.13) cover all hydrogen fueling equipment configurations including those with piped-in or trucked-in hydrogen as well as systems with on-site processing for hydrogen production from methane or water plus on-site hydrogen purification and compression.

2.2 Regulatory barriers – alternative fuel vehicle infrastructure

2.21 *Unlike gasoline and diesel fueling or electric charging, dispensing systems for gaseous alternative fuels such as CNG, LNG and hydrogen can involve on-site processing at the dispensing site causing facilities permitting for these fuels to be treated more like industrial process facilities than retail vending operations.*

Explanation of this issue:

CNG fueling and hydrogen fueling both can involve significant processing of the fuel substance at the dispensing facility site. This is a very different situation from conventional gasoline/diesel fueling where no on-site fuel processing is involved. (LNG fueling stations generally include above-ground storage tanks, fuel unloading equipment, pumps and heat-exchangers, but on-site processing is minimal.)

In the case of CNG, this on-site processing can include removal of moisture and gas compression. With hydrogen, on-site processes can include either hydrogen extraction from natural gas (methane gas reformation) or hydrogen extraction from water using electrolysis (electric power) or using other water-splitting processes with energy inputs. Hydrogen fueling may include gas compression and possibly purification of the hydrogen at the dispensing site as well.

These factors cause CNG and hydrogen fueling facilities proposals in some municipalities to be treated by local construction code and fire inspections permitting as industrial production facilities and not just as retail fuel dispensing operations. This is due to the habits of permitting process, real or perceived risk, or noise and visual impacts from relatively large volumes of on-site equipment. In

some cities and towns this impacts the permitting process, the design and operational requirements imposed by officials, facility costs and project timing.

Compressed natural gas (CNG) dispensing facilities that are connected directly to the natural gas grid for their gas supply usually require some "processing" at the dispensing site to remove water (and other impurities?) and to pressurize the CNG to between 3000 psi and 3600 psi. This "processing" involves operation of compression and drying machinery. This creates noise that may be considered more disruptive to adjacent communities than is the case with conventional gas/diesel fueling station equipment.

With or without specific regulations for noise limits in local zoning/permitting regulations, noise from CNG operations frequently becomes an issue for CNG facilities permitting. CNG facilities installers say that measures can be taken to deal with the noise situation in locations where it creates an unacceptable disturbance. The public (or public officials) may become opposed to CNG fueling systems based on noise -- or the public may use the noise issue as the ostensible basis for opposition which is actually based on other concerns that have less legal standing in the regulatory codes.

Options for changes – effectiveness and feasibility:

Specific noise-level regulations and noise mitigation measures and aesthetic/visual impact rules can be developed as siting/operational requirements in the model ordinance provisions covering CNG and hydrogen facilities (See issue 1.11). Specific noise and aesthetic impact rules should be keyed to on-site “processing” of gaseous fuels – CNG and hydrogen. Specific guidelines or standards do not seem to be currently available for hydrogen fueling when gas reformation or electrolysis is performed at the dispensing station site.

As CNG and hydrogen station designs and equipment configurations are standardized around best practices (see issues 1.15 and 1.16) model standards and design codes can be developed that require engineering changes and/or performance standards that eliminate this problem.

As new fueling technologies evolve that include chemical, mechanical and/or electrical processing at the dispensing system site, permitting criteria need to be updated to require acceptable operation of these facilities using predictable rules. These updates can use the knowledge-base of codes and standards for such processing in industrial facilities, but with an awareness that on-site "processing" of vehicle fuel is scaled far below the levels of processing in industrial plants, and must be treated in a manner that makes gaseous fuels permitting as simple and predictable as permitting for gasoline or diesel stations.

Recommendations:

1. Conduct further research to determine the extent to which NFPA and International Codes Council (ICC) accepted standards exist for noise, fumes, light, vibration and other environmental impacts from on-site processing of gaseous fuel materials specifically at CNG and hydrogen – and possibly LNG and propane – vehicle fueling facilities.

2. As part of state-level, regional-wide or national programs to develop model codes streamlining alternative fuel permitting (see issues 1.11, 1.12 and 1.13), specific rules must be included to control impacts from on-site fuel processing. If the standards base for these rules is not available from the codes & standards organizations, the state model ordinance committees (see issue 1.11) and the gaseous vehicle fuel industry organizations (e.g. Natural Gas Vehicles for America and H2USA) should get the codes organizations (NFPA, ICC and others) to finalize such standards for direct use in local and state permitting nationwide.

2.22 *Gaseous hydrocarbon alternative fuels are, in some cases, treated as "hazardous materials", perhaps making infrastructure development approvals more cumbersome than necessary.*

Explanation of this issue:

Partly for historical reasons, some gaseous hydrocarbons are treated in local ordinance and regulations as "hazardous material" industrial materials requiring exemptions from hazardous material control regulations when used for vehicle fuels. Hazardous material (HazMat) risk factors are related to fire, explosion, toxicity and environmental pollution. CNG and propane fuels are, in some cases, treated as hazardous material, triggering process and equipment requirements that are more expensive than is the case for gasoline fueling although gasoline may actually have equivalent or greater hazards and risks that have become accepted through years of familiar use. Controls on the use of these materials for vehicle fueling may be more restrictive than is justified by risk analysis relative to gasoline.

This project's research has discovered that some local fire, building and zoning/land-use ordinances or regulations defer to federal hazardous material rules to protect the municipalities from legal risk in handling some fuel materials. This is a logical response to situations where codes and standards have either not been fully developed or not effectively promulgated to cover use of these materials in vehicle fueling equipment.

Options for changes – effectiveness and feasibility:

It should be determined how common it is in the New England region to treat CNG, LNG, propane or hydrogen vehicle fuels as hazardous materials at the point of dispensing and storage.

1. Where this is the case, what is the basis for hazardous designation?
2. Do these gaseous fuels constitute more of a hazardous situation than gasoline or diesel fuel?
3. Have codes governing the storage and dispensing of these gaseous fuels been sufficiently updated to enable local officials to change permitting criteria with adequate risk protection to their communities?

Answers to these questions should indicate whether industry codes and standards – and local government permitting regulations - should be revised to deal with these fuels in a manner that is more consistent with their actual risk factors.

Recommendations:

The New England states Clean Cities programs might undertake a sample survey of local permitting regulations and ordinances to address the questions listed above. Depending on the findings, changes may be considered so gaseous fuels fueling facilities can be permitted for construction and operation under terms that are consistent with actual risk. Such changes should be incorporated into the model codes recommended by this project.

2.23 *Building codes and the related approval/inspection procedures are sometimes applied to gaseous fueling system applications when no buildings are involved.*

2.24 *As opposed to building permits, construction permits may, in some cases, be a better tool and process for initial permitting point of contact, but does the "construction permit" exist in most towns?*

Explanation of these issues:

Gaseous fuel infrastructure developers encounter situations where their facilities get initial review by the local "authority having jurisdiction" (AHJ) under "building code" requirements when there is no "building" involved. This reportedly adds expensive and time-consuming complexity that is viewed by the alternative fuel facilities industry as unnecessary and irrelevant to the issues at hand.

Compared to approval processes for conventional gasoline and diesel fueling stations, permitting approvals for alternative fuel facilities are felt to be burdened by the need for additional design work and documentation. On the other hand, gasoline permitting criteria are felt to be applied to alternative fuels out of familiar habit on the part of reviewing authorities when some of these criteria are unnecessary or inappropriate to the alternative fuels.

Options for changes – effectiveness and feasibility:

This issue needs clarification regarding the generally-accepted definition of a "building" that requires building code approval --

- What is the generally-accepted definition of "building" requiring building code approval?
- How is a gasoline station now reviewed at the local level if it is fueling facilities only -- with no "building"?
- Does this differ from state to state?
- Is this legal and appropriate or should it be challenged?
- If it is concluded that building permits do not apply to fueling facilities when no buildings are involved, are construction permits the appropriate tools to initiate local review – as is done in Vermont, or is fire code review by the local fire department the most appropriate first point of contact for project permitting?

Should the actual building associated with a fueling station (convenience store and rest room facility for example) come under the "building code" rules while stand-alone fueling, fuel storage and processing facilities are dealt with by fire, electrical, plumbing and zoning codes? Local authorities seem to make the most efficient permitting of such facilities by coordinating the overall project review through planning department staff with input by the building inspector, fire department and code enforcement officer

If local authorities can have a continuously updated guidebook and associated training program for local approvals of all transportation fuels infrastructure, development of alternative fuel facilities should become faster, less expensive and more predictable. However, that will also complicate the jobs of local permitting officials. How can these changes be made so the benefits more than offset the complications and costs to permitting authorities?

Some towns in Vermont use construction permits in addition to building permits and apply the construction permit review to developments which do not include enclosed buildings. This concept might be considered as part of the model ordinance and codes development to enable fueling facilities permitting to be focused on only the factors that are relevant.

Recommendations:

This issue suggests the need for model construction permit terms and standards to be presented to the New England communities as an option for more efficient regulation of non-building construction in general – not just fueling facilities. Because a construction permit covers a much wider range of facilities than just fueling stations, it should be prepared with a wider input than just the fueling facilities issues discussed here. Statewide municipal government organizations should assist in this process -- Municipal Associations in Maine, Massachusetts and New Hampshire, Leagues of Cities and Towns in Rhode Island and Vermont.

2.3 Remove barriers to fueling station operation

2.31 *For reasons that vary by fuel and by state, alternative fuels may not be allowed to be dispensed by the "public" -- i.e., by vehicle owners and drivers.*

Explanation of this issue:

It appears that in at least some of the project states it is not possible under state gaseous materials handling regulations to establish CNG or propane fueling facilities that enable customer or driver self-service operation. For example, in Maine, the dispensing of propane for vehicle fuel is treated by state regulations the same as filling of propane tanks for home heating or filling grill tanks. The filling process must be conducted by a trained employee of the gas-dispensing entity. Currently, CNG fueling tends to be for fleets at private facilities where public self-serve operations may not be a major issue. However, if hydrogen, a gaseous fuel, is treated by state regulators as requiring dispensing by trained employees, that will be a significant obstacle to the envisioned roll-out of simple, public-use hydrogen fueling.

It is perceived in the propane and CNG fueling industries that public self-service fueling will NEVER fly with most local fire codes officials.

Options for changes – effectiveness and feasibility:

This issue raises questions that should be addressed:

1. How does the true risk here compare with the true risk with gasoline/diesel?
2. How does the insurance industry view the risks associated with public self-service fueling with gaseous fuels?
3. Is the problem due to a history of acceptance of gasoline as a public-use fuel vs treatment of gaseous fuels as industrial substances?
4. Going forward, can this be changed by some objective research followed by codes review and code enforcement personnel training?
5. If hydrogen fueling evolves more into the public fueling realm, will local codes enforcement for hydrogen fueling stations react negatively to approval of fueling stations using self-service?
6. If CNG, LNG and propane remain primarily in the fleet and truck markets is self-service fueling unimportant with these fuels?

If self-service is deemed by the marketplace to be the desirable or required fueling method - for reasons of customer convenience or operational cost - restricting fueling to trained employees may be an obstacle to increased gaseous fuel usage (CNG, LNG, propane and hydrogen).

Recommendations:

Clarification is needed re. whether and how this issue applies to each of the 5 states and each of the 5 energy sources ("fuels"). Once the nature and scope of this issue are clarified for each fuel and state, recommendations may be needed to determine -- first, whether it makes safety and operational sense to enable self-service public fueling for each fuel – both at the fleet and public fueling levels - and secondly, what (if any) measures should be taken to enable self-service for each gaseous fuel in a safe and convenient manner.

2.32 *Public response to propane and CNG (and LNG and hydrogen?) fueling facilities in some cases focuses on visual aesthetic impacts when objections are actually rooted in general public discomfort with new and relatively unfamiliar fuel types in local communities.*

Explanation of this issue:

Both propane and CNG developers report that the public's lack of familiarity with gaseous fueling equipment results in these facilities sometimes being obstructed based on aesthetic impacts -- visible tanks, pipes and fixtures - compared to gas stations and other developments that have become accepted with time.

Options for changes – effectiveness and feasibility:

A solution might be to produce best practices design, layout, installation and operation standards and associated model codes that minimize unsightliness, enabling such facilities to be located where conventional fueling facilities would be deemed acceptable.

Recommendations:

Model codes for local regulation of vehicle alternative fuel dispensing facilities (see issue 1.11) should include clear and predictable requirements for aesthetic impacts – based on best practices facilities designs for each fuel type.

2.33 *The public has become comfortable with unseen underground fuel tanks with gasoline stations. Above-ground tanks for alternative fuels draw opposition based on aesthetic objections and perceived safety risk.*

Explanation of this issue:

Local permitting and zoning land-use approval procedures often involve public hearings or input. The public has come to accept fueling stations with unseen, underground fuel storage tanks. For various reasons (expense, permanence, permitting problems, fire codes) fleet-owned, behind-the-fence propane, CNG, LNG and hydrogen fueling facilities and associated compression/conversion equipment have tended to be installed above ground. As these fuels move into public, retail markets in more publicly-visible locations, above-ground tank and piping facilities are being resisted by public response. Underground tank locations and/or visibility screening walls (built to fire/explosion protection standards?) are required in some cases - at higher costs to the developer. This situation tends to make each installation become a custom design job with numerous reviews and modifications – ostensibly more than is the norm for gasoline/diesel stations.

Options for changes – effectiveness and feasibility:

Cost, safety and regulatory factors ostensibly limit or prohibit underground storage for CNG, propane, LNG and hydrogen. This project has not researched the details of these limiting regulatory factors which must be different for each of these gaseous fuels. Thus it is not clear, for each of these fuels, whether underground storage is currently a feasible and accepted option or conversely whether emerging storage technologies show promise for safe and legal underground storage of any of these fuels at either public or restricted dispensing facilities. If such storage can be made feasible – and acceptable to informed permitting officials – a significant aesthetic impact obstacle might be removed for gaseous fuel dispensing facilities.

Unlike gaseous fuels, biodiesel is sufficiently similar to conventional diesel in chemical properties that it can generally be permitted for underground storage the same as conventional diesel fuel.

Recommendations:

Best practices design models coupled with model codes may be the solution here. This requires examination of the specific fire and safety codes to summarize exactly what, if any, underground storage is allowable for CNG, LNG, propane and hydrogen. This research should also clarify whether emerging storage technologies are being developed and examined by the codes and standards to offer feasible underground storage of these fuels in the future. Regardless of whether such storage methods are currently feasible, training for codes officials should include information updates on the engineering and regulatory prospects for underground storage of these fuels.

2.34 *Unlike gasoline and diesel, gaseous fuels do not leach damaging liquid hydrocarbons into soil and water resources. Approval criteria and processes should recognize this difference and be modified accordingly.*

Explanation of this issue:

When an issue comes up suggesting underground installation of fuel storage tanks, in most states this issue involves permitting by an entity different from (or in addition to) the local building and fire codes review process. Usually this permitting is done by an environmental, water and natural resource protection and/or public health agency at the state level. This is because underground tank fuel storage has historically been an issue involving gasoline and diesel fuel (in some cases with toxic additives such as MBTE) plus ethanol. Such liquid fuels create issues of fuel-substance leakage and resulting soil and groundwater contamination - a major problem in the past, and one that tends to fit within the jurisdiction of state environmental and public health entities.

By comparison to liquid fuels, underground and above-ground tank storage of gaseous fuels is more strictly an issue of safety and air quality - rather than an issue of groundwater/soil, wetlands or surface water contamination, .

Options for changes – effectiveness and feasibility:

Local land use permitting for fueling facilities generally involves the town or city planning board, zoning board of appeals, code enforcement office and building inspector and the fire department whose approval of design, engineering and operations is usually required by the planning board and the building inspector. Sometimes the Conservation Commission is asked to weigh in on the permitting decision. The state environmental protection and natural resource protection functions come into play with respect to air (non-recovered vapor) emissions and fuel spills, surface runoff & infiltration and potential leakage from underground tanks.

The challenge is to replace irrelevant portions of this review process by a single, simpler and faster review for all fuel dispensing facilities, and including permitting terms for gaseous fuels that exclude surface and groundwater impacts that are irrelevant to gaseous fuels.

National-scope organizations dealing with groundwater and soil protection may have developed guidelines for the states on adjusting their rules for gaseous fuels. Current status of laws/regulations needs to be determined for each of the 5 New England states. In each state, it is necessary to determine whether underground tank permitting for gaseous fuels simply follows liquid fuels criteria and whether such soil-water protection permitting has been adjusted - or dropped completely - for gaseous fuels. This project has not examined the details of those rules in each state.

Recommendations:

Determine the current details of groundwater and soils contamination prevention laws and regulations in each state – specifically whether gaseous vehicle fuels come explicitly under the same rules as gasoline and diesel, or whether the rules deal with gaseous fuels in a manner consistent with their chemical and risk realities. Any changes in these rules to accommodate gaseous fuels must be largely a function of legislated adjustments to state laws and approved changes to administrative regulations in each state.

If change to some states' rules is called for, such changes should be developed based on what successful states have done and what national standards organizations have determined to be appropriate rules for the gaseous fuels storage and soils/groundwater impacts. A single model statute and accompanying administrative regulations for state-level permitting should be suggested for tailoring by each of the five project states.

2.4 Codes and standards – Alternative fueling infrastructure

2.41 *With respect to fire suppression requirements, there are contentions that the regulations should be different and in some respects more stringent for gasoline in comparison to CNG.*

Explanation of this issue:

Compressed Natural Gas (CNG) fueling installations have had experiences where fire suppression facilities requirements were less extensive with CNG than for gasoline. This would not have been the case unless decision-makers felt that data and standards substantiate a different and perhaps lower risk fire hazard with CNG dispensing than is the case for gasoline facilities. It is not clear to all local permitting authorities whether such differences are backed up by research and standards tested and supported by the National Fire Protection Association (NFPA).

Similar issues are beginning to show up with respect to the fire suppression equipment required for LNG, propane and hydrogen fueling facilities and to some extent for level-3 and other high-speed technologies for electric vehicle charging.

Options for changes – effectiveness and feasibility:

If the NFPA supports different fire suppression equipment requirements for CNG fueling vs gasoline/diesel, most local ordinances do not yet reflect such a difference. It is clear that New

England local permitting officials - except perhaps a minority who have dealt with real CNG facilities proposals - are not yet comfortable with making such changes to permitting standards for gaseous and electric alternatives to gasoline & diesel fueling.

Without clear, highly credible and NFPA-backed content, local officials will not put their towns into a perceived risk situation with such changes. Furthermore, justification for different risk calculations have clearly not been accepted by the insurance industry (see issues 8.11 - 8.14).

Recommendations:

It is clear from discussions with NFPA that differences in facilities design/layout and operational standards are necessary based on the NFPA's own codes that obviously recognize different fuel material behaviors. However, these codes have not generally been communicated and translated into permitting criteria at the local level – accept where one-off exceptions have been applied in the few communities where CNG facilities have been built.

It is suggested that a New England gaseous fuels task force be encouraged by the state Clean Cities programs and by the 5 state fire marshals, to give local officials in the region a comprehensive manual for developing local fire prevention & suppression regulations that distinguish fueling station fire protection requirements for gasoline, diesel, biodiesel, CNG, LNG, propane, hydrogen and electric charging. Other North American states have made more progress on this issue than is evident in New England – notably California and Ontario. Those and other regions should be consulted to learn from their “homework” on this issue with NFPA.

2.42 *Equipment is being introduced to the market for compressing natural gas and fueling vehicles in homes. Approval authority and processes, standards and codes for installation of this equipment are not clear for homeowners and building construction/renovation contractors.*

Explanation of this issue:

This is a very small market, and it is questionable whether it will grow into a very significant component of the public's vehicle fueling. However, with technologies in alternative fueling, vehicle designs and energy economics evolving rapidly, it should certainly not be ruled out.

CNG and electric vehicle charging change the vehicle "fueling" paradigm by shifting the fueling infrastructure - to some degree - away from centralized commercial facilities to decentralized CNG fueling and electric charging at homes or at employment locations. This is because electric power and CNG are available on a far more distributed basis than other fuels that have to be trucked to fueling sites.

If home fueling becomes significant for CNG, it will bring the home component of the natural gas distribution infrastructure into fuel facilities regulations. This constitutes a new piece of equipment connected to home natural gas supply system. Fire and building codes at the residential level come

into play with such installations. Gas connection code conformance is clearly necessary on the part of the installer.

With respect to home fueling with CNG, at least 4 US companies (Go Natural, General Electric, Whirlpool, Eaton) are developing and marketing equipment products for home use that compress and dispense CNG from the home natural gas line into a vehicle tank. These products are attracting interest from natural gas retail utilities -- local gas distribution companies or LDCs -- that have millions of customers, including Questar Corp in Utah and AGL Resources Inc. in Georgia.

Options for changes – effectiveness and feasibility:

Installers and local codes generally are not at all familiar with this equipment. If/when these technologies become a factor in New England, there will be a need to add permitting criteria and standards to local codes procedures as well as local code enforcement training for successful installation, operation and safety with these systems.

Recommendations:

The best course of action on this issue is simply to monitor the evolution and market acceptance of home fueling technologies for gaseous fuels and see if enough market demand develops to suggest any need for changes.

3: Permitting and regulatory issues specific to electric vehicle charging

3.1 Streamlined permitting for fueling (and charging) infrastructure

3.11 A large amount of charging station electrical services will be needed to energize the volume of PEVs required to make significant energy and environmental impacts. The current population of power service and equipment installers do not have sufficiently clear instructions on how to install this equipment according to the confusing range of relevant codes, standards and local regulations.

Explanation of this issue:

The general term for electric vehicle recharging station equipment is EVSE – “electric vehicle services equipment”.

In order for plug-in, rechargeable battery electric vehicles to make significant market penetration in the U.S. -- and to make significant impacts on fuel usage and the environment -- the number of required charging or EVSE locations, based on present technology, will be many times larger than for the other fuels covered by this project, but with lower equipment costs and lower impacts per facility. A very significant roll-out of EVSE technologies would affect virtually all communities in New England because the charging facilities will be almost ubiquitous, not just located at traffic centers or in areas of commercial activity.

Most communities see the permitting process for electric vehicle charging as being one of deciding on specific locations for charging followed by relatively conventional electric code inspections for approval of installations. At present levels of market penetration, this appears to suffice for the time being. If market penetration evolves as many people hope, this planning/approval system will probably become inadequate to handle the volume of change.

California has envisioned this change and is planning to handle it. Few other states are prepared. In the 5-state project area, Rhode Island and Massachusetts appear to be moving ahead on these issues whereas Maine and New Hampshire are lagging, and Vermont is somewhat in the middle.

Article 625 in the National Electric Code (NEC) covers Electric Vehicle Charging Systems. Without better guidance, EV equipment installers and some local building officials appear likely to interpret article 625 in ways that will create unnecessary problems for homeowners, PEV owners and the electricians installing dedicated power service and equipment for vehicle charging. Some local jurisdictions have not yet adopted the latest version of the National Electric Code, thus they are probably missing components of the code that pertain to recent advances in electric vehicle charging and power supply technologies.

Relevant sections in the NEC include 625.4, 625.9, 625.13, 625.25 652.26. The NEC is nation-wide, so its application to both home and business installations will be very significant. Also, UL listed electric vehicle charging equipment is covered by two categories – UL category FFWA (electric vehicle supply equipment) that is evaluated to UL 2594 and UL category FFTG (electric vehicle charging system equipment) that is evaluated to UL 2202.

UL category FFWA will cover a majority of the new installations being installed at dwellings and at retail, commercial and employment facilities. Electric vehicle supply equipment typically covered by this category will include primarily level 1 and level 2 charging systems.

UL category FFTG covers the installation of level 3 charging systems, or what the industry is calling DC Fast Chargers because unlike most level 1 and level 2 power connection technologies, the DC Fast Charge systems do more than just supply electric power to the vehicle's on-board charger/inverter. The level 3 (DC Fast Charge) charging equipment includes both power supply and the charging function. Level 3 bypasses the PEV's on-board charger, and feeds power directly to the vehicle's batteries. This may add a degree of complexity to local electrical codes enforcement.

Local codes officials in most states have not put the study of this information into their priorities – for good reason. Widespread roll-out of EVSE charging equipment has not yet appeared imminent. This may change quickly. Also, because of the rapid changes occurring in these technologies, this adoption delay can either delay permitting or risk improper installations.

Recommendations:

This all suggests the need for a permitting and installation manual of clear and consolidated instructions on how to install level 2 and level 3 power supply and charging equipment according to the confusing and wide-ranging combination of relevant codes and standards.

This also suggests the need for a continuing system of technical and process feed-back from local and state officials throughout the U.S. back to the National Electrical Code and UL for continuous process improvement if/when large volumes of recharging stations become necessary. The five project states (MA, ME, NH, RI and VT), the municipal associations or leagues of cities and towns in the states and the five state clean cities programs should very actively engage in the evolution of these codes so electric vehicles can be accommodated quickly in the region with public interests fully protected.

3.12 *Local government can plan better and adjust zoning and permitting to enable communities to accommodate demand for ZEV charging (PEV) and fueling (hydrogen) stations.*

Explanation of this issue:

From the California Zero Emissions Vehicle (ZEV) program: “There are numerous actions that local governments can take to become plug-in electric vehicle (PEV) ready. Identifying what amount and type of publicly available charging stations are needed. Establishing zoning and code requirements that enable ZEV driving and parking. Improving permitting for charging stations. Coordinating with the local utility" -- i.e., developing local policies to enable access to and use of charging equipment. The 5 New England states covered by this project have acted at different levels toward accomplishing objectives such as these. MA and RI have significant programs to facilitate local planning. VT has begun an initiative with state-level policy. NH and ME have accomplished less in the way of guidance for local governments in EVSE planning.

Options for changes – effectiveness and feasibility:

A simple but effective starting point for reference by the 5 project states is the “California 2013 ZEV Action Plan - A roadmap toward 1.5 million zero-emission vehicles on California roadways by 2025”. February, 2013, First Edition - Office of Governor Edmund G. Brown Jr.

The California ZEV Action Plan was developed by the California Governor’s Interagency Working Group on Zero-emission Vehicles --

California Air Resources Board (CARB),
California Department of Food and Agriculture including the Division of Measurement Standards, (CDFA) California Department of Transportation (Caltrans),
California Energy Commission (CEC),
California Housing and Community Development Department (HCD),
California Independent System Operator (CAISO),
California Labor and Workforce Development Agency, including the Employment Training Panel (ETP),
California Public Utilities Commission (CPUC),

Department of General Services (DGS), including the Division of the State Architect (DSA) and Building Standards Commission (BSC),
Governor's Office of Business and Economic Development (GO-Biz),
Governor's Office of Planning and Research (OPR)

(Electronic version of the report is available at www.opr.ca.gov)

Recommendations:

The California ZEV Action Plan is an excellent template for state-level guidance of local community planning to accommodate plug-in battery electric vehicle charging equipment – electric vehicle service equipment (EVSE). The state-level energy office in each of the project states should use the California plan as the basis for proposing or adopting guidance programs and recommended state and local measures to facilitate EVSE installation. Although not fully appropriate for direct adoption by New England states, the California plan – and the entities comprising the CA Interagency ZEV working group – enable each state to start the planning process, using rather than duplicating California's work.

Depending on the circumstances of each state, the process might be initiated by non-governmental entities supporting alternative vehicle energy and clean air, by Clean Cities entities in each state, but the Governor's Office or energy office or by the state's Municipal Association or League of Cities and Towns. Lacking immediate need for action, government agencies generally need the action incentive to be applied by either an elected official such as the governor or by a power-positioned NGO or environmental interest group.

3.2 Codes and Standards – Alternative Fueling (charging) Infrastructure

3.21 *Updates may be needed to the National Electric Code (*ANSI/NFPA 70*) to accommodate rapid development/installation of level 2 and level 3 (DC fast charge) vehicle charging.*

Explanation of this issue:

Level 3 (DC fast charging) Plug-in Electric Vehicle (PEV) and Plug-in Hybrid Electric Vehicle (PHEV) charging stations are in the early stage of roll-out. Changes to codes for power connections and operations of both level 2 and level 3 charging stations are evolving.

On October 11, 2011, the Fire Protection Research Foundation (FPRF) published a study done by California Polytechnic State University that recommended filling regulatory gaps in NFPA 70 and 70E to assist in regulating electric vehicle recharging. (See pages 19 through 23 in http://www.nfpa.org/~/media/Files/Research/Research%20Foundation/rfevcharging.pdf .

In this report, specific suggestions for changes were made by the FPRF to the National Fire Protection Association (NFPA) . Most of the suggestions were small changes but with potentially significant impacts on power circuit performance and the potential to use electric vehicles as electric

storage devices and as electricity supply sources within a smart grid arrangement. It is unclear whether the recommended changes have been finalized, communicated successfully to local officials, accepted for guidance of EVSE installations and adopted by state public utilities regulatory entities for guidance of power distribution utilities' grid upgrades.

With respect to level 3 charging, there reportedly is a deficiency of clearly defined procedures for presenting level 3 charging station plans to relevant power distribution/delivery utilities to enable the utility to assess the need for power system upgrades to handle the high Wattage and 3-phase power requirements at proposed sites. The states of Rhode Island and Massachusetts have initiated projects to establish clear steps for level 2 and level 3 charging station review by the power distribution utilities. Status in the other 3 project states is less clear.

Co-location of electric vehicle charging station equipment with gaseous or liquid (gasoline, diesel) fueling equipment raises the issue of “hazardous location” (HAZLOC) circumstances where locally approved fueling equipment layouts and spacing must prevent the possibility of gas or vapor explosions caused by electric arcing. This would be most relevant for level 3 electric vehicle charging equipment which is likely to be located at existing fueling stations or other sites where other vehicle fuels (gaseous and/or liquid) are dispensed.

The National Electrical Code (NEC) includes provisions for preventing ignition hazards from electrical installations, however, it is clear that most local fire officials do not have experience with permitting criteria for level 3 electric vehicle charging facilities co-located with gaseous and liquid fueling operations.

Options for changes – effectiveness and feasibility:

At the time that research was being conducted for this report, (spring 2014) the NFPA had not fully adopted National Electric Code standards to cover level 2 and level 3 charging.

Relevant questions are:

1. Did NFPA fill the gaps either as recommended in the FPRF report or in some other fashion?
2. If not, are such modifications to these codes under active consideration by NFPA?
3. If these changes have not been made, is it nevertheless possible to show a state fire marshal that there is an existing NFPA standard that would effectively and efficiently control the installation of level 3 charging stations?

Recommendations:

In order to be prepared for Level 3 charging facility proposals, local fire codes should be updated reflect the new electric vehicle charging specifications when they are added to the National Electrical Code (NEC) by the National Fire Protection Association (NFPA) and the American National Standards Institute (ANSI).

NFPA training programs for Fire Marshals in each of the project states should include updated information regarding the NEC changes made in response to the FPRF 2011 report cited above.

Specific training should prepare local fire officials to confidently control level 3 electrical charging station layouts and installations, especially when such charging equipment is co-located with dispensing equipment for gaseous or liquid vehicle fuels.

3.22 *Building codes have not evolved to fully handle electrical system requirements associated with installation of level 2 PEV charging systems in homes and businesses.*

Explanation of this issue:

From the state of California's Zero Emissions Vehicle Guidebook section on installation of public and privately owned electric charging infrastructure for PEVs --

"Building codes related to PEVs also can provide guidance on the following issues: The number of circuits needed and service panel requirements, placement of electric meters, sourcing of electricity for on-street and lot parking, the impact of charging infrastructure on building electrical loads and local electrical distribution, allocation and sizing of parking spaces to accommodate charging infrastructure, and compliance with the Americans with Disabilities Act (ADA)" (See California ZEV Guidebook, "Access to PEV Charging" for more information.

Building inspectors in New England would be well served for dealing with Level 2 vehicle charging station installations – in both residential and commercial settings – by incorporating specifications for these installation issues within local building codes. Standard building codes – such as the International Building Code model codes (International Code Council - ICC) form the basis for most local building codes in the 5 project states.

Options for changes – effectiveness and feasibility:

Clarification is needed regarding the International Code Council's (ICC) status in incorporating standards for electric vehicle charging station installations as outlined in the California ZEV Guidebook. Centralized development of such standards by the ICC – perhaps induced by the state of California – would make such standards available to all U.S. States more efficiently than separate building code enhancements by each state.

Recommendations:

Followup is recommended to determine how much progress has been made by the state of California and the International Code Council toward incorporating detailed specifications for Electric Vehicle Services Equipment (EVSE) installation into ICC building codes used by state and local building codes in the U.S. The New England states, together with California, can encourage completion of these codes enhancements by the ICC.

The issue of Level 2 charging equipment in commercial and residential properties appears less urgent than installation issues for Level 3 DC Fast Charging as installers are comfortable in treating Level 2 systems much the same as other, more routine 240-volt equipment installations.

4: Equipment and facilities codes, standards and regulations

4.1 Remove barriers to fueling station operation

4.11 *Diesel exhaust fluid is a new substance in diesel fueling station design and permitting, and it may add complexity to the process – the implications for biodiesel are not clear.*

Explanation of this issue:

A recently introduced factor in the design and permitting of diesel fueling facilities is the need to accommodate “diesel exhaust fluid” (DEF) -- an aqueous urea fluid catalyst injected into the exhaust stream of diesel engines to produce ammonia which cleanses the diesel exhaust of nitrous oxide pollutants - NOx.

In 2010 the U.S. Environmental Protection Agency (EPA) updated vehiucle emissions standards requiring reduced nitrous oxide (NOx) and particulates emissions from diesel-powered vehicles. Since 2010, Selective Catalytic Reduction (SCR) has been incorporated into vehicle designs by many diesel vehicle manufacturers to meet the 2010 standards in new diesel trucks, vans and SUVs. Diesel exhaust fluid (DEF) is used with the SCR system to achieve emissions requirements. This requires a relatively small onboard DEF tank that must be filled periodically.

Diesel Exhaust Fluid (DEF), commonly referred to as AdBlue and standardized as ISO 22241 is an Aqueous Urea Solution made with 32.5% high-purity urea (AUS 32) and 67.5% de-ionized water. German Association of the Automotive Industry (VDA) controls the "AdBlue" trademark and uses it to ensure quality standards are maintained in accordance with DIN 70070 and ISO 22241 specifications.

Diesel engines run with a lean burn air-to-fuel ratio to ensure the full combustion of soot and prevent unburnt fuel from being exhausted. The excess of oxygen necessarily leads to generation of nitrogen oxides (NOx), which are harmful pollutants, from the nitrogen in the air. Diesel exhaust fluid (from a separate, on-board DEF tank) is injected into the vehicle's exhaust stream, and the aqueous urea vaporizes and decomposes to form ammonia and carbon dioxide. Within the SCR catalyst, the NOx are catalytically reduced by the ammonia (NH_3) into water (H_2O) and nitrogen (N_2), which are both harmless and are released through the exhaust.

The urea solution is clear, non-toxic and safe to handle. However, it can corrode some metals and so must be stored and transported carefully.

The injection rate depends on the specific after-treatment system, but is typically 2-6% of consumption volume. The rate at which the DEF is applied to the exhaust stream is quite low meaning rather long intervals between fluid refills and small tank size.

As of 2014, a number of truck stops were beginning to add DEF pumps, in which diesel exhaust fluid is dispensed similar to pumping diesel fuel, with the DEF pumps located adjacent to fuel pumps. Although not toxic, DEF can cause very harmful de-oxidation of water bodies leading to damage of the aquatic environment with possible groundwater and soil pollution implications.

Because NOx pollutants are produced from the diesel fuel combustion rather than from substances in the fuel there is no indication that biodiesel will be treated differently from conventional diesel in terms of DEF requirements.

In the U.S., the production, handling and transportation of Diesel Exhaust Fluid (DEF) are governed by the ISO 22241 standard.

The small sampling of New England municipal officials interviewed for this project indicate little familiarity with DEF in conjunction with diesel fueling facilities permitting.

Relevant questions are:

1. What is the status of specifications governing installation of facilities for DEF storage and dispensing?
2. Are local permitting authorities familiar with DEF and with standards for storage and dispensing to prevent environmental impacts from this liquid substance?
3. How does the installation and maintenance of DEF handling facilities impact the cost and space requirements for bio-diesel fueling facilities?

Options for changes – effectiveness and feasibility:

As an impediment to biodiesel fueling, DEF appears minor at this point, perhaps because many diesel-powered vehicles in use today were manufactured prior to 2010. This significance may increase, but the volume of DEF required remains very low by comparison with diesel fuel volumes.

Recommendations:

Updated followup with the National BioDiesel Board is necessary to determine the extent to which DEF requirements currently impose a barrier to roll-out of biodiesel fueling facilities. Further actions depend on the response. Since DEF applies to both conventional and bio-derived diesel fuels DEF should not impede conversion from conventional diesel to bio-diesel, though it may create a disadvantage for bio-diesel relative to other alternative fuels such as LNG or CNG for trucks.

4.2 Codes and standards – alternative fueling infrastructure

4.21 *Codes do not deal with safety issues and facility designs where one or more alternative fuels – plus gasoline and/or diesel - are all dispensed at the same facility site.*

Explanation of this issue:

Vehicle fueling over the past 80+ years has been relatively simple – gasoline or diesel.

Alternative fuels add complexity regarding the combinations of fuel that might be dealt with by local permitting officials either at fueling sites that handle individual fuels or especially where multiple fuels might be added to fueling facilities that are established and well located for existing vehicle fueling markets. It is more than reasonable to envision passenger vehicle fueling stations handling mixtures of fuels including some or all of gasoline, diesel, biodiesel, DC fast charging and/or battery swapping, compressed natural gas or hydrogen.

Many of the alternative fueling facilities built in New England thus far service specific fleets with limited use by the general public. Significant penetration of the vehicle fuels market by alternative energy will require some combination of commercial fueling/charging facilities and home-based (and office-based) facilities. The scenario of constructing commercial facilities for new fuels "from scratch" would appear to be much more time-consuming and expensive than simply adding alternative fuels to the gasoline and diesel offerings at existing and new stations.

Conversations with New England local government permitting officials generate two conclusions:

1. Permitting officials – especially fire department officials - are very nervous about the prospect of regulating commercial, publicly-accessible multiple-fuels dispensing facilities.
2. Permitting officials lack detailed and reliable codes and standards guidance to confidently deal with fuel dispensing for multiple liquid, gaseous and electrical energy sources at vehicle “fueling” stations.

Guidelines are incomplete regarding how the dispensing of these different fuels, together at common sites, can be permitted, co-located, designed, planned, built, operated without the various fuels causing problems in the presence of other fuels.

NFPA 30A covers *“Motor Fuel Dispensing Facilities and Repair Garages”*. The NFPA *“Code for Motor Fuel Dispensing Facilities and Repair Garages”* (NFPA 2000) applies to facilities dispensing both gaseous and liquid fuels at the same facility. By reference, NFPA 2000 includes requirements of NFPA 88B.

There are holes in this coverage and confusion and perception of high risk on the part of local permitting authorities. Since proposals for multiple-fuels facilities are scarce at this time, the issue is not perceived as imminent. That could change quickly.

Co-location of vehicle electric charging DC Fast Charge (Level 3) equipment with gaseous and liquid fuels is address in section 3.21 above, but his issue covers a broader range of vehicle fuel/energy combinations.

Relevant questions:

1. Can addition of CNG, LNG, propane, hydrogen and/or electric fast charging facilities be easily evaluated and permitted as an approved expansion of existing gasoline and diesel fueling stations?
2. Do the current standards, codes and permitting enable these fuels to be co-located at existing or new fueling stations?
3. What changes are needed?
4. Can standards and best practices be developed that give clear guidance to multiple fuels co-location and for expansion of existing fueling facilities to handle additional fuels – especially CNG, propane and LNG plus hydrogen and DC fast charging?
5. Where does development of such co-location codes and standards stand at NFPA?

Options for changes – effectiveness and feasibility:

This is a complex and important issue that requires additional work with NFPA that has been beyond the scope of this project. All options for action require the initial step of determining the details of NFPA's current programs to address fire protection and public safety issues associated with co-location of gaseous, liquid and electric energy “fueling” for vehicles.

Recommendations:

The scope and future prospects for this issue can be presented by the Fire Marshals in multiple states (New England states and others) to the National Association of State Fire Marshals for a national-scope effort with the National Fire Protection Association (NFPA).

The purpose of this effort would be to accomplish the following:

1. Present to the state fire marshals throughout the U.S. A status summary of permitting standards, codes and procedures currently recommended by the NFPA for effective local-government control of fueling system facilities that handle multiple vehicle fuel/energy types at single sites – fuel types to include various combinations of gasoline, diesel, CNG, LNG, propane, hydrogen and electric charging.
2. Present a clear explanation of NFPA's current programs and program objectives to improve guidance for state fire marshals and local officials on multiple fuel dispensing.
3. Assess NFPA's ongoing and planned programs for improved control of multiple-fuel dispensing facilities, identify gaps and shortcomings in both standards development and training programs, and recommend program improvements to NFPA.

5: Conversion of vehicles to alternative fuels

5.1 Alternative fuel vehicle (AFV) conversions & maintenance licensing

5.11 There is confusion regarding design standards and codes for indoor storage and maintenance of gaseous fuel vehicles – indoor risks that are very different among the various gaseous fuels which in turn are all very different from gasoline risks.

Explanation of this issue:

Some vehicle fueling facilities include repair and/or storage of vehicles inside buildings. Vehicle conversion to alternative fuels also can require vehicles to be in enclosed buildings. CNG and propane fuel vehicles that are housed in such enclosed situations raise fire and public safety concerns that are different from those that come into play for enclosed facilities housing gasoline or diesel fueled vehicles. The code-driven designs for these alternative fuels facilities have not evolved into standard, consistent rules to guide facilities design, making the planning process more costly and uncertain than is the case for facilities servicing gasoline and diesel vehicles. Best practices model designs would enable preparation of ordinances to cover these situations and that in turn should expedite permitting and approval processes at the local level.

Codes of relevance here include NFPA 88A and NFPA 88B. Since some CNG and propane fueling for fleets is co-located with vehicle repair and storage buildings, the approval of fueling facilities frequently includes approval for such indoor maintenance and storage of vehicles. Indoor repair and storage of vehicles powered by gaseous fuels involves different building design and outfitting standards for each fuel type. Propane behaves differently from CNG requiring different building standards due to different combustion points for propane vs. natural gas (mostly methane), and propane being heavier than ambient air whereas methane (natural gas) is lighter.

Electrical facilities designs, HVAC layouts etc. must deal with such simple but highly important factors as the fact that propane sinks downward and natural gas rises. Local government building and fire inspection procedures are reported to vary considerably in terms of their abilities to handle these issues expeditiously with appropriate knowledge. This makes it difficult and unpredictable to make safe, effective facilities designs happen with minimal delay, risk and cost to both developers and municipalities. In order to standardize the facilities construction process for these fuels and ensure quick, safe and low cost roll-out of facilities, these discrepancies might be dealt with through training, state-mandated processes/standards and standardized equipment designs.

Codes of relevance here include NFPA 88A, Standard for Parking Structures –1998 - Open, enclosed, basement and underground parking structures – with references to NFPA 52 and 57. Also NFPA 88B, Standards for Parking Structures - Standard for Repair Garages -1997 -- subsumed in 30A-2000. This includes specific requirements for garages working with natural gas vehicles. Factors covered in these standards include ventilation, electrical requirements near the ceiling, temperature of exposed surfaces on heaters etc.

Codes for operation of gaseous fuel vehicles - CNG, propane, LNG and hydrogen – in some cities also restrict operation of vehicles using these fuels in enclosed areas including driving in tunnels, driving and parking in enclosed parking facilities, and operation of repair activities in repair shops.

Sandia National Laboratories is undertaking some work to deal with these and some other alternative fuels codes issues - mostly related to hydrogen fueling, including fueling in indoor spaces (See http://www.sandia.gov/~kgroth/publicationfiles/SAND2012-10150.pdf) Other work is scattered among the codes and standards development organizations and others. A comprehensive inventory of such ongoing work has not been completed for this project.

Options for changes – effectiveness and feasibility:

CNG, propane and LNG fueling technologies have largely stabilized. Biodiesel fueling is essentially the same as conventional diesel fueling which has stood the test of time with respect to codes, standards and related governmental regulations. Hydrogen and electric charging technologies, on the other hand, are rapidly evolving and changing with respect to equipment designs, equipment-vehicle interfacing, overall facilities siting and layout standards.

New England needs to monitor the technology changes and related codes/standards modifications happening world-wide so the New England region can keep up with the rest of the world in new fuels utilization as well as the related requirements of public safety and environmental protection. This needs to be linked to on-going training commitments and programs to keep local and state approval/inspection people up to date on current technologies.

Authorities Having Jurisdiction (AHJs) with respect to this issue are largely local fire code permitting and enforcement professionals and state Fire Marshals and thier staffs. State Fire Marshals and local fire departments are the ones with the most at stake here. They recognize this issue and see it as likely gaining importance in the future, but the issue gets relatively little attention by these groups now since the market penetration of vehicles using these fuels is small.

The key standards and codes development organizations (SDOs) relevant to this issue include the National Fire Protection Association (NFPA), American Society of Mechanical Engineers (ASME), Compressed Gas Association (CGA), Underwriters Laboratories (UL), International Organization for Standardization (ISO), and the International Code Council (ICC).

Recommendations:

An appropriate initial action would be to simply poll the 5 state fire marshals in the project states to determine whether they see this as a sufficient public safety issue to justify more coherent codes-based permitting for these facilities.

If this is recognized as a codes deficiency and a safety hazard situation, appropriate action would include consolidating all existing relevant codes into a training manual for local fire officials and having the National Association of Fire Marshals communicate their concerns and request focused codes and standards upgrades by the relevant standards and codes development organizations that are listed above.

6: Alternative fuels issues related to weights, measures and fuel quality regulations

6.1 Remove barriers to fueling station operation

6.11 *With respect to hydrogen, electric charging, CNG and LNG, states have not finalized the rules for measuring the dispensed amounts of these fuels.*

Explanation of this issue:

There are two sub-issues here. First is the matter of how accurately the fuels are measured for dispensing and the certification of dispensing equipment. Second is the separate issue of measurement metrics to be presented to the buying public – e.g., gaseous fuel volume, mass, energy content or energy equivalents (gasoline or diesel gallon equivalents).

Currently, in the U.S., legally recognized sales transactions for the dispensing of vehicle fuels & energy require government weights and measures standards to ensure fair transactions of dispensed fuel material or energy. Under loose federal jurisdiction, measures are generally standardized within specific states, made somewhat consistent among states, and in some regions, such as New England, transaction measurement controls are further modified and administered by local governments. This complex of jurisdictions creates a cumbersome process to put the pieces in place for legally approved measurement of new vehicle fuels.

As long as new fuels are in the experimental stage or are used primarily by private fleets using non-public dispensing facilities, the problem is minor. However, when moving such new fuels into the public mainstream, fueling facilities developers encounter delays and investment uncertainly due to these obstacles. This has been the case especially for CNG and LNG and to some extent for electric charging and propane. Measurement problems for hydrogen fueling are still in the somewhat early stages, but they are significant.

U.S. weights and measures organizations – principally the non-governmental National Conference on Weights and Measures (NCWM) and the U.S. Office of Weights and Measures within the U.S. Department of Commerce's National Institute of Standards and Technology (NIST) - have achieved some nationwide agreement on measurement standards for alternative fuels and vehicle energy. An example is the recently agreed-upon rules stating that vehicle electric charging is to be measured in kilowatt-hours throughout the U.S.. In the case of gaseous fuels, however, the complex federal, NGO, state and local decision-making process has resulted in some slow decisions and unresolved measurement standards, a situation that constitutes a significant barrier to mainstream use of gaseous vehicle fuels.

Accuracy standards vs. equipment costs

Equipment for measuring fuel materials to a given accuracy reportedly is more expensive for low-density fuels – i.e., gases - than is the case for liquid fuels. For example, with respect to hydrogen

fueling measurement, the U.S. National Institute of Standards and Technology (NIST) Handbook 44 (the basis for most states' fuel measurement rules) specifies that vehicle fueling equipment must measure with an accuracy of plus or minus 2% - the standard that has evolved as feasible and expected for gasoline dispensing. In the case of hydrogen - a very non-dense fuel material - hydrogen dispensing measurement equipment to match the measurement norm of + or – 2% is presently much more expensive than the equipment used to measure dispensed gasoline.

In response, the state of California has proposed, through the California Department of Food and Agriculture (the weights and measures agency in California) that California vary from the general NIST guidelines and enable hydrogen fueling to get "off the ground" with an accuracy standard of + or – 10% but with stipulations that this margin for error be reduced in the future. For details of the CA proposal (Nov. 2013) see http://www.cdfa.ca.gov/dms/pdfs/regulations/ISOR-H2-Device.pdf

Measurement standards for electric vehicle charging are also a bit problematic, but relatively simple, requiring mostly institutional agreements rather than technology development. Kilowatt-hours of delivered electricity can be measured very accurately and at low cost, plus there is finally agreement among the measurement and energy stakeholders to accept kilowatt-hours as the standard for vehicle charging. Issues with electric charging are more a matter that public utilities regulators in each state must agree on conditions under which business (utilities and others) and public entities can actually sell electricity for vehicle charging and on tariff terms and pricing. (See 9.11 "*State public utilities regulations limit who can sell electricity on the retail market...")*

Marketing objectives vs. fundamental measurement

Part of the delay problem with CNG and LNG measurement is due to the strong lobbying by the CNG and LNG industries to present the measurement of dispensed CNG and LNG in terms of energy equivalents to gasoline or diesel in order to emphasize – to the fuel-buying public – the cost savings from CNG or LNG vs. gasoline or diesel. Thus for gaseous fuels there is an extenuated conflict between advocates for measurement presentation by volume (cubic feet or cubic meters), mass (kilograms), energy (Btu's or therms), "gasoline gallon equivalents" (GGE) or "diesel gallon equivalents" (DGE).

Nationally in the U.S., many weights experts strongly oppose the use of GGE or DGE as inconsistent with the way substances should be measured and as inconsistent with the way gases are measured for other uses. At this point, the issue boils down to kilograms measurement favored generally by measurement regulators vs. GGE favored by the CNG industry (mostly focused on automobiles and small trucks) and DGE favored by the LNG industry (mostly to expand the long-haul trucking LNG market. The conflict is between measurement objectives and marketing-development objectives.

World-wide, gaseous fuel measurement appears to be coalescing around either kilograms or Btu's. It appears likely that kilograms will also win out in the U.S.

People in the gaseous fuels business also report confusion due to differences in the way dispensed fuel and energy measurement are administered, handled and reported by the various states, the U.S. Office of Weights and Measures and the Internal Revenue Service.

Options for changes – effectiveness and feasibility:

Solutions to these fuel measurement issues include technology improvements as well as decisions regarding acceptable measurement procedures and equipment, accuracy standards and inspection procedures. These are highly inter-related.

Measurement technologies and standards are evolving faster in Europe, Asia, Canada and California than is the case in New England. This project might compile the most important and relevant weights and measures and tax administration information from these sources as the basis for recommendations on these issues for New England.

The biggest bottleneck to stabilized measurement rules for gaseous fuels is 50 individual states in the U.S. each having a separate weights and measures function, and in most cases, each answerable to its state legislature for policy approval and for the staff & funding to implement and enforce measurement policy. A base of common policy and technical rules is given to the states by the National Institute of Standards and Technology (NIST) Office of Weights and Measures. However, NIST looks to the non-governmental National Conference on Weights and Measures (NCWM) for advice on rules changes, and the NCWM is largely a creature of the 50 state weights and measures agencies. This can make decisions and progress difficult – as is the case right now with CNG and LNG.

Adding to the complications in the U.S., measurement standards are principally applied, administered and enforced by state and local governments that vary significantly in terms of issues focus and priorities. Just within New England, weights and measures agencies (and their focus priorities?) range from agriculture to industrial & business regulation to consumer affairs to labor, training and worker safety. This all makes changes, agreement, consistency and efficiency slow and elusive. Measurement standards for gaseous fuel have been delayed in this confusion for years. Problems from this confusion are notably challenging in New England with its huge number of rule-making jurisdictions within a small geographic area.

Among the five New England states dealt with by this project, the state-level weights and measures functions are performed by the following entities: (For additional information about all agencies and key organizations referenced by this project see Appendix 1.)

Maine - Maine Department of Agriculture, Conservation and Forestry, Quality Assurance and Regulations, 90 Blossom Lane, Augusta, ME 04330, 207-287-3841.

Massachusetts - State of Massachusetts, Office of Consumer Affairs & Business Regulation, Division of Standards, Weights and Measures -- One Ashburton Place, Room 1115, Boston, MA 02108, 617-727-3480,

New Hampshire - New Hampshire Dept. of Agriculture, Markets and Food, Division of Weights and Measures – 603-271-3700 – http://www.agriculture.nh.gov/divisions/weights_measures/

Rhode Island - Rhode Island Weights and Measures: Dept. of Labor and Training, Occupational Safety, Weights and Measures Unit, Center General Complex, 1511 Pontiac Avenue, Cranston, RI 02920 – 401-462-8570, http://www.dlt.ri.gov/occusafe/wmform.htm

Vermont - Vermont Agency of Agriculture, Food & Markets, 116 State Street Montpelier, VT 05620-2901

Maine – The Maine Dept. of Agriculture, Forestry and Conservation, Quality Assurance and Regulations Office conducts licensing of vehicle fueling stations as well as certification of fuel dispensing measurement accuracy and maintenance of quality standards for gasoline and diesel fuels. Maine state government is inadequately staffed and funded to deal with measurement and qualify for new fuels, lacking equipment for measurement testing and lacking legislated budgets for expanded testing. As an interim measure, Maine has considered allowing use of private testing entities' equipment. If public alternative fuels facilities are built, statutes require that they be certified, but the Maine Department claims that they cannot do so due to lack of equipment, rules and staff.

In Massachusetts, the Division of Standards, Weights and Measures Director is responsible for overseeing the enforcement of laws, rules and regulations relating to weights and measures within the Commonwealth. The Director also supervises the certification of all local weights and measures officials. The Division's current Director, Charles H. Carroll, is currently serving on the Board of Directors of the National Conference on Weights and Measures (NCWM). Director Carroll has also twice served as chairman on the NCWM Specifications and Tolerance Committee, which is responsible for developing standards for commercial weighing and measuring devices. Relevant Massachusetts statutes: Massachusetts Motor Fuel Law, Section 295A - Definitions. Massachusetts Motor Fuel Law, Section 295B - Licensing of Retail Dealers. Massachusetts Motor Fuel Law, Section 295C - Display of Price of Motor Fuel on Dispensing Devices

In Rhode Island, the Weights and Measures Unit (Department of Labor and Training, Occupational Safety) enforces the weights and measures statutes in Title 47 of the Rhode Island General Laws. *“This unit certifies sealers to perform inspections to ensure the calibration of all measuring devices used by businesses within Rhode Island. Other functions of the unit include certifying scales used for retail and wholesale purposes, certifying gasoline measuring devices to prevent fraud and deception and the licensing of oil dealers.”* – (http://www.dlt.ri.gov/occusafe/weightsmeasures.htm)

The Rhode Island weights and measures function differs from the others in New England in that it resides in the occupational health and safety agency of state government along with business services regulation functions such as boiler and elevator safety and emergency planning related to the storage and transportation of hazardous chemicals.

The Rhode Island statutes are a relatively simple example of the rules governing fuel weights and measures and New England –

From Rhode Island *“TITLE 47 - Weights and Measures, CHAPTER 47-8, Gasoline and Petroleum Products, SECTION 47-8-1, Testing of measuring devices – Forbidding use – Fee:*

(a) The director of the department of labor and training is hereby authorized and directed to have tested all gasoline measuring devices used in the sale of gasoline, from time to time, as in his or her judgment it may be deemed necessary, to prevent fraud or deception in the use of these devices or to insure the accurate measurement of gasoline in the sale.

(b) Any town or city sealer of weights, measures, and balances shall have authority to condemn and forbid the use of any gasoline measuring device for the sale of gasoline in his or her respective town or city, or until the device has been duly tried and sealed, or until the gasoline measuring device has been equipped with such an attachment, contrivance, or apparatus as will insure the correct and proper functioning of the measuring device for the sale of the gasoline by accurate measurement."

Within this regulatory context, Rhode Island is typical of the 5 New England states covered by this project in that the state-level regulatory agency and the local town and city weights and measures authorities will not approve of fuel dispensing/measurement equipment until the state has either compiled its own testing results for the equipment of the state authorities have confirmation from the U.S. National Institute of Standards and Technology that the equipment in question has been adequately tested.

For the alternative fuels covered by this report, there are widely varying levels of comfort on the part of state and local authorities regarding the certifiable measurement accuracy of dispensing equipment --

For compressed natural gas (CNG), liquified natural gas (LNG) and propane, equipment authorities seem reasonably comfortable with the fundamental measuring/dispensing equipment accuracy used for fuel dispensing in non-public fleet fueling situations. As gaseous fueling moves more into the realm of wide-open, public, commercial fueling stations – either for commercial trucks or private cars – measurement becomes more problematic and unresolved. As a specific example, LNG fueling equipment must avoid inaccuracies caused by the LNG fuel changing from liquid to gaseous state within the measurement device at rates that vary due to ambient temperatures and atmospheric pressures.

In Vermont, the Agency of Agriculture administers measurement standards. The Agency licenses commercial weighing and measuring devices used for the sale of gasoline, home heating fuel, small and medium capacity scales in retail outlets and heavy duty scales used for sales of concrete, hot mix/asphalt, animal feed, etc.

For reference, in the state of Connecticut (not included in this study) the fuels weights and measures regulatory function is within the Department of Consumer Protection.

Not surprisingly, the state of California's weights and measures function for vehicle fuels is notable for its progress in dealing with measurement standards, rules and technologies for vehicle alternative fuels. Specifically,

The National Conference on Weights and Measures (NCWM) is the entity that coordinates fuel commodity measurement standards among the 50 states. Its actions are largely a function of voluntary participation by states' weights and measures offices, and its decisions are essentially

advisory only to the states and to the federal NIST. The organization has struggled with measurement issues for gaseous fuels. Imminent status forced decisions on electricity measurement for electric vehicle charging. Less urgent issues have languished.

A notable example of nationwide efficiency/consistency in fuel measurement regulatory functions is Measurement Canada, the weights and standards administration entity with national juridiction in Canada. Measurement Canada's Electricity and Gas Inspection Act, (R.S.C., 1985, c. E-4, An Act relating to the inspection of electricity and gas meters and supplies) contrasts with the highly complex and currently stalemated U.S. process for defining rules and appropriate consistency for gaseous fuels measurement. Canada's rules state that for the sale of gas - transportation and other uses --

"(b) the unit of measurement for the sale of gas shall be

(i) in the case of sale by volume, the cubic metre or the cubic foot,

(ii) in the case of sale by energy units, the joule or the British Thermal Unit, and

(iii) in the case of sale by mass, the kilogram."

(*http://laws-lois.justice.gc.ca/eng/acts/E-4/page-2.html#h-3*)

In the Canadian rules, no mention is made of marketing-oriented metrics such as gasoline or diesel gallon equivalents.

In Canada there essentially are no Provincial or local weights and measures functions. Measurement Canada covers regulations and inspections nationwide with 10 regional offices.

The U.S. decision-making process for gaseous fuels measurement appears headed toward similar metrics to those used in Canada, but the highly complex National Council on Weights and Measures (NCWM) and National Institute of Standards and Technology (NIST) process is delaying final and clear and predictable measurement rules, thus possibly interfering with investment in gaseous fuels infrastructure.

Recommendations:

The issues and the decision-making system are complex, but logical recommendations are simple.

Measurement accuracy standards and equipment costs

1. The New England states should follow the precedent set by California and assert measurement accuracy standards – either temporary or permanent – that enable reasonable costs for measurement equipment used in the early, low-volume stages of gaseous fuels public infrastructure roll-out while adequately protecting the public's need to ensure fair transactions.

2. The New England states, through their representation on the National Council on Weights and Measures, should push for U.S. standardization of gaseous fuels measurement in kilograms.
3. In conjunction with the kilogram gaseous fuels measurement standard for fuel dispensing transactions, the New England states should assist in defining national (NIST) standards by which fuel dispensing systems should, in the short run, calculate and display the comparison of energy content in the dispensed fuel vs. more familiar gasoline and diesel fuel.
4. For longer-term consumer comparisons of fuel alternatives, NIST should be encouraged to develop a consumer information system similar but more broadly applicable to the wide range of vehicle fueling options that are evolving – that is comparison of all fuel and energy types in terms of energy content dispensed, probably measured in Btu's. This enables all fuel/energy types to be compared by the consumer, not just CNG, LNG, gasoline and diesel.
5. Energy and transportation leadership (legislative and executive) in each of the 5 project states should consider tighter standardization and state control of fuel measurement, removing much of the confusion and administrative duplication that exists with weights and measures rules variations at state and local levels – in addition to the based of standards given to the states by the NIST. Local assertion of weights and measures standards – as well as inspection criteria and procedures, seem unnecessarily cumbersome and expensive for modern governments.

6.12 *With respect to hydrogen, electric charging, CNG and LNG, states are not fully prepared to inspect measurement equipment and to apply fuel measurements in calculating fuel taxes (under the current fuel excise tax systems).*

Explanation of this issue:

For over 100 years New England's (and North America's) vehicle energy fueling situation has been very simple – gasoline and diesel fuel. This simplicity is changing. More fuel types are hitting the market. This in turn means that New England governments are likely to be facing much more complexity in certifying fuel measurement systems and enforcing compliance. As some of the new, “alternative” fuel types achieve significant market presence, these governments are not currently equipped to certify and inspect public commercial dispensing systems for these additional fuel and energy types.

This project covers six vehicle fuel/energy sources that are coming into the market to compete with conventional gasoline and diesel. When (if) the evolving changes in vehicle fueling finally sort out into a new and possibly stable mix of vehicle fuels it is not at all clear which energy sources will be the 'winners” and how many will remain “standing”. In the near-term, however, New England's plethora of state and local regulatory authorities with jurisdiction over fuel measurement will be faced with controlling a somewhat more complicated mix of dispensing systems. Rightly or wrongly, the New England states have not yet prepared to expand fuel measurement programs for this change.

Within the scope of state government operations, this is small. However, as an impediment to roll-out of alternative fuels, it appears likely to become significant. How significant depends on how many of the new fuel types “make it” in the commercial marketplace, the extent of market penetration and the speed at which demand evolves for some or all of these new fuels.

Hydrogen presents perhaps the biggest challenge. From the state of California Zero Emissions Vehicle Plan: *"Hydrogen dispensers must be certified before hydrogen can be sold on a per kilogram basis in a retail transaction".* Commercial sale of hydrogen to the public involves very new technologies, albeit technologies which are very effective.

For other alternative fuels covered by this project, measurement equipment testing, certification and enforcement will be somewhat less of an adjustment for regulators, yet the overall situation of many more products possibly being added the massive fuel dispensing network means substantial added complexity for the state weights and measures entities.

With respect to propane fueling of vehicles, certification and inspection systems have already evolved to some extent for recreational and home appliance propane dispensing at existing retail facilities including gasoline stations. (Minor adjustments to the propane dispensing approval process are suggested – see issues 2.12 and 2.13)

Similarly, biodiesel – normally a blend of biodiesel and conventional diesel - is sufficiently similar to straight conventional diesel to need few if any new measurement regulations or measurement equipment testing.

Electric vehicle charging measurement is largely covered by electric codes and by simple measurement technologies in wide use by utilities and industry, however power dispensing for vehicles still adds measurement challenges for the weights and measures and fuel taxation entities in each state.

This issue has implications for state-level collection of highway-use excise taxes (the “gas tax”) as well as for consumer protection. The current structure for collecting both state and federal highway use taxes from fuel consumption assumes legally defensible measurement of dispensed fuel in each state. With alternative fuels presently constituting only a very small percentage of vehicle operations, alternative fuel/energy measurement for taxation is – so far – not high on the radar screens of transportation officials and legislators (both state and federal). Very recently, however, that has begun to change in response to two recent trends:

1. Improved electric vehicle technologies (both plug-in and fuel cell) have substantially increased the number and credible future prospects for electric vehicle sales.
2. Relatively inexpensive natural gas has quickly caused the long-haul trucking industry to make major moves toward LNG fueling of trucks, causing a demand for commercial LNG fueling facilities, especially along major truck routes.

(For more information about highway-use taxation matters see issues 7.11 and 7.12.)

Options for changes – effectiveness and feasibility:

Solutions to these fuel measurement issues in New England will likely involve establishment or expansion of state-level (or regional? and/or local?) staff, facilities and equipment to administer certification and ongoing inspection of vehicle fuel/energy dispensing facilities to ensure accurate sales measurements/transactions to the public as the number of fuel types covered by state wieghts and measures programs expands from essentially just two fuels to as many as seven or more.

From the perspective of the present state-level weights and measures agencies, this will require more staff, more testing equipment (including procurement of examples of the dispensing equipment being used by commercial operators) and expanded administrative rules for testing, approval and inspection of dispensing system equipment.

Currently it looks like the states are most likely to respond with budgets, time-consuming political and funding approval, equipment procurement, administrative rules changes, staff and process expansion being carried out in duplication in all five states, with the added complication of updating processes and training in hundreds of New England municipalities. As one example, the state of Maine reports that they currently are totally unequipped to provide these services. The other four states are at similar status, with some progress reported in MA and RI.

The states are reluctant to expand their fuel measurement certification functions until these fuels are moving clearly into the public-commercial market. Electric vehicle charging and LNG fueling for long-haul trucks are the two areas where the states are feeling initial pressure to expand these services. State agency and legislative personnel are reluctant to expand these services to more fuel types when they have seen alternative fuel types appear and disappear from the marketplace in the past.

Apparent options for measurement regulatory program changes include continuing to handle testing, certification and inspection by each state, by a consortium of states, or by a private entity serving multiple states. New England's status as six state governments in a relatively small geographic area strongly suggests that the expansion of measurement regulations from 2 to perhaps as many as 7 vehicle energy product types could be done much more economically by either a governmental, quasi-governmental or private entity serving the entire New England region. The obvious trade-off is localized control vs. collective advantages of operational efficiency, reduced cost, speed of implementation (possibly) and regional consistency.

Recommendations:

A regional approach to this issue seems well worth considering to say the least.

For each New England state to gear up to handle additional fuels with equipment and inspection gear and staff may be much less desirable than establishing a New-England-wide regional entity to perform the equipment testing, certification, approval and continuing inspection processes with a single administrative structure, staff and equipment.

Suggested possibilities include:

1. An existing or new regional energy services entity authorized by the states,

2. A public-private partnership entity, or
3. A regional government entity with services contracted to a private service-delivery firm.

The recommendation is for some or all of the project states to examine the feasibility and economics of these options and to assess the advantages of these options for enabling faster responses to new public commercial fuel/energy facilities proposals. The initial scope of such analysis should focus on electric vehicle charging and LNG fueling although hydrogen fueling is also gaining momentum in the New England region as well.

By contrast, CNG fueling is shaping up, at least in the sort term, to be serving local and small regional commercial truck and some localized automobile fleets (for example, trash collection trucks) with relatively little activity using public fueling stations. Biodiesel is largely a substitute fuel for petroleum-derived diesel using essentially the same dispensing and measurement methods as used for the conventional diesel fuels which weights and measures regulatory entities know well. Therefore, CNG and biodiesel fuels require few changes to the measurement certification and enforcement process. (For further comments regarding propane dispensing regulations see issue 2.12.)

6.2 Laws and regulations for fuel quality

6.21 *There is no batch control to enable quality control measures to be applied to natural gas delivered specifically for vehicle fueling, and the quality controls on natural gas delivered by gas utilities are not geared toward vehicle fueling requirements.*

Explanation of this issue:

Issues involving quality of "alternative" fuel delivered to retail customers varies by fuel type.

In the case of gasoline and diesel - the fuels that the fuel quality regulators are presently accustomed to - fuel is delivered to dispensing sites in truck-loads from distinct batches, with each specified batch tested relative to quality parameters. Vehicle fuel quality enforcement at the state level is currently based on this batch testing and batch test data. By contrast, compressed natural gas for vehicle fueling is generally made by compressing natural gas at or near the dispensing site – gas which is supplied in a continuous stream from the gas grid. Therefore, there are no specific “batches” of natural gas tested for vehicle-used quality.

Natural gas – the primary feed-stock for compression into CNG vehicle fuel – is supplied on a continuous basis from the gas grid system that supplies thousands of users. Natural gas quality control is limited to standards maintained at the source of gas refining and gas monitoring with sample testing done for the gas grid as a whole and for the general population of gas consumers, most of which are not using the gas for vehicle fuel. Current natural gas quality control criteria is based on the requirements for the historically significant markets for natural gas -- which does not include fueling for vehicle operation.

To the extent that gas for vehicle fuel may require specific chemical properties and impurity contents, grid-delivered gas has no process for testing of the fuel before it reaches the site for compression and vehicle fueling. This has not become a major problem for the internal combustion engine vehicle CNG fuel markets that are being served thus far. Going forward, use of CNG in more passenger cars may cause this lack of quality test to become a problem. Also, natural gas is one of the feed-stock options for hydrogen used in fuel cell vehicles. This may also require quality standards that exceed the gas quality testing parameters currently used for the overall natural gas grid.

Also, natural gas suppliers have been known to inject propane into the gas grid to expand supply while keeping the propane content within levels that are acceptable for the broader natural gas market. This addition of propane apparently is not a problem for home, industrial and power generation uses of natural gas. Might it create problems for gas used in vehicle fueling?

Options for changes – effectiveness and feasibility:

Natural testing regulations and procedures to ensure quality specifically for vehicle fueling are not in place within the New England states. This appears to be only a potential issue, not an imminent problem. However, if CNG fueling is to be rolled out to a wider market of privately-owned individual cars and trucks, assurance of fuel quality may become more of an issue.

SAE J1616 covers *"recommended practice for compressed natural gas vehicle fuel and recommendations on vehicular fuel composition".* CNG sold in California is covered by California Code of Regulations, Title 13, Div 3, Ch 5, Article 3, Sec 2292.5 which applies specific requirements for CNG composition. How is this enforced in a continuous-process delivery system? Should the CA quality model be applied to New England?

Recommendations:

Further information is needed from the CNG vehicle, CNG fueling and natural gas supply industries and from natural gas regulatory entities to determine whether:

1. Vehicle fueling requires (or is likely to require) different fuel quality than is supplied within the standards, controls and testing for grid-distributed natural gas delivered in New England.
2. The current gas quality control process in New England meets present and likely future vehicle fueling requirements for both internal combustion and fuel cell vehicle engines with respect to percentage content of non-methane hydrocarbons plus levels of non-hydrocarbon impurities and other contaminants.
3. Natural gas regulators and natural gas suppliers who operate the current testing function for grid-supplied natural gas have evaluated the feasibility and costs of expanding gas quality testing to include parameters of importance for internal combustion vehicle engines and for fuel cell vehicle fueling – for example, incorporation of SAE J1616 or regulations similar to California's Code as cited above. Another example of state standards is Texas Administrative Code, Title 16, Part 1.

6.22 *Fuel quality controls and quality issues for bio-generated or landfill-generated methane gas differ from natural gas, but no firm fuel quality standards are applied to these bio-sourced gases.*

Explanation of this issue:

Although most vehicle fuel compressed natural gas (CNG) currently comes from fossil-fuel-derived natural gas sources, methane can be supplied for CNG from non-fossil sources such as sewage waste and landfill gas. These other sources have different implications for quality control than is the case with utility-supplied natural gas (primarily methane) from fossil fuel extraction sources. Landfill gas in particular tends to contain far more contaminants than natural gas – contaminants that will create problems as fuel in vehicles as well as in other power production equipment.

Use of landfill and sewage treatment methane for vehicles is a rather uncommon application at this time, but it is a very desirable alternative fuel application in many respects. A barrier to use of these non-fossil sources is contaminant content of the gas. The need to remove such contaminants is widely recognized by the engineers who design energy systems using this fuel, so “bio-gas” purification is a well-developed technology. Engineering guidelines for contaminant removal have evolved in the engineering field, but they do not appear to be codified into gas quality regulations at the state level for methane that is used in motor vehicles – either for internal combustion engines or for use in fuel cell vehicles.

Options for changes – effectiveness and feasibility:

The small market penetration of bio-derived gas for vehicle fueling means that the issue of quality standards for such fuels is far from being an imminent issue. Nevertheless, the issue can presumably be dealt with quite simply by codifying state-level quality standards for natural gas use as vehicle fuel and to simply include in those rules the requirement that gas (primarily or exclusively methane) derived from waste material digestion and processing must meet the same quality requirements as natural gas derived from fossil fuel extraction and processing.

Recommendations:

In conjunction with state-level establishment of quality standards for use of natural gas for vehicle fuel, the same quality standards should be explicitly applied to methane fuel derived from sewage and other waste digestion and from landfill gas.

6.23 *It is unclear what (if any) quality standards are required in/by the New England states for propane used as vehicle fuel – as opposed to propane used for home heating and cooking and for industrial processes.*

Explanation of this issue:

Propane fuel is a manufactured product supplied to the fuel dispensing site via truck-delivered batch, theoretically enabling delivered batch-based quality control with respect to attributes such as content levels of propane, butane, ethane and propylene as well as non-hydrocarbon impurities in the delivered liquid product. These attributes have different implications for use in internal combustion engine fueling than is the case for the more conventional propane uses - heating, cooking and industrial applications.

Options for changes – effectiveness and feasibility:

ASTM Standard 1835 applies to propane quality for motor fuel applications, and it should be applied as the consistent base quality standard for motor fuel use of propane in the New England states in order to give clear and predictable guidance to the propane or “autogas” industry to roll out fueling infrastructure for broader use propane as a vehicle fuel.

This project has not obtained a clear reading on where the propane vehicle fuel industry will stand with respect to state-level quality standards for propane vehicle fuel. Clear standards would seem to minimize confusion and uncertainly as the propane industry seeks to expand more broadly into public fueling of cars and trucks.

Since propane fuel is not sold and delivered under the auspices of public utility commission control (as is the case with natural gas), different processes of quality assurance would come into play at the state level if state-level regulation is deemed to be appropriate. Alternatively, the autogas industry can self-police with it's own quality standards adopted from existing sources such as ASTM – an approach similar to that used by the bio-diesel fuel industry.

Recommendations:

This project has not fully examined the propane fuel quality issue to determine whether the industry is adequately served with respect to fuel quality assurance by either government or by the fuel-supply industry itself.

Recommendations are to obtain more information regarding:

1. Current state-level regulations – if any – controlling propane quality for vehicle fuel applications, and the agencies in charge of these regulations, and
2. What - if any - adjustments to propane quality assurance testing and regulations are needed in order for propane vehicle fueling to expand into wider markets.

6.24 *Fuel quality control has been an issue for biodiesel suggesting the need more stringent requirements that biodiesel meet the industry's BQ9000 standards as a minimum with a likely need to apply standards that deliver a higher level of quality to the customer than BQ9000.*

Explanation of this issue:

Biodiesel fuel quality has been a very significant issue in the past, harming the reputation of the product to some extent. The quality issue persists to some degree creating somewhat of a barrier to further market penetration by this fuel which can offer superior environmental options to conventional diesel with fossil-derived carbon.

Also, there is the continuing issue of whether car and truck vehicle manufacturer (OEMs) will honor new vehicle warranties when biodiesel is used in various percentage mixtures with conventional diesel. Vehicle warranty recognition and acceptance of bio-diesel is evolving for both trucks and cars, but in the meantime, the biodiesel industry points to the Magnuson warranty act of 1975 to claim that vehicle manufacturers cannot deny warranty recognition when bio-diesel is used. This opinion is not universally accepted.

ASTM standard D6751, implemented in 2008, establishes a base-level of product characteristics for biodiesel to be blended with conventional diesel for products sold in various diesel/biodiesel mixtures. In addition to this base, and in response to the bio-diesel quality issues in the marketplace, the bio-diesel fuel producers and suppliers have chosen to self-administer their own product quality program. Biodiesel quality is thus handled by the private National Biodiesel Accreditation Commission under their BQ9000 specifications covering fuel characteristics as well as production and handling processes. The biodiesel fuel industry is therefore largely in charge of its own fate with respect to product quality and the impact of product quality on their market-development efforts.

There is the question of whether additional quality-control discipline might accelerate adoption of bio-diesel by the diesel vehicle market. The Commission's BQ9000 sets a base-level of quality standards. Some biodiesel producers, including firms in New England, produce fuel at higher standards than the BQ9000 specifications. They do so to both improve the reputation of the fuel and to increase their firms' market penetration relative to competition. However, this degree of product variation leaves consumers with the task of evaluating quality claims – a task which tends to discourage consumers from using the biodiesel alternative fuel.

This situation causes some biodiesel stakeholders - fuel producers and marketers as well as existing and potential customers – to suggest that biodiesel fuel quality should be controlled at a higher quality standard than BQ9000 and that perhaps such quality regulation should be administered by the existing system of government fuel quality regulators rather than by the biodiesel fuel industry itself.

With respect to most regulatory issues such as fuel dispensing and measurement technologies, fire codes, facilities layout specifications etc. bio-diesel is legitimately treated pretty much the same as conventional fossil-based petroleum diesel fuel. When it comes to fuel quality implications for vehicle engine performance, vehicle warranties and fuel storage issues, however, the chemical differences between biodiesel and conventional diesel become significant. This means that biodiesel quality cannot simply be controlled using the same quality specifications as are used for conventional diesel.

Some claim that higher levels regulation would give biodiesel greater credibility in the marketplace, enable simpler and more confident purchasing decisions by the public and commercial markets, ensure adequate protection of customer interests, maintain a more marketable reputation for biodiesel product usage in a wider range of diesel vehicles, and minimize the risk from manufacturers threatening to void vehicle warranties when high percentage biodiesel mixtures are used in their vehicles.

Options for changes – effectiveness and feasibility:

If the biodiesel fuel industry's own quality control program and standards is not achieving fuel's potential for market penetration, should outside entities step in? That is a question perhaps for the industry itself, for environmental interests, for vehicle manufacturers and maybe for government consumer protection interests. If these interests have recently been queried on this matter, the results of any such questioning have not been obtained for this project.

There is the added complications that biodiesel is produced for two very distinct markets – vehicle fueling and the home heating oil market – both using essentially the same fuel. Fuelo quality implications for these two uses are somewhat different, although both should be served by quality standards that meet the requirements of the most demanding market.

Recommendations:

Analysis of this issue is somewhat speculative. It needs an updated and complete understanding of opinions from the key stakeholders as listed above – the biodiesel producers and marketers, the existing and potential biodiesel customer base, environmental interests, vehicle manufacturers and government consumer protection interests.

Do these stakeholders in general favor consideration of higher fuel quality standards for bio-diesel, and should these standards be administered by the bio-diesel industry itself or by a private standards organization or by government consumer and product quality regulatory entities?

This issue also suggests the need for an updated assessment of whether the 1975 Magnusson Act and other pertinent laws do in fact limit the ability – in the U.S. - for motor vehicle manufacturers to refuse warranty claims for vehicles that have been fueled with various percentage mixtures of biodiesel and conventional diesel fuel.

Any further actions of this issue would logically depend on these findings.

6.25 *The hydrogen production and fuel cell manufacturing industries have published explanations of quality issues and guidelines but not a universally applied fuel quality standard for hydrogen used as vehicle fuel.*

Explanation of this issue:

Hydrogen quality standards are very important to fuel cell vehicle performance, maintenance and longevity as well as energy delivery. Important quality parameters include moisture level and levels of other impurities including CO, CO2, hydrocarbons, sulfur and many other impurities. Quality control procedures for hydrogen may vary depending on whether the hydrogen is produced at centralized plant facilities and piped or trucked to the dispensing site or the hydrogen fuel is produced at the dispensing site from reformation of natural gas (conversion of methane to hydrogen and carbon dioxide) or water (splitting of water using electricity to produce hydrogen and oxygen).

The Society of Automotive Engineers (SAE) has developed and maintains/updates SAE Standard J2719, the most widely accepted hydrogen fuel quality standard for commercial proton exchange membrane (PEM) fuel cell vehicles. This standard was developed by the Hydrogen Quality Task Force (HQTF) of the Interface Working Group (IWG) of the SAE Fuel Cell Standards Committee. (See http://www.fuelcellstandards.com/2.1.7.2.htm)

Effective January 2014, the state of California's weights and measures agency – the California Department of Food and Agriculture, Division of Measurement Standards – adopted SAE J2719 as California's quality definition for hydrogen fuel. No other U.S. state has adopted J2719 as its hydrogen fuel quality standard.

Prior to adopting SAE J2719, California adopted an interim standard to control hydrogen fuel quality. From 2008 to 2013, the California Division of Measurement Standards was able to develop testing and administrative procedures for the hydrogen vehicle fuel quality enforcement function. This indicates the process investment needed to put such standards programs in place. The New England states can save time and expense by using the California system as a template for New England.

Options for changes – effectiveness and feasibility:

SAE J2719 is being actively maintained by the SAE Fuel Cell Standards Committee, especially since J2719 has been adopted by the state of California, the state with the most aggressive program for development of hydrogen fuel dispensing stations. Adoption of SAE J2719 is a very logical step for the fuel quality agencies in each of the five New England states covered by this project. The only evident options are –

1. Which organizations should take on the task of getting J2719 adoption accomplished in the New England states, and
2. What measures are necessary in order for each of the 5 states' fuel quality regulatory agencies to certify hydrogen fuel quality and enforce quality standards.

Appendix 1 contains a list of the fuel quality agencies in the five project states.

The H2USA program, affiliated with the Fuel Cell and Hydrogen Energy Association, has the objective of enabling hydrogen energy fueling facilities throughout the U.S. One of H2USA primary regions for hydrogen fueling infrastructure development is the Northeast U.S. (see www.h2usa.org).

The Northeast ElectroChemical Energy Storage Coalition NEESC (see www.NEESC.org) has developed hydrogen fueling and fuel cell energy policy roadmaps for the 8 Northeast states from New Jersey to Maine. NEESC is in the position, together with its member-state organizations, to push the case for adoption of J2719 by each 0of these states.

Recommendations:

Insert state adoption of J2719 into H2USA's Infrastructure Committee agenda and into the implementation program for the NEESC Northeast states Hydrogen and Fuel Cell Energy Roadmaps. Focus should be on the six New England states plus New York and New Jersey to create a firm, predictable and consistent system of hydrogen fuel quality assurance throughout the U.S. Northeast.

Consistent with the recommendations for issue # 6.12, the New England states, or perhaps the 8 U.S. Northeast states, should examine the viability and efficiencies of regionally administered fuel quality testing, certification and enforcement programs for all vehicle fuels, including hydrogen. (See issue 6.12.)

6.26 *Quality requirements covering natural gas used for fuel cell vehicles are different than for use in internal combustion engines, yet the gas quality standards for fuel cell use are unclear or not applied.*

Explanation of this issue:

In the context of vehicle fueling, natural gas is presently used primarily for fueling internal combustion engines – in the form of either compressed natural gas (CNG) or liquified natural gas (LNG). In the future, natural gas is likely to be also used as a hydrogen production feed-stock for fueling fuel cell vehicles (methane reformed to hydrogen and carbon dioxide).

Natural gas for hydrogen fuel cell vehicle fuel production may require different quality attributes than is the case for combustion of gas in internal combustion engines. This refers to the quality attributes required for natural gas (primarily methane) to be processed successfully in gas “reformation” equipment from hydrocarbon materials to carbon dioxide and hydrogen with the hydrogen meeting the quality requirements of vehicle PEM fuel cell power systems. Presumably the hydrogen quality requirements would be as specified in SAE standard 2719 (see issue 6.25)

Options for changes – effectiveness and feasibility:

Once firm state-level quality standards are in place for hydrogen fuel (see issue 6.25), the quality of natural gas feed-stocks for hydrogen fuel production may become a non-issue, at least from the perspective of government regulation. The ultimate issue is the quality of the hydrogen fuel to be used in fuel cell vehicles. The quality of the feed-stock natural gas for hydrogen fuel production would simply be a matter for fuel manufacturing entities to deal with in their own production operations.

Recommendations:

The first step would be to determine whether quality standards for natural gas used in internal combustion engines will also meet the quality requirements for hydrogen production.

The second step is to determine whether natural gas quality metrics are an issue for fuel quality regulation or simply an internal production concern for hydrogen fuel production firms – regardless of whether hydrogen production is taking place at the fuel dispensing facility site or at a centralized industrial plant with hydrogen delivered in bulk to fueling stations.

Findings from this query will determine whether state quality measures are needed or whether this is a non-issue from a regulatory perspective.

7: Alternative fuels issues related to fuels taxation

7.1 Fuel taxation

7.11 Plug-in electric vehicles (PEVs) and plug-in hybrids currently are not paying fuel excise (highway usage) tax on the electric power consumed. For the other alternative fuels, there are various problems of non-acceptance of fuel taxation methods.

7.12 Regardless of problems with alternative fuels taxation, the entire highway funding and taxation system looks likely to be substantially revised by states and the feds, and alternative fuels (and electric charging) will have to be built into the revisions.

Explanation of this issue:

With respect to fuel excise (state and federal highway fund) taxation, the market penetration of CNG, LNG, propane and biodiesel (plus the fact that biodiesel fueling largely involves mixtures of biodiesel with conventional diesel) mean that these fuels are being taxed for highway fund revenue (state and federal). On the other hand, hydrogen fueling and electric charging largely have escaped taxation thus far in New England due in part to vague or non-existent taxation regulations and in part to lack of enforcement by the states due to the small number of vehicles involved. State transportation departments and legislative transportation committees are, however, aware that alternative fuels – especially electric power – will negatively impact highway fund revenues significantly if the present method of taxation is retained and these vehicle fuel/energy sources become much more widely used.

Hydrogen and electric charging (both involving electric drive systems) mark the biggest departure from the internal combustion fuel taxation concept of cents per gallon or per gasoline or diesel gallon

equivalent, so these two energy and propulsion technologies create the biggest challenges for highway funding. The present per-gallon gas taxes used throughout the 5-state study region (and used in various forms throughout the nation at the state and federal levels) are not being adjusted to tax operators of plug-in electric vehicles (PEVs) based on sales of EV electric energy, EV usage or any other metric. New England PEV users currently are not paying into the federal Highway Trust Fund or the state-level highway funds in the New England states, so electric cars are not paying for a share of road construction costs based on their mileage driven. Due to the relatively small penetration into the New England vehicle market by PEVs thus far, this has not yet become a serious issue in the minds of most highway funding interests, but a goal of serious volume roll-out of plug-in electric vehicles and fuel cell electric vehicles is causing the issue to surface rapidly because federal and state highway maintenance budgets are being severely squeezed.

Beyond these circumstances with alternative fuels, the U.S. federal highway construction funding system, and many of the state funding systems, are essentially broken – unable to pay for infrastructure maintenance. This situation may require substantial change in how funds are generated and/or how money is spent. However, as some or all of the emerging vehicle “alternative” fuels come into widespread use, this highway funding dilemma can be turned from a problem to an opportunity to advance new vehicle and fueling technologies. It behooves PEV (and other alternative fuels) interests to be proactive in driving the highway funding issue early so the social costs advantages of PEV operation, vs. conventional fueled vehicles (emissions advantages etc.), can be reflected in highway fund revenue policies.

The Federation of Tax Administrators Motor Fuel Uniformity Committee is developing a "Taxation, Diversion and Alternative Fuels" Booklet. The Committee has approved Section 11 to be added to the booklet: Section 11-Taxability & Conversion Rates for Compressed Natural Gas (CNG), E85, Electric Vehicles/Electricity, Gasoline Hybrid Vehicles, Hydrogen, Liquefied Natural Gas (LNG), Liquefied Petroleum Gas (LPG), Methanol or “M85”and other fuels. Alternative fuels model legislation is also being developed by the FTA.

Not long ago, state and federal motor-fuel taxes (known generally as “gas taxes” or “fuel excise taxes”) motor vehicle taxes and fees and highway tolls - all collectively known as “user charges - provided the majority funds for highway maintenance and construction – with state and federal fuel taxes making up the lion's share of these “user charges”. As indicated in the table below, as recently as 2000, 58% of highway funding (federal, state and local) was supplied from motor fuel taxes and vehicle taxes and fees. By 2010 this percentage had dropped to 38%.

Source	U.S. Federal, State and Local Government Revenue Sources for Highways, 2000 to 2010 - Percentage Distribution by Revenue Source					
	2000	2002	2004	2006	2008	2010
Motor-Fuel and Motor-Vehicle Taxes and Fees	57.7%	54.2%	52.6%	50.5%	44.0%	38.1%
Tolls	4.3%	4.9%	4.5%	4.9%	4.7%	4.3%
Property Taxes and Assessments	4.7%	4.8%	5.2%	5.3%	4.7%	4.3%
General Fund Appropriations	14.7%	15.1%	16.2%	16.7%	20.8%	26.5%
Other Taxes and Fees	4.3%	5.6%	5.4%	6.0%	6.3%	5.5%
Investment Income & Other Receipts	5.6%	6.0%	5.2%	5.7%	8.6%	6.3%
Bond Issue Proceeds	8.6%	9.4%	10.9%	10.8%	10.9%	14.9%
Total Revenues ($ billions)	**$131.10**	**$134.80**	**$145.30**	**$169.00**	**$192.60**	**$221.00**

Source: U.S. Department of Transportation, Federal Highway Administration, "2013 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance", Chapter 6 – Finance.
http://www.fhwa.dot.gov/policy/2013cpr/chap6.htm#2

Making up the difference over this period, "general fund" appropriations (federal, state and local) increased from 15% to 27% of highway funding, and bond issue proceeds increased from 9% to 15%. (See http://www.fhwa.dot.gov/policy/2013cpr/chap6.htm#2) This is due to the combined impacts of increasing highway construction and maintenance costs, fuel taxation rates (cents per gallon) which have been held constant at the federal level for many years, reductions in per-mile vehicle fuel consumption because new vehicles get better fuel mileage and lower vehicle-miles driven by the public and by commercial fleets.

In effect, without implementing an explicit policy to this effect, the U.S. federal government and the states have collectively moved from a policy of highway funding largely by the fuel taxes and other user fees user fees to highway funding much more from general taxes and bonds.

From Funding and Financing Highways and Public Transportation, September 23, 2013, Congressional Research Service 7-5700, www.crs.gov R42877:

"*Congress has yet to address the surface transportation program's fundamental revenue issues, and has not given serious consideration to raising fuel taxes in recent years. Instead, Congress has financed the federal surface transportation program by supplementing fuel tax revenues with transfers from the U.S. Treasury general fund. The most recent reauthorization act, the Moving Ahead for Progress in the 21st Century Act (MAP-21; P.L. 112-141), signed by President Barack Obama on July 6, 2012, authorized spending on federal highway and public transportation programs through September 30, 2014 and provided for general fund transfers to finance the programs.*"

This report further concludes:

> *“ • Raising motor fuel taxes could provide the highway trust fund with sufficient revenue to fully fund the program in the near term, but it may not be a viable long-term solution due to expected future declines in fuel consumption.*
>
> *• Replacing current motor fuel taxes with a fuel sales tax or a fee based on vehicle miles traveled (VMT) raise a variety of financial and administrative concerns.*
>
> *• The political difficulty of adequately financing the highway trust fund could lead Congress to consider the desirability of changes to maintain the trust fund system or eliminating it altogether. Such changes might involve a reallocation of responsibilities and obligations among federal, state, and local governments.*
>
> *• Interest in improving transportation infrastructure with private and non-grant funding sources, such as tolls, public-private partnerships (PPPs), and federal loan programs is increasing, but many projects may not be well suited to alternative financing.”*

The combined impacts of federal and state transportation (primarily highway) funding shortfalls are major political and economic issues in virtually every U.S. state.

What does this mean for “alternative” fuels?

Into this highway funding and fuel tax problem come vehicles that do not use gasoline or diesel – the fuels which form the rate basis for the current state and federal gas tax system. This means that in addition to dealing with major funding shortfalls, highway funding decision-makers (federal and state) have to figure out how to deal with the complexity of going from essentially two fuels that are taxed to designing tax formulas for perhaps as many as seven fuel types.

Adding several more vehicle fuel types to the mix makes tax calculations more complex, and for plug-in hybrid and battery electric vehicle charging the added complexity of tax calculation and tax collection means that in many states (including all 5 of the project states) electric vehicles presently make no “fuel tax” payments for road upkeep.

The bottom line is that the current highway-funding revenue system is badly in need of overhaul, and the inevitable changes should accommodate new vehicle fuel/energy types that sell in significant volumes. That is, changes to the gas tax and broader highway funding systems are urgently necessary to keep roads repaired (and to fund other transportation modes) and to specify how alternative fuels and alternative vehicles should be taxed to pay their fair share of highway costs.

The key decision-makers in this dilemma are the U.S. Congress and the 50 state legislatures. Our focus is just on just the five states covered by this project.

For alternative fuels that are hydrogen or hydrocarbon liquids or gases, some states (including Maine) have instituted taxation formulas that are based on volume of fuel material dispensed with some adjustments to achieve a combination of two objectives –

1. Payment of a fair share of taxes based on the energy content of the alternative fuels in comparison to gasoline or diesel,

2. Taxation discounts for alternative fuels as cost inducements to the market to shift to alternative fuels.

Electric vehicle charging is different, however. Recent increases in sales and related publicity of electric cars have raised the issue that in most states electric cars generate no highway "fuel" tax revenue and thus are seen as not paying their fair share. In many states the same is true of fuel cell electric vehicles (FCEVs), although the low market penetration by fuel cell cars means that – thus far - FCEVs are generating less highway funding concern than battery electric vehicles (BEVs).

Not only do new vehicle fuels add complexity to the calculation of taxes – they also create problems concerning how the tax money will be collected. Unlike sales taxes on general purchases, "gas" taxes (on gasoline or diesel fuel) are, in most states, efficiently calculated for and collected from the bulk suppliers of fuel. This enables a small number of calculations and transactions as opposed to tax collections from each retail purchase – a huge volume of transactions. This is done efficiently through the bulk batch delivery system for gasoline and diesel fuel. Batch delivery of propane and biodiesel and LNG can also fit this model.

CNG and electricity do not fit this efficient model since natural gas and electric power are diverted out of a general purpose product stream, making efficient bulk/batch calculations and transactions more difficult or impossible for these two "fuels".

An advantage of hydrogen as an energy carrier is that is can be produced and delivered in a wide variety of manners. This flexibility of technology also adds complexity to taxation since the hydrogen can be delivered in bulk via trucks or by pipeline, or hydrogen can be produced at the dispensing site from water and electricity (including on-site renewable power sources) or produced on-site from natural gas that is in turn supplied either from the gas grid, from on-site methane sources (such as sewage treatment) or from trucked-in CNG or LNG.

Is this overall taxation dilemma and future complexity a "barrier" to alternative fueling for cars and trucks? It does create a barrier to the extent that uncertainty regarding fuel costs and tax-rate calculations interferes with developer decisions to invest in fueling facilities, with equipment manufacturer decisions to prepare and market new dispensing technologies, and most importantly with consumer decisions to confidently invest in alternative fuel vehicles.

As with the fuel quality and measurement issues, the New England states are less than fully prepared for expanding their "gas tax" systems to a wider range of fuels beyond gasoline and diesel. Maine has adopted fuel taxation rates for alternative fuels, including natural gas and hydrogen, that are linked to energy content of those fuels. In general, however, in New England and throughout most of the U.S., the states are - probably wisely - waiting to see which fuel/energy types achieve significant market share and to see how the bigger issue of overall highway-use taxation/funding plays out before they make major tax system changes to accommodate alternative fuels and electric charging.

A controversy that complicates the fuel tax issue is the scope of public costs that should be recovered from taxation of fuel consumption or vehicle use – and whether/how those costs should be dealt with. Use of motor vehicles generates costs to society at large - “societal costs”. The societal cost dealt with by the traditional gas taxes is highway wear and tear maintenance and construction. However, efforts are underway, in New England and elsewhere in the U.S., to pay for the apparent societal costs that strongly appear to be due to climate change impacts of vehicle carbon emissions and to other pollutant impacts. In the very likely scenario that federal and state highway-use or gas tax systems will be opened up for significant changes, environmental interests will likely push to include payments by vehicle users to “internalize” the pollution and climate change societal costs due to carbon emissions. If new taxation methods are designed to factor in the variation in carbon impacts from various fuels and vehicle types, this could make alternative fuel vehicles more economically competitive.

Options for changes – effectiveness and feasibility:

Initial research into the status and prospects for state and federal gas tax changes leads to the following tentative conclusions:

1. Every state in New England – and many other states – recognize that the revenue system for funding highway transportation (federal and states) needs to be changed quickly in order to prevent very serious deterioration of highway infrastructure.
2. As of late 2014, the highway and transportation infrastructure funding issue had not yet reached a sufficient level of crisis status to force serious action at state levels in New England.
3. A very potent combination of constituencies, stakeholders and lobbyists is “on board” in recognizing the highway/transportation funding problem although their self-interests conflict around possible solutions –
    - Transportation committees in the U.S. Congress and in state legislatures,
    - Federal and state government Department of Transportation (DOT) officials,
    - Chambers of commerce at the local, state and federal levels,
    - Highway engineering and construction firms and their regional and national organizations,
    - Conventional (gasoline and diesel) fuel production and marketing firms and business organizations,
    - Truckers and other commercial transportation firms and their business and lobbying organizations,
    - Car, truck and commercial vehicle manufacturers, OEMs and suppliers,
    - “Good roads” lobbying groups in all states and at the national level,
    - Environmental and alternative fuels advocacy organizations,
    - Global warming activism organizations.

4. A wide range of solutions alternatives is being deliberated by these interest groups making for potentially very complex national and regional debates on the matter, and complex

debates make for long deliberations unless the situation becomes perceived as acute by powerful interests.

5. Investment in alternative fuel supply and dispensing/charging infrastructure is not yet seriously impeded by this taxation dilemma, but alternative fuel interests want the issue resolved in order to clarify the economics of their businesses and investments.
6. Given the ostensible public goals of cost-effective transportation, a physically and economically solid transportation infrastructure and reduced environmental/climate impacts from transportation, alternative modes of transportation will also come into the taxation picture. Bus and rail transit, pedestrian and bicycle advocacy, supporters of improved land-use configurations and other interests will seek funds if the highway funding/taxation issue gets fully examined.
7. In New England, state legislators – especially those serving on legislative transportation committees – and the states' Department of Transportation (DOT) officials are eager to get constructive input to deal with what they see as a very difficult issue with no clear solution.

Numerous options are being deliberated for making the highway and/or transportation funding situation more solvent and effective and to accommodate the complexities of electric vehicles and alternative fuels. Factors considered in developing these financing alternatives include vehicle mileage driven and vehicle weight (both directly related to road deterioration), energy consumption (a measure that can be compared across all fuel/energy types), carbon footprints/impacts from various fuel and vehicle technologies,

Among the more logical options being considered –

1. Per-gallon taxation

Adjustments to the present state and federal systems that are essentially calculated as fractions of a dollar of taxation per gallon of fuel purchased. The current fuel tax concept would continue to be adjusted to cover taxation of new vehicle fuels especially gaseous fuels (CNG, LNG, propane and hydrogen) and electricity using appropriate measures of dispensed fuel/energy. These adjustments to the present per-gallon tax concept will accommodate new fuels but with the burden of higher complexity of both taxation calculations and tax collection methods.

The current per-gallon taxation model is leaving the federal government and many states far short of the budgets they feel are necessary to maintain the highway infrastructure type and size favored by the dominant constituents for transportation funding. Therefore, this option means that either the infrastructure needs to be scaled down or levels of taxation per gallon need to be increased at the federal level and in many states – options that currently both face strong opposition.

An option considered for enhancing the state and federal transportation funds from the per-gallon model is to index the cents-per-gallon rate to follow inflation. This option, with a limit on the level that the tax could be increased, was passed by the Massachusetts Legislature in 2013, then rejected by Massachusetts voters in a statewide referendum in November, 2014. Other states and the feds took notice.

Another option being considered is maintaining the dedicated revenue stream for transportation (largely highways) funding, but shifting from a per-gallon tax to a sales tax calculated – as with other sales taxes – as a percentage of the transaction $ amount. The change to a sales tax would make it

much easier to tax the emerging mix of fuel types with the various measurement and delivery methods explained above. Variations in measurements and energy contents would no-longer be an issue. This would especially enable taxation of commercially-supplied electricity for electric vehicle charging – although home charging of vehicles would bypass this taxation unless sophisticated home power measurement systems are required.

In any case, shifting to a sales tax will not replenish the highway/transportation funds unless the price of fuels across the board – including currently inexpensive electricity and gas – rise faster than the impacts of less driving and higher vehicle efficiency.

2. Per-Btu taxation. Modification of the present system to tax all fuel/energy types as fractions of a dollar tax per Btu of energy value dispensed. This would replace a potentially confusing mix of fuel volume calculations and tax rates with a universal measure, Btu's of energy value, as the basis for taxation. Whenever a new fuel or energy source becomes significant in the market, its Btu content is used to calculate taxation.

This would offer the administrative and operational simplicity of a universally-applicable basis for taxation – the energy content sold. However, this would still be only an indirect and approximate indicator of highway-usage impact, and it would not eliminate the issues of collecting tax for energy types – such as CNG, electricity and some production modes of hydrogen - that are not batch delivered.

3. Per-mile or Vehicle Miles Traveled (VMT) taxation – GPS-based
Taxation based on vehicle-miles driven on highways as calculated by global positioning system satellite (GPS) tracking. This would eliminate the complications of calculating and collecting taxes on fuels that contain different energy contents per measured quantity. It would also eliminate the complications – explained above – of collecting taxes from numerous individual dispensing transactions vs. the present system of tax collections from a limited number of batch deliveries. This would also form a much more accurate base measure of highway-use impact than is the case with per-gallon taxation of fuel consumption.

The U.S. Transportation Research Board and the state of Oregon have been researching and experimenting with this miles-driven method for a few years, using Global Positioning System (GPS) satellite and Internet or other data communication technology to continuously monitor and calculate miles traveled by each taxable vehicle. The Oregon experiments conclude that this taxation method offers the advantages of being based on a more accurate measure of road wear than is the case with per-gallon taxation. This method also calculates tax the same way regardless of fuel type.

With the mileage-based tax calculation adjusted for vehicle weight and number of axles or wheels, the tax would be based on an even better measure of highway impact from vehicle use. The tax could also be adjusted to factor in the carbon-impact costs of vehicle operation by adjusting the tax rate based on the “well-to-wheels” or total life-cycle carbon emissions from the combination of vehicle/engine technology and fuel/energy type.

The primary problems with this method are its technological complexity and what is felt to be a privacy intrusion imposed by the monitoring of distances traveled and thus the geographic locations of vehicles, presumably by a government entity or contractor. Also, car rental entities may oppose

this method since it might shift the initial tax payment responsibility from car drivers (renters) to car owners (car rental companies).

Depending on the level of vehicle location data allowed with this method, the system could be further fine-tuned to calculate a vehicle's mileage driven in each state enabling taxes to be paid to the state where road impacts are made rather than where fuel is purchased - a significant consideration in the small-state region of New England.

4. Vehicle Miles Traveled (VMT) taxation – odometer-based. Taxation based on miles driven as measured by an accurate device that already exists in most vehicles – the electronic mileage odometer. This would require odometers to be secure and highly untamperable devises, probably necessitating upgrades to odometer technology and security by the vehicle manufacturers. Therefore, this system might have to be adopted by numerous states and the federal government in order to be viable.

As with the GPS-based per-mile taxation (see above), the basic calculation of tax and the collection process would be the same for all vehicles regardless of fuel type. There are numerous ways that the tax can be collected. One method would be to collect the tax as part of the annual vehicle registration or upon registration cancellation. Alternatively, the tax could be collected on a quarterly basis, reducing the cash-flow impact on the vehicle owner.

This method offers the advantage of relative simple and standardized application across all fuels. However, a possible disadvantage as perceived by drivers would be the need to explicitly make periodic tax payment as part of the car registration process as opposed to having the tax hidden in the sale transaction – unless vehicle mileage is required to be reported and paid for each dispensing transaction. Such mileage reporting at the “pump” is already common among fleet vehicle owners who require their drivers to report odometer mileage at each fill-up for cost-control and fleet management purposes.

As with other per-mile taxation options, the tax rate could be adjusted up or down depending on the vehicle weight and number of axles or wheels. It might also be adjusted based on the carbon emission and carbon footprint implications of the vehicle propulsion system and fuel type.

In some states, a political obstacle to per-mile taxation – an objection that may or may not be substantiated by economic facts – is the concern that mileage traveled out-of-state by state residents would be taxed by the state in which the vehicle is registered, while in-state mileage driven by non-residents would not be taxed where the road impacts occur. Legislators in some states – especially tourism-dominated states like Maine and Vermont - feel that the later mileage exceeds the former, thus enabling a net benefit to the state from out-of-state visitors under the current fuel tax system – a benefit they do not want to lose.

Compared to GPS-based VMT taxation, the odometer-based mileage taxation would have the advantage of being less intrusive of drivers' privacy, but it would also collect less detailed data than a GPS-based system. This would enable fewer real-time options such as variable taxation rates based on time of vehicle use on busy roads as a cost incentive to drive at times less of lower highway congestion.

5. Funding through general fund, non-dedicated revenues

This sounds like a drastic departure from the existing federal and state models of per-gallon taxation, however, this is essentially the taxation model that the U.S. is currently adopting absent explicit decisions by Congress and state legislatures to either increase per-gallon “gas tax” rates or scale back the highway infrastructure.

As cited above, nationally, by 2010, the percent of federal, state and local highway funding covered by dedicated fuel and vehicle taxes had dropped to 38%. During that period, the percentage of highway maintenance and construction funding covered by non-dedicated and general fund revenues at the federal, state and local level increased above 51% as Congress and legislatures sidestepped the revenue issue. This has shifted taxation from the highway users to income, sales, excise, property and other taxes including repayment systems for state and municipal transportation bonds.

Some transportation stakeholders favor drawing the majority or all highway maintenance/construction revenue from non-dedicated or general fund sources asking why transportation, like any economic and social support program, should be spared the responsibility of competing with all public needs for funding.

The politics of explicitly replacing all or most of the dedicated federal Highway Trust Fund and analogous state highway funds with budget-cycle funding competitions against all public funding constituencies would be a big change. However, absent explicit action by states and Congress, this is where the U.S. and many states seem to be heading through the past 15 years..

The politics of shifting toward non-dedicated revenue sources might be sweetened by converting the tax on fuel to a sales tax computed as a percentage of fuel purchase price rather than cents per gallon. The sales tax approach would also largely eliminate the emerging problem of calculating fuel taxes for up to 6 or 7 different fuel types with different volume or energy measures. Virginia has eliminated its cents-per-gallon fuel taxes in favor of a sales tax on fuel, but the sales tax on fuel is dedicated to transportation funding, not inserted into the general fund. In New England, both Vermont and Connecticut currently have fuel tax systems that combine a per-gallon tax and a percentage or sales tax.

From the perspective of alternative fuels and alternative fuel vehicles, the general fund method would eliminate most obstacles to accommodating new fuel types into the current per-gallon taxation model. However this shift might also eliminate the tax-system incentives for alternative fuels in many states – including some of the New England states, where alternative fuels are given a pricing boost through fuel tax rate advantages.

6. Other Options

Other transportation infrastructure funding options being considered include expanded use of toll roads, loan programs, public-private partnerships or purely private options for financing and operating roads or passenger rail lines, and value-capture methods where transportation system financing captures some the added value from the real estate value enhancement that can be attributed to better road, rail or bus access.

Recommendations:

It appears virtually certain that the federal and state “gas tax” model will be reconsidered at the federal level and in many states. Some regions are losing patience to the point of by-passing the federal and state non-decisions on highway funding. For example, Clark County Nevada has recently established a county gas tax in order to put needed transportation infrastructure projects back on schedule. Local or county gas taxes exist in other states as well.

The likely federal and states tax-system reconsideration can be made advantageous to alternative fueling. The following steps are suggested for the entire New England region:

1. Put to use throughout New England the highway/transportation funding options information summarized in this report plus the much more extensive data from the Federation of Tax Administrators Motor Fuel Uniformity Committee "Taxation, Diversion and Alternative Fuels" project and the recent Congressional Research Service Report Funding and Financing Highways and Public Transportation Congressional Research Service 7-5700 www.crs.gov R42877 as well as the huge range of other available analyses. Use this information to task and fund a New England transportation research entity, such as the University of Vermont Transportation Research Center and/or the Northeastern University Dukakis Center, with the challenge of assessing and comparing these and other financing alternatives to the current New England states' fuel-excise-tax-based funding systems in terms of:

- Revenue implications for each state,
- Administrative costs,
- State and regional economic and competitive implications,
- Political viability,
- Compensation/payments for social costs,
- Privacy and fairness considerations,
- Other key factors.

Submit these findings to the New England Governors Association to enable analysis of these options on a regional basis to save money for the states, expedite and educate the process in each state and maximize the quality of input to each state's response to the transportation financing dilemma.

2. Convene a New England Governors' conference (or series of conferences) on state highway and transportation infrastructure funding at which the completed analysis of options is presented in detail, examined and evaluated using solid background data on costs, revenues, viability, fairness, privacy etc. The conference should include Executive Branch energy officials, DOT Commissioners, key executive staff and transportation committee leaders from the state legislatures, representation from the Federation of Tax Administrators Motor Fuels Tax Section and from the U.S. DOT. An idealized outcome of a single recommended system for all 6 New England states should not be expected or even desired. More appropriate would be efficiently informed input so each state's executive and legislative process can be carried to a highway and transportation infrastructure financing solution more fully and quickly than will be the case if each state researches the options independently with limited resources.

7.13 *When LNG is taxed as a liquid fuel on a per-gallon basis the customer pays approximately 70% more tax than for an equivalent diesel fuel energy value. This is viewed as a disincentive to convert trucks from diesel to LNG.*

Explanation of this issue:

The current federal highway excise tax is 24.3 cents per gallon for both LNG and diesel, but approximately 1.7 gallons of LNG contains the same Btu energy content as one gallon of diesel fuel. As a result, the LNG industry contends that LNG is unfairly taxed at a 70-percent higher rate than diesel on an energy-content basis. This LNG industry feels that this differential forms a very significant economic barrier to adoption of LNG as a replacement for conventional diesel.

Over the past few years, the LNG industry has pressured for changes to equalize the tax level on a per-Btu basis at the state levels throughout the U.S. and at the federal level. In New England, Maine has adjusted the rate, but other New England states have not.

In 2013, U.S. Senators Michael Bennet (D-CO) and Richard Burr (R-NC) introduced legislation, titled the *"LNG Excise Tax Equalization Act of 2013" (S.1103)*. This legislation would have changed the way LNG is taxed—from a volume (gallon) to an energy content (diesel-gallon-equivalent or DGE) basis. Also in 2013, U.S. House Representatives Mac Thornberry (R-TX) and John Larson (D-CT) introduced similar legislation, H.R. 2202.

Options for changes – effectiveness and feasibility:

The state of Maine's treatment of LNG taxation has been adjusted to reflect the per-gallon energy content of LNG which is used as a direct replacement for conventional diesel, reducing fuel costs especially in long-haul trucks. The Maine approach is a good example for the other New England states, and a possible formula for changes to the federal fuel tax treatment of LNG and other gaseous and liquid alternative fuels.

The fastest way to induce U.S. state legislatures to make this logical change to their fuel tax rates may be for the U.S. Congress to change the federal tax rate giving the states a clear and consistent template to confidently adjust their tax rates – for CNG, propane and hydrogen in addition to LNG.

Recommendations:

Unite the New England Congressional delegation as fully as possible behind federal legislation to change the federal fuel taxation rates for LNG, CNG, propane and hydrogen to be in line with the energy content of each of these fuels. The state of Maine taxation formulas for these fuels form a logical basis for modification of federal and state tax rates.

7.14 *In the cases of CNG, hydrogen, LNG and electric charging, non-batch fuel delivery methods and on-site fuel processing, make it difficult or impossible for taxing entities to use the current, relatively efficient mode of taxing fuel at the wholesale, bulk delivery level where the taxes are passed to the retail level within product prices.*

Explanation of this issue:

According to the Federation of Tax Administrators (FTA) White Paper Document on *"Motor Fuel Tax Issues with Natural Gas and Other Alternative Fuels 2009"* – a major alternative fuels issue recognized by the FTA was that state taxation of highway motor fuels - gasoline and diesel - is done relatively simply at the bulk transportation level. That is, the relatively small number of wholesale transactions of fuels are taxed - not the far larger number of retail transactions. The tax is then passed on within the wholesale fuel price as delivered to the retail entity. Propane is also delivered and thus taxed in bulk.

The FTA's concern was that compressed natural gas cannot be taxed at this efficient bulk batch delivery level. Electricity and CNG are both delivered by mass distribution grids in a constant stream for many uses, so separating out the motor fuel component volume for taxation would require secondary meters and would be cumbersome and expensive. The option of computing and collecting taxes for individual CNG (or electricity or hydrogen) retail sales is also prone to non-reporting and would involve tracking far more entities in the taxation enforcement function.

With CNG, electricity and hydrogen and some modes of LNG delivery as well, the FTA and the state taxation entities stated - as of 2009 - that they had not figured out how to track and thus tax the volumes of gaseous fuels and electricity consumed for transportation vs. other non-taxed uses. This issue has not been remedied.

Options for changes – effectiveness and feasibility:

If the method for generating highway construction revenue is changed (see issues 7.11 and 7.12, above), this tax calculation and collection issue for non-batch fuels can be eliminated with mileage-based taxation, a shift to a fuel sales tax or a more complete transition to funding from general funds and/or other non-dedicated revenue sources.

If the per-gallon (or per-volume) taxation method is retained taxation collection might shift to the retail level much like sales tax collections for other taxable retail transactions. With advances in data technologies, this becomes more feasible and less burdensome to retailers, although it would likely be resisted by small retailers for whom the process and technologies represent a relatively higher financial burden.

The Federation of Tax Administrators (FTA) has recommended new data-collection forms and data fields to report fuel sales for taxation under the current system of federal and state fuel taxation. These suggested forms include fields for recording sales and taxation of alternative fuels: CNG, LPG, LNG, electricity, ethanol, methanol, and "other". Biodiesel and hydrogen are not included on these suggested forms, although biodiesel might be reported as "diesel" for taxation purposes.

Measurement metrics suggested by the FTA for these fuels include gallons, lbs, cubic feet, and kiloWatt hours. Therefore, these alternative fuels are being recognized for inclusion into the taxation system. However, if the current per-gallon (or per-volume) tax system is retained, there is the concern that a significant percentage fuels which cannot be taxed at the bulk wholesale level (CNG, electricity, and possibly hydrogen and LNG) may escape taxation.

Recommendations:

This issue is part of the broader matter of how highway and transportation funding will be dealt with as (if) new vehicle and fuel technologies gain significant market share – see issues #7.11 and #7.12, above. A recommendation is to use this issue to leverage changes to the overall funding system. That is, if vehicle fuel and energy retailers become unhappy with an increased need to calculate and collect taxes at the retail transaction level, that constituency can add impetus to changing the transportation funding mechanisms at all government levels. Thus the recommendations for issues #7.11 and #7.12 (above) are the appropriate strategy for this issue as well.

7.15 *In the case of LNG fuel taxation, the fact that LNG is very likely to be used almost exclusively in long-haul trucks means that the current IFTA system for taxation on interstate and international trucking is likely to complicate (or possibly be facilitated by) revision of the highway funding system.*

Explanation of this issue:

Highway-use taxation (or “gas tax” or “highway excise tax) presents a different set of issues for LNG vs the other alternative fuels. Present technology and market trends show LNG fueling primarily limited to interstate and long haul trucks. This brings the International Fuel Tax Agreement (IFTA) into the picture. The IFTA covers most U.S. states and Canadian provinces requiring interstate truckers to pay fuel tax based on the number of miles driven in each state or province rather than simply paying based on the volume of fuel purchased in each state.

The International Fuel Tax Association, a private entity, administers the IFTA, redistributing the tax dollars paid to each state by collecting from each truck the volume of fuel purchased in each state as well as the distance driven in each state. The association re-distributes diesel fuel tax payments to the states based on the mileage driven by truckers in each state. The IFTA system was established largely to apply adjustment to a system that previously had trucks purchasing fuel - and thus paying taxes - in states different, to some degree, from where they drove and impacted the highways.

Purchases of LNG for IFTA-registered trucks should be adjusted in the same manner as diesel fuel purchases. How will the IFTA arrangement be modified if the general system for highway funding is overhauled (shifting from per-gallon to miles-traveled taxation for example) and how will it impact truckers who use LNG?

Options for changes – effectiveness and feasibility:

If the gas tax is shifted to a miles-driven model in most states, and the data compiled for tax calculations specifies that state in which the driving has occurred, that may simplify the tax-state $ redistribution function that the IFTA currently performs.

If the highway and transportation funding model shifts more completely toward general fund and other non-dedicated sources, the IFTA system and adjustment process may become unnecessary.

Recommendations:

This issue requires more analysis and background data than this project has been able to undertake. Further work should focus on addressing the following questions:

1. Is LNG fueling currently accommodated within the IFTA revenue adjustment model?
2. What research and policy positions have been suggested by the International Fuel Tax Association in response to highway and transportation funding system changes that are being considered in the U.S.?
3. Is it likely that some options for changes to the U.S. highway funding models (federal and state) can simplify allocation of funds to the states based on highway-use impacts caused by trucks?

8: Policies and issues related to property, equipment and casualty insurance

8.1 Remove barriers to fueling station operation

8.11 Property and casualty insurers generally do not have (and thus do not use) full and accurate assessments of risk associated with alternative fueling facilities. This appears to result in higher than necessary insurance costs for alternative fueling facilities owners.

8.12 Compared to the insurance situation for gasoline and diesel fueling stations, few insurers provide coverage for CNG facilities, and this may also be the case for propane, hydrogen and LNG.

Explanation of these issues:

The property and casualty insurance industry's current response to alternative fuels fueling/charging appears to be a situation where insurance to cover the equipment and potential liabilities connected with that equipment is written only by a few insurers. Also, Insurance coverage for many alternative fuel dispensing facilities is written by the “surplus lines” market – the portion of the insurance underwriting and contracting business that covers entities, equipment and activities which have limited history of operations and thus limited data for risk assessment. This appears to apply mostly

to the gaseous or liquid-to-gas fuels – CNG, hydrogen, propane and LNG. It is not clear whether/how this will apply to electric vehicle DC fast charging stations.

According to a participant in the insurance industry, less than 10% of insurance agents can handle "surplus lines" insurance coverage. Therefore, when a gaseous fuel dispensing or fuel handling facility requires coverage through the surplus lines market, insurance coverage is likely to be significantly more expensive and more difficult to arrange than would be the case for more familiar coverage of common gas station facilities. At this point, many alternative fuel infrastructure developers and facilities owners are not fully aware of the cost differential for property and casualty insurance for their facilities compared to gasoline and diesel dispensing facilities.

This creates two issues for alternative fueling: When relegated to the "surplus lines" (as opposed to "standard lines") of property and casualty coverage, the insurance companies have more leeway to charge higher insurance rates to cover the uncertainty/risk that results from lack of technical information, meaning they can charge considerably higher rates than the true risk might warrant without being pushed by the market or by regulators to research the true risk and incorporate it into their rates. Related to that problem, surplus lines insurance underwriting – in most states – does not come under regulation by the states' insurance commissioners, so fuel facilities developers and owners are apparently, in many cases, buying insurance in the unregulated market.

These circumstance tend to put some alternative fuel dispensing system developers and owners at a significant economic disadvantage with respect to ownership and operational costs relative to conventional gasoline and diesel facilities. This is a situation that is common to many new, early-market technologies. Nevertheless, this is an impediment to market advancement of alternative fuels – an impediment that might be quickly removed with aggressive application of rigorous risk analysis within the U.S. P&C insurance industry.

Options for changes – effectiveness and feasibility:

Action on this matter might be undertaken by any or a combination of relevant entities:

1. Insurance Commissioners in each of the 5 project states who presumably have an interest in ensuring fair insurance coverage and in bringing appropriate segments of new and growing insurance business under regulatory control.
2. Energy directors in each of the project states who have an interest in removing such barriers to successful establishment of alternative fueling infrastructure.
3. Business development organizations representing the vehicle alternative fuel/energy industries that are most impacted by this insurance situation – CNG, LNG, propane, hydrogen and DC fast-charge electric charging.
4. Energy facility developers.
5. Codes and standards organizations that administer the key guidelines and rules used to minimize fire, public safety and property damage risks from fueling facilities – most notably the National Fire Protection Association (NFPA). (See also issues #s 1.12 to 1.15 above).
6. State and local codes enforcement and fire protection authorities – state fire marshals.
7. Insurers that specialize in arranging and negotiating terms for property and casualty insurance on new technologies, especially public-access energy facilities.

Recommendations:

Actions with state insurance commissions and others to eliminate unjustified insurance cost differences should start with awareness on the part of the developers of CNG, propane, LNG and hydrogen fueling facilities. This process might be started with a webinar by a major insurer (The Chubb Group for example) to explain the current alternative fuel facilities insurance pricing situation and the risk assessment differential vs. conventional fueling and to suggested steps to put insurance pricing more in line with true risk.

A suggested sedond step on this issue is to convene a small series of discussion meetings to address this issue in one of the project states – Massachusetts would make sense. The meeting might be organized and planned by the Massachusetts Department of Energy Resources with participation by the Office of the Insurance Commissioner, representatives from the CNG, LNG, propane, hydrogen and DC fast-charge industries, the State Fire Marshal, the National Fire Protection Association, the Clean Cities Program and others as appropriate including interested parties from the other New England states.

Objectives for the meeting would include:

1. Determining the extent to which insurance coverage, rates and regulation issues constitute an impediment to expansion of alternative fuel facilities in the state,
2. Clarification regarding the surplus lines vs. standard lines status of insurance for alternative fuel facilities,
3. Explanation of the regulatory status for insurance of these facilities,
4. Suggested actions to apply more rigorous risk data to insurance pricing and contracting in this market.
5. An agenda of steps to move alternative fueling facilities into “standard lines” insurance coverage, risk assessment and pricing.

The results of these meetings would suggest appropriate followup actions for Massachusetts and for the other four project states. However, to maximize leverage in dealing with this issue, the New England states should work with other states that are addressing insurance costs for alternative fuel facilities – most notably California.

8.13 In many respects, dispensing of gaseous alternative fuels may involve lower risk than is the case with gasoline, but insurance risk assessments and rates do not reflect this.

Explanation of this issue:

Producers and installers of alternative fuels dispensing equipment make a strong case that such equipment has been developed from the ground up using current technology and with the requirement to conform to standards and public expectations that did not exist through much of the

100+ years when conventional fuels dispensing equipment evolved and became accepted for everyday use. The argument is made that this has resulted in superior-performing equipment, yet risk assessments are not commensurate with this performance level. For example, a CNG fueling nozzle cannot dispense CNG into the open air or onto the ground. Similarly, hydrogen fueling equipment built to NFPA2, NFPA-30A AND NFPA-50A standards includes highly sophisticated dispenser-vehicle connections and flow controls. This functionality does not appear to be incorporated yet into insurance risk data.

Options for changes – effectiveness and feasibility:

Since relatively few alternative fuel dispensing facilities are built each year compared to gasoline and diesel facilities, and because the market is not clamoring for competitive pricing on alternative fuel facilities insurance, the property and casualty insurance business has little compelling incentive to update their risk assessments with information about alt fueling equipment. Therefore, at this point any responsibility for updating the insurance industry's equipment knowledge lies mostly with the alternative fuels industry organizations, perhaps facilitated by the U.S. Department of Energy.

Insurance rates do not appear to be an issue for biodiesel facilities.

Recommendations:

It may behoove the CNG, LNG, propane, hydrogen and electric vehicle charging industries to join together in an effort to update the property and casualty industry with current information about their fueling facilities equipment, codes and standards conformance status of this equipment and other information relevant to insurance risk assessment. Despite the competitive status of these industries, collectively they might achieve more progress with the insurance industry to reduce their insurance costs.

Relevant fuel industry organizations for this purpose include:

- Natural Gas Vehicles for America (NGVAmerica)
- National Propane Gas Association
- Fuel Cell and Hydrogen Energy Association
- Plug-In America

This could initially take the form of a webinar orchestrated by a third party or by any of the business organizations representing one or the alternative fueling interests. The webinar objectives would be to initiate a process that informs the property and casualty (P&C) insurance industry about the current status of dispensing equipment for each of these fuels and to bring updated fuel dispensing and storage technology information into the P&C risk assessment.

An insurance organization to orchestrate the insurance industry's participation might be the Property Casualty Insurers Association of America.

8.14 *Accurate risk assessments and appropriate insurance pricing may be hampered by lack of "best practices" models for alternative fuels dispensing stations.*

Explanation of this issue:

Insurance companies can become more comfortable with issuing reasonably priced property and casualty insurance coverage if they are covering facilities that they know have been designed consistent with "best practices". This is an additional reason to develop "Best Practices" designs for fueling station configurations and equipment.

Options for changes – effectiveness and feasibility:

In addition to the objectives spelled out in Issue # above, fueling station best practices and standard designs for each fuel type could also help to reduce insurance prices and to bring alternative fueling facilities insurance coverage within the realm of standard coverage that is regulated by state insurance commissions.

Recommendations:

Use the insurance industry updating process initiated for Issue #8.13 to provide “Best Practices” design and operational information to the insurance industry. “Best Practices” design and process details are explained under Issue #1.16.

9: State-level public utilities rules, regulations and policies

9.1 Remove barriers to fueling station operation

9.11 *State public utilities regulations limit who can sell electricity on the retail market. This appears likely to interfere with the ability of business entities to sell electric charging services and to establish pricing for this product/service.*

Explanation of this issue:

The rules under which electric power can be supplied as a vehicle “fuel” are very different from the regulations that impact delivery of other fuels. Currently the rules for selling electricity are not at all geared toward retail vehicle fueling. This can create problems if one's objective is to function as a private, commercial entity selling electricity for plug-in battery electric cars and trucks.

Unlike the other fuels, electricity is delivered by centralized retail power distribution utilities working under a distinct system of state and federal regulations that control pricing, specify who can sell power, control power distribution methods and technologies and influence locations of power availability. Utilities rules in most states limit the ability of regulated retail electric utilities to sell power

to entities that would re-sell that power. There are also restrictions on the ability of investor-owned utilities (IOUs) to invest in competitive business ventures where rate-payer-funded resources are at risk. Sale of power by a utility for electric vehicle charging may be subject to such restrictions.

At the volume of electric power necessary to run the number of PEVs that would constitute a significant portion of the U.S. car and small truck fleet, most suppliers of that power would presumably require payment for the power based at least in part on the volume of power dispensed. The laws in each of the 5 states covered by this project need to be researched to determine whether these power sale restrictions apply. Depending on the findings of this research, either the restrictions would need changes, or such restrictions may need to be removed to enable sales of power for vehicle charging. Conversely, perhaps a very different paradigm of power-supply economics would be needed to compensate power suppliers (utilities or third parties) for the power supplied to vehicle charging and for the service of delivering the power to the charging sites.

If electricity sales laws and regulations in the 5 project states restrict the rather new business of vehicle charging stations, state energy and public services/utilities policy-makers face the question of whether these rules, as they currently stand, are appropriate or whether they constitute inappropriate obstacles to widespread, cost effective, commercial and retail vehicle charging services.

Due in part to the still somewhat limited market penetration by plug-in electric vehicles (PEVs), sales and pricing of electric power for vehicle charging runs the gamut from no fee to the amount paid to the homeowner's electric power supplier for the kWhs put into the vehicle to per-kilowatt hour charges for power consumed to service-only fees based on the time that the charger is used or the time that the vehicle is parked in a charger-equipped parking space. However, electric vehicle charging fee strategies are constrained by public utilities regulations (varying by state) that make it difficult or illegal for independent business entities other than approved utilities to sell - or resell - electric power on a cents-per-kilowatt-hour basis.

Some states have restricted the ability of Investor-Owned Utilities (IOUs) to own and operate charging station infrastructure at utility ratepayer expense. Policy thinking on this is that electric power utility ratepayers should not be forced to fund equipment that the utility will use to generate revenue that has a possible negative impact or virtually no positive impact on the ratepayer's electric power rates. Thinking is also that such ratepayer subsidy of costs to supply vehicle “fuel” (energy) would enable electric utilities to monopolize a portion of what is viewed as the highly competitive vehicle fueling market.

This uncertainty constitutes a barrier to high-volume roll-out of charging services for an expanding electric vehicle market. This issue is important to enabling charging stations especially the DC fast-charge and level 2 stations that will provide charging services at public facilities. It seems necessary that either independent businesses will be made legally able to re-sell electric power that they buy from the grid utility or utilities will be enabled to sell their power directly for retail customers' cars and trucks much as those utilities sell and supply power to the homes and buildings of individuals and businesses.

These issues are being discussed in the five project states, but absent a surging market demand for commercial charging services, there is little incentive for the states' public utilities regulators and legislatures to resolve these questions.

Options for changes – effectiveness and feasibility:

The supply of electric vehicle power and charging services appears to be evolving into 4 supply channels –

1. Home charging where, under present power-supply technologies, the power-supplying entity does not distinguish vehicle charging from other uses of the electricity.
2. Charging service supplied at no cost by a third party such as an employer, a shopping mall, hotel, automobile dealership etc.
3. Charging service supplied by a third party such as a parking garage or a municipality where a fee is paid for the service of being connected to the charging station.
4. Charging service supplied by a commercial energy or fuel supplier – such as a fueling station or store – where a fee is paid to the commercial entity based on some combination of time connected to the service and/or the amount of electric power supplied.
5. Charging service and electric power supplied directly by an electric power delivery utility with a fee paid for the charging service and for the electric power.

Although there may be some legal uncertainty around each of these situations, it appears that with #s 1 & 2 there are no legal constraints on supplying the power for charging.

In the case of #3, there is some legal uncertainty where charging service and equipment suppliers feel that charging can be sold as only a service without issues of reselling electric power. State public utilities regulator are not inclined to fully agree with that.

For #4, state utilities regulations come into play, in some cases restricting the ability of a commercial entity other than a licensed utility to re-sell power procured from a power distribution utility.

With #5, state laws in some cases may prohibit or restrict the ability of a retail power-supply utility to earn revenue from selling electric power to people and entities that are not utility customer accounts.

The situations of #s 4 & 5 are where legal work is needed to either clarify the law in each state, enable power sales under the laws, modify the public service or utilities laws and related regulations, or prohibit such sales of electric power.

Some states are examining these issues. In New England, the Massachusetts Department of Public Utilities, Electric Power Division is undertaking an analysis of these matters with the intent to enable electric vehicle charging. The Maine Public Utilities Commission has been asked whether electric power can supplied by third parties for vehicle charging when charging is supplied only as a service, not as the resale of electricity. There has not been a clear answer.

Recommendations:

Work beyond the scope of this project is needed to determine, for each of the five project states, whether:

1. Electric power can be purchased from an electric utility by a commercial entity and resold to a public customer or to another commercial entity in the form of electric vehicle charging services and electricity supply.
2. Electric power produced by a non-utility entity (on-site solar-generated power for example) can be sold to a public customer or to another commercial entity in the form of electric vehicle charging services and electricity supply.
3. A retail power distribution and sales utility, or a subsidiary of such a utility, can sell electric power to a public customer or to another commercial entity in the form of electric vehicle charging services and electricity supply.

The five New England states covered by this project – ME, MA, NH, RI and VT, have researched these issues to varying degrees. The results of this work should be compiled, and gaps in this analysis should be filled with additional research in order to produce a clear understanding of the legality of electric power sales for vehicle charging. The need for this analysis is urgent as the market for rechargeable electric cars and trucks is growing rather quickly.

9.12 *Depending on the rate structure of the particular electric utility involved, DC fast charging stations may incur spikes in electric power consumption that will incur substantial demand charge costs in addition to power consumption and supply fees. This will increase the cost of vehicle charging services.*

Explanation of this issue:

Installation of DC fast-charge stations is likely to involve high spikes of energy demand which, under some present electric utility rate structures, may mean high power demand charges placed on the charging station operators by the electric utilities when power is supplied from the grid. These “demand charges” are in addition to kilowatt-hour energy purchase rates.

Demand charges are fees charged to a customer by electric power distribution utilities to cover the cost of being prepared to meet the maximum power demand likely to be needed by that customer. If a state's policies for encouraging plug-in electric vehicles are obstructed by the demand charges applied by power distribution utilities operating in that state, review and possible modification of those rate tariffs may be considered to meet the public's electric vehicle interests.

Options for changes – effectiveness and feasibility:

Changes in electricity generation, supply and control technologies and economics are forcing power regions, states and electric utilities to consider significant restructuring of electric power grid operations. That restructuring will bring demand charges and other power-delivery tariff items into question. Such grid and power tariff changes will almost certainly have to accommodate electric

vehicles both as consumers of electric power and as storage units for electricity. This may or may not include measures to adjust demand charges in light of the power-consumption spikes with DC Fast-Charge units. In any case, the issue will most logically be dealt with through grid restructuring in each state and within the full ISO New England power system.

Recommendations:

Plug-In America, other advocacy organizations for electric vehicle charging, environmental organizations, vehicle charging equipment manufacturers and installers, electric vehicle manufacturers and other stakeholders for electric vehicle advancement would be well advised to participate actively in deliberations dealing with power grid system operational and legal changes. This input should present the public service implications of power rate alternatives to the present demand charge arrangement that exists in most states. Participation in grid restructuring deliberations should also present the value and needs of an economically-sound vehicle charging system as well as the realistic energy storage functions offered by electric vehicles. (See Issue # 9.13 below.)

9.13 *In order to make full use of the smart grid energy storage capabilities of plug-in and fuel cell electric vehicles, state and regional (ISO) electric services regulators and energy agencies need to define the terms for supplying energy from vehicle storage to the grid.*

Explanation of this issue:

The potential appeal of electric vehicles – both battery electrics and fuel cell electric vehicles – includes the possibility of smart-grid incentives for vehicle charging to be done at times of low grid power prices and for electric vehicles' energy storage functions to supply power back to the grid at times of high power demand. This can potentially reduce overall power supply costs for grid customers. Providing this service could also reduce overall energy costs for vehicle operation, providing additional cost incentives for adoption of both battery and fuel cell electric-powered vehicles.

The technologies, operational rules and pricing tariffs to accomplish these goals encompass the currently separated domains of electric power markets and vehicle fuel/energy supply. Therefore, the rules and mechanisms for this function have not been adopted or even fully developed at this stage. The status of rules presently governing (or potentially governing) these power storage functions needs to be understood and upgraded to facilitate appropriate energy storage using fuel cell and battery electric cars & trucks.

Options for changes – effectiveness and feasibility:

The approach for dealing with this issue is the same as outlined for Issue #9.12 above.

Recommendations:

The process recommended for Issue # 9.12 should include rigorous development in each state of tariffs and detailed grid connection & operational rules for 2-way power exchange between the electric grid and electric cars and trucks – both battery and fuel cell vehicles. This work should draw upon successful accomplishments in other states and countries. Of note is the work being done in the state of California and the comprehensive grid restructuring analysis recently initiated by the Public Service Commission and NYSERDA in New York State.

9.14 ***Electricity-supplying utilities may need data regarding planned and permitted electric charging stations – especially level 3 stations at the planning stage -- so the utilities can adjust power availability to the station sites or notify the proposing entity that power cannot be made available.***

Explanation of this issue:

Installation of level 3 DC fast-charge (DC/FC) stations requires relatively high levels of power service (3-phase, 125 amp). This level of power supply does not currently exist at most sites that would be appealing charging station locations from a real estate and market access perspective. In New England, installation of such power service usually involves permitting under local building or electrical codes as well as power company investment. Power service supply terms and tariffs in these five states are not clear to charging systems installers regarding how a power station developer can obtain such service as well as the costs for the 3-phase power. This needs clarification.

Options for changes – effectiveness and feasibility:

This issue is essentially a communication function between local permitting authorities and the relevant electric power-supply utility.

Recommendations:

A useful addition to the existing communication between utilities and local governments would be for local jurisdictions that issue electric vehicle supply (charging) equipment (EVSE) installation permits under local building codes to notify utilities when permits have been issued.

In each state, as part of standardized local permitting applications and checklists, consider including a check box and process that permits the local permitting authority to share EVSE installation plans with the relevant electric utility. While permit information itself is already a matter of public record, this additional process can facilitate the timely information utilities need to promptly and effectively plan for the additional power service facilities and electric load required by DC fast-charge EVSE equipment.

10: Federal rules impacting state regulations on infrastructure development

10.1 Regulatory barriers – alternative fuel vehicle infrastructure

10.11 ***There is some confusion within the fuel facilities and vehicle conversion industries due to the existence – and use by states – of two sets of air emissions approvals – EPA and CARB. Vehicles converted to run on alternative fuels such as CNG or propane require one of the other or both of these approvals.***

Explanation of this issue:

All vehicles and vehicle conversions sold for public road usage must be product configurations that are approved with respect to air emissions. This does not just pertain to each fuel type, rather it is specific to the combination of vehicle/engine product and fuel type. For this approval process some states use US EPA rules, and other states use California Air Resource Board (CARB) rules. This apparently creates the expense, time consumption and uncertainty of satisfying two sets of requirements.

Options for changes – effectiveness and feasibility:

For all fuel/vehicle combinations, are the CARB vehicle emissions certifications simply a more restrictive super-set of EPA regulations in which case satisfaction of CARB requirements necessarily also satisfies EPA requirements?

Recommendations:

It is appropriate to initially confirm how much of a problem this issue represents. If CARB vehicle emissions requirements for most or all vehicles are essentially a super-set of of EPA regulations, then straight adherence to the CARB rules can simplify the process and produce lower emissions.

10.12 It is unclear how (and whether) the EPA's regulations on air impacts of vapor emissions from fueling (vapor recovery systems requirements) will be applied to alternative fuels, especially gaseous fuels using totally sealed fueling and storage technologies.

10.13 "State Implementation Plans" (SIPs) for EPA-mandated air quality standards at the state level are in some cases/respects unclear as to to how vapor (or gaseous) escape will be handled in the processes of both vehicle filling and filling of on-site storage units with alternative fuels.

Explanation of these issues:

A major component of environmental regulations controlling gasoline station equipment is federal EPA regulations controlling vapors emitted during filling of on-site storage tanks and during fuel dispensing into vehicles. The federal office that administers these vapor emissions regulations is the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Furthermore, nder the Clean Air Act – and subsequent legislation – each state has to produce and get EPA acceptance of a “State Implementation Plan” (SIP) which is that state's regulations for air emissions, putting the state into compliance with the federal laws. Included in each state's SIP are rules regarding emissions from both the combustion and handling/storage of gasoline.

These federal and state air emissions controls are fully developed for gasoline. However, since the market penetration by alternative fuels is small, such regulations have not yet been fully developed for the new fuels. Uncertainty about potential emissions regulations could become a barrier to extensive infrastructure development for alternative fuels.

Given the chemical nature of gasoline, and the open (to the atmosphere) equipment used to store gasoline, released vapors are a major pollutant that has to be captured. However, the emissions situations with alternative fuels are very different from gasoline and thus should be treated differently. The case can be made that gaseous, volatile or vapor emissions from most alternative fuels are less harmful than gasoline vapors. More importantly, the gaseous state of CNG, propane, hydrogen and released LNG has resulted in storage technologies for these fuels that are far more completely sealed against emissions than is the case for older gasoline storage and dispensing systems. As federal and state emissions regulations further evolve for alternative fuels, they should reflect these differences.

This situation should, in many respects, make alternative fuels easier to accommodate for fuel dispensing operations. However, in the case of CNG and LNG – and to a lesser extent propane – carbon greenhouse gas substances are a major emissions issue, especially methane which is not considered toxic but is a major contributor to global warming. Emissions releases of hydrogen are not considered to involve toxic impacts, carbon gases or other recognized global warming impacts.

For gasoline, these regulations have required expensive vapor recovery equipment to be installed with facilities that dispense gasoline into fueling station customers' vehicle tanks and with the equipment that fills fueling station gasoline storage tanks. This equipment and prescribed tank filling procedures captures (“recovers”) gasoline vapors that would otherwise be emitted to the atmosphere when tanks are filled. This vapor recovery equipment (known as “stage I” and “stage II” vapor capture equipment) is also required by most state SIPs in order to conform to the federal EPA regulations .

Unlike the gasoline systems, gaseous fuels handling and dispensing systems (for CNG, LNG and hydrogen) are closed systems when fully connected, so there is not the same emissions issue as with gasoline. However, EPA has issued rules placing limits on CNG gas emissions allowed per vehicle fueling (Federal Regulations 40 CFR 80.33 – controls applicable to natural gas retailers).

Bottom line: This situation presents alternative fuel developers with some uncertainty regarding whether emissions capture equipment will be required as part of the capital investment in fueling station equipment.

Options for changes – effectiveness and feasibility:

The Environmental Protection Agency (EPA) Air Quality Office is the authority in charge of rules covering fuel storage and dispensing emissions with administration of emissions controls handled by EPA and by the states. At the time when this project's research was being conducted, the EPA Air Quality Office had not fully refined and promulgated regulations covering vapor or gas releases from handling of CNG, LNG, propane, hydrogen and biodiesel. Similarly, the states have not fully incorporated alternative fuels dispensing and storage into their air quality State Implementation Plans (SIPs). This project has not compiled a comprehensive listing of alternative fuel emission regulations in each state's SIP plan.

Recommendations:

An update is needed to determine the current status of EPA and state SIP rules regulating emissions from storage and dispensing operations involving CNG, LNG, propane, hydrogen and biodiesel. The business organizations that are market-development stakeholders for alternative fuels should examine the evolving or completed rules for their respective fuel types to ensure that the regulations appropriately reflect the chemistry of the fuel type and the emissions implications of their storage and dispensing technologies.

Appropriate business organizations to monitor emissions regulation of these fuels are:

- CNG - Natural Gas Vehicles for America (NGVAmerica), www.ngvc.org
- LNG - Natural Gas Vehicles for America (NGVAmerica), www.ngvc.org
- Propane - National Propane Gas Association, www.npga.org ,
- Hydrogen - Fuel Cell and Hydrogen Energy Association, www.FCHEA.org
- Biodiesel – National Biodiesel Board, www.nbb.org

It is first of all important to determine whether this issue is truly important or just perceived as a possible problem. That can be determined by researching the SIP plans currently in place in as few as two or as many as all five of the project states to determine:

1. How the states' existing SIP plans handle fueling station emissions of gasoline and diesel.
2. Whether the SIP plans and regulations cover fueling station emissions for any of the alternative gaseous or liquid fuels covered by this project – CNG, LNG, propane, hydrogen and biodiesel.
3. What (if any) emissions standards or specific emissions control/capture equipment is required in each state for each of these alternative fuels.
4. If a state has not included rules or standards to cover ostensible emissions from alternative fuels filling of storage tanks and vehicle tanks, determine whether the air quality authorities in that state feel that such state-level controls are required under EPA regulations.

10.2 Remove barriers to fueling station operation

10.21 *OSHA regulations - regarding human exposure to fuel substances – may come into play with respect to handling of the chemical substances of alternative fuels, and fuel system developers appear to be somewhat unprepared for these impacts.*

Explanation of this issue:

U.S. Department of Labor Occupational Safety & Health Administration (OSHA) worker safety issues apply to fuel substances. Working conditions that can result in exposure to health-impacting substances (such as benzene from gasoline handling at gas stations) have OSHA rules, standards and operational procedures. There is no available compilation of such controls and permissible exposure limit (PEL) values for alternative fuels. This raises the question of whether development of alternative fuels dispensing stations might be impacted if the lack of such standards is determined to put employees or the public at risk.

OSHA has taken action on public and worker safety on one vehicle energy alternative – electric vehicle charging. OSHA certification by a National Recognized Testing Laboratory (NRTL) is required for level 3 DC fast-charge stations in California. (Testing requirements associated with OSHA regulation are found in Title 29 of the Code of Federal Regulations (29 CFR), and provisions for NRTL certification are in Part 1910 (29 CFR Part 1910).)

If the expansion of alternative fuel use is likely to bring about more specific OSHA controls on handling of alternative fuels, the industry's plans for technology and infrastructure development require knowledge of such regulations.

Options for changes – effectiveness and feasibility:

As is the case with other issues, the steps for dealing with this matter are largely in the hands alternative fuel industry itself. Initial steps are awareness of this issue followed by education on what the OSHA regulatory requirements are now for alternative fuel materials and equipment and where those regulations are headed.

Recommendations:

Similar to the air emissions situation, an update is needed to determine the current status and likely future direction of OSSHA rules regarding CNG, LNG, propane, hydrogen, biodiesel and electric vehicle charging. The business organizations that are market-development stakeholders for alternative fuels should examine the evolving or completed rules for their respective fuel types to ensure that the regulations appropriately reflect the nature of the fuel/energy type and the handling and dispensing equipment for these fuels.

Appropriate business organizations to monitor OSHA regulation of these fuel/energy operations are:

- CNG - Natural Gas Vehicles for America (NGVAmerica), www.ngvc.org
- LNG - Natural Gas Vehicles for America (NGVAmerica), www.ngvc.org
- Propane - National Propane Gas Association, www.npga.org ,
- Hydrogen - Fuel Cell and Hydrogen Energy Association, www.FCHEA.org
- Biodiesel – National Biodiesel Board, www.nbb.org
- Electric vehicle charging – Plug-In America,

11: Incentives to facilitate adoption of alternative fueling

11.1 Encourage conversion to alternative fuels

11.11 *Alternative fuel vehicle registration data should be made available so fuel supplying entities – electric utilities, private fuel suppliers, station developers – can plan energy-supply infrastructure, and vehicles using alternative fuels should be clearly labeled to guide first responders.*

Explanation of this issue:

PEV electric charging interests and other vehicle alternative fuel advocates point out that state vehicle registration processes should capture information regarding the fuel type used in each vehicle that is registered. This data is important for at least two purposes – to let first responders know what kind of fuel or energy system is contained in any vehicle that is involved in a crash and to facilitate the private/public-sector process of planning the number and placement of fueling and charging facilities by fuel type using data on where alternative fuel vehicles are owned and located. Both objectives can be part of the vehicle registration process at the state level.

In many (if not all) states, vehicles using natural gas are required to display a badge showing that they are CNG-fueled so first responders to an accident situation will be informed and deal properly with the risks associated with CNG fuel which are different from gasoline or diesel hazards. This labeling requirement should be considered for expansion to a consistent fuel-type labeling of all vehicles, covering all fuel types with consistent labeling requirements for all vehicles. If vehicle fuel types are identified and labeled as part of the vehicle registration process, the data can then be made available regarding the number and registration locations of vehicles by fuel type. Labeling might be in the form of a very rugged badge as is used for most CNG vehicles or it might be a national requirement to have the type of fuel and power system specified on the vehicle registration record and also indicated on the registration plate. This would facilitate compilation of data regarding the number of vehicles of each fuel type being sold into fuel market areas.

Options for changes – effectiveness and feasibility:

Implementing these data systems would involve, in each state, the constituent entities for vehicle registration, police and fire first responders, national alternative fuels market development entities,

alternative fuel vehicle manufacturers, fuel suppliers and alt fuel facilities developers. Government entities would likely be in react mode putting the onus on the alternative fuels business development groups to initiate the process.

Recommendations:

To the extent that their constituents would benefit from faster roll-out of alternative fuel vehicles, the alternative fuels business organizations – along with first responder groups – have the biggest incentive to push for action on this issue. A suggested first step: an informational webinar orchestrated by the alt fuels business organizaions and aimed at first responders, vehicle manufacturers, motor vehicle registration, and alt fuel vehicle advocacy organizations.

11.12 *The federal Renewable Identification Number (RINS) system for tracking renewably-sourced fuels that account for credits toward the EPA-administered Renewable Fuel Standard (RFS) does not allow renewably-sourced electrical power to be tracked for this purpose, and this removes an economic incentive to use of electric vehicle (plug-in or fuel cell) powering in place of fossil fuel vehicle power.*

Explanation of this issue:

A RIN is a “Renewable Identification Number” assigned to each batch of renewably produced fuel. Fuel suppliers submit RINs (the numbers themselves) to the Environmental Protection Agency (EPA) to prove the company has met or exceeded EPA's renewable fuel standard (RFS) requirement that the fuel produced by the company include a required percentage of renewably-sourced fuel. RINS have value and can be bought, sold and traded either with the fuel itself or separately from it. The more batches of renewably-sourced fuel a fuel-supplier company uses the more RINs they have.

Some companies have developed a secondary market in RINs, and if some proposed changes are made to the EPA RIN rules such marketers would become able to share their RIN revenue with electric charging or hydrogen fueling station developers at the level of at least a few cents per kWh. That could be the difference between profit and loss for start-up fueling/charging station developers.

Federal regulations do not allow for RINs to be earned from use of electricity as a “fuel” (a "pathway to RINs") even if the electricity is made from the sun, wind, hydro or biomass. If RINs could be applied directly to renewably produced electricity or to hydrogen produced from renewably-sourced electricity - both used as vehicle "fuel" – the RIN value could generate incentive income to stimulate faster deployment of electric charging and hydrogen fueling for vehicles.

Firms interested in expansion of the RIN market have been pressing for rules changes with EPA and the Office of Management and Budget since 2011. EPA responded with proposed new rules toward enabling this electric power RIN arrangement. The proposed rules apply to many fuels, not just

electricity. The interested firms apparently feel that the proposed EPA rules need modification in order to effectively stimulate growth in electric vehicle charging/fueling infrastructure.

Options for changes – effectiveness and feasibility:

Follow-up to this project can determine the current status of the proposed EPA rules changes and whether those changes can be implemented with modifications to stimulate development of electric charging and hydrogen fueling infrastructure.

Recommendations:

As a first step – since the RIN rule change would initially most directly impact the market for hydrogen dispensing and electric charging fuel/energy facilities, Plug-In America, and the Fuel Cell and Hydrogen Energy Association (FCHEA, including H2USA) should be encouraged to seek updated clarification from the EPA on proposed RIN rule changes that would enable RIN credit to be applied when hydrogen fuel is produced from renewable energy sources (renewably-powered electrolysis for example) or when electric vehicle charging stations are supplied with power from certified renewable generation sources.

Appendix 1:

5 New England States Alt. Fuels Regulatory Barriers Project (Clean Cities) – Key Issues: Agencies & Decision-impacting Entities (and related notes)

Section 1 – Local and state-level permitting, zoning and approval

	Energy and state-level land use planning offices in each of the 5 states	
	1-1	State of Maine, Executive Department, Governor's Energy Office, 62 State House Station, Augusta, Maine 04333-0062, Patrick Woodcock, Director, patrick.c.woodcock@maine.gov, (207) 624-7405, Lisa J. Smith, Senior Planner, lisa.J.Smith@maine.gov, (207) 624-7445
	1-2	State of Massachusetts, Executive Office of Energy and Environmental Affairs, Department of Energy Resources -- Green Communities Division Director, Meg Lusardi, 617-626-7364, Energy Efficiency Division Director, Christina Halfpenny, 617-626-7313, Energy Markets Division Director, Birud Jhaveri, 617-626-7365, Marketing & Stakeholder Engagement Director, Susan Kaplan, 617-626-7361, Renewable Energy Division Director, Dwayne Breger, 617-626-
	1-3	New Hampshire Office of Energy and Planning, Governor Hugh J. Gallen State Office Park, Johnson Hall, 3rd Floor, 107 Pleasant Street, Concord, NH 03301, Telephone: (603) 271-6651 – Chris Northrop, in charge of advice to local planning authorities - potentially including planning, codes and zoning recommendations for fueling infrastructure. Brandy Chambers, Energy Analyst; Technical Assistance Energy Contact, 603 271-8316, brandy.chambers@nh.gov .
	1-4	Rhode Island Office of Energy Resources, One Capitol Hill, Providence, RI 02908, 401-574-9100, energyresources@energy.ri.gov – Municipal relationships contact: Rachel Sholly 401-574-9121 rachel.sholly@energy.ri.gov . Ryan Cote, transportation person – 401-574-9118 ryan.cote@energy.ri.gov
	1-5	State of Vermont, Public Service Department, Planning and Energy Resources Division - 112 State Street Third Floor, Montpelier, VT 05620-2601, Asa Hopkins, Director, 802-828-4082, Kelly Launder, Assistant Director, 802-828-4039, Anne Margolis, Renewable Energy Development Director, 802-828-3058.
	1-6	Sue Minter, Deputy Secretary, Vermont Agency of Transportation -- One National Life Drive, Montpelier, VT 05633-5001 -- 802-828-2657 - sue.minter@state.vt.us transportation, energy and land use – Vermont Agency of Transportation, Chris Cole, Director of Policy, Planning and Intermodal Development, 802-828-1647, chris.cole@state.vt.us -- Karen Songhurst, Policy Analyst, 802-828-1078, karen.songurst@state.vt.us -- Gina Campoli, Environmental Policy Manager, 802-828-5756, gina.campoli@state.vt.us
	Municipal association (or equivalent) in each of the 5 project states	
	1-7	Maine Municipal Association, One Community Drive, Augusta, ME 04330 -- 207-623-8428
	1-8	Massachusetts Municipal Association, One Winthrop Square, Boston, MA 02110 -- 617-426-7272 -- Geoff Beckwith - Gbeckwith@mma.org
	1-9	New Hampshire Municipal Association, 25 Triangle Park Dr., Concord, NH 03301 -- 603-224-7447 - Timothy W. Fortier, Communications and Member Services Coordinator
	1-10	Rhode Island League of Cities and Towns, One State St., Suite 502, Providence, RI 02908 401-272-3434 Peder A. Schaefer, Associate Director – peder@rileague.org ext 12
	1-11	Vermont League of Cities and Towns, 89 Main Street (City Center Bldg., corner of Main and State Streets), Montpelier, VT -- 802-229-9111 - info@vlct.org
	State entities administering building codes – MA, RI, VT,	
	1-12	MA - Executive Office of Public Safety and Security, Board of Building Regulations and Standards, One Ashburton Place, 13th Floor, Room 1301, Boston, MA 02108 -- (617)727-3200. Kim Spencer, Building Official Certification Program and Education Coordinator. Thomas M. Riley, B.S.M.E., Code Development Manager. Building codes for construction and renovation of all buildings including detached one and two family homes.
	1-13	State of Rhode Island, Building Code Commission, 1 Capitol Hill, 2nd Floor, Providence, RI 02908 – http://www.ribcc.ri.gov/ -- 401-222-1129 – John P. Leyden, C.B.O., State Building Code Commissioner, 401-222-3529. Admin Asst: Jeanne Enos, 401-222-1129, Jeanne.Enos@doa.ri.gov . Michael Scallon, State Plumbing/Mechanical Code Inspector – 401-222-1430 Michael.Scallon@doa.ri.gov. "Model building codes provide for protection from fire, structure collapse and general deterioration. Model codes serve to keep construction costs down by establishing uniformity in the construction industry. This uniformity permits building and materials manufacturers to do business on a large-scale. This large-scale, in turn, creates cost savings for the end consumer code also help protect real estate investments, commercial and personal, by providing a minimum level of construction quality and safety." -- http://www.ribcc.ri.gov/
	1-14	Vermont Department of Environmental Conservation, Regional Permit Specialist, Districts 2 & 3, 100 Mineral Street, Springfield, VT 05156 – Jackie Carr, 802-885-8850 -- jackie.carr@state.vt.us

	State Fire Marshals – ME, MA, NH, RI & VT	
	1-15	Maine Office of the Fire Marshal, 45 Commerce Drive, Suite 1, 52 State House Station, Augusta, ME 04333-0052, -- Main Line/Investigations Division: (207) 626-3870, Inspections Division/Plans Review Division: (207) 626-3880, Joseph Thomas, Fire Marshal (207) 626-3871, Plans Review Division Contact Information - Rich McCarthy, Assistant Fire Marshal (207) 626-3886, richard.mccarthy@maine.gov
	1-16	Massachusetts Executive Office of Public Safety and Security, Division of Fire Safety - Department of Fire Services, One State Road, Stow, MA. Stephen D. Coan, MA State Fire Marshal, Department of Fire Services. Code Compliance and Enforcement Unit – 978-567-3375. The unit is responsible for ensuring uniform statewide compliance with the laws and regulations the State Fire Marshal is charged to enforce - MGL Chapter 148 or 527 CMR. Code Compliance officers support the regulatory compliance efforts of local fire department officers, review plans and issue permits for the operation of above-ground storage tanks and for self-serve gas stations. The regulations also require that all such tanks have an annual Use Permit issued by the Fire Marshal and be inspected no less than annually.
	1-17	State of New Hampshire, Department of Safety, Division of Fire Safety, Office of the State Fire Marshal (J. William Degnan). Bureau of Building Safety & Construction, 33 Hazen Drive (James Hayes Safety Building), Concord, NH, 03305 -- 603-223-4289. -- Jeffrey Cyr, Chief Inspector, Jeffrey.cyr@dos.nh.gov -- Les Cartier, Hazardous Materials Coordinator - leslie.cartier@dos.nh.gov. The Division of Fire Safety/State Fire Marshal's Office is responsible for: fire cause investigations, fire code interpretations and enforcement, hazardous materials accidents, public fire safety education, emergency response, staff and local responders training, technical plans review. NH Joint Committee on Code Enforcement, Office of the State Fire Marshal was (2014) developing minimum certification requirements for municipal building officials in response to concerns that some code officials, and those acting in that capacity, do not have appropriate training resulting in possible legal exposure to communities.
	1-18	State of Rhode Island, Division of the State Fire Marshal, One Regan Court, Varley Building #46, Cranston, RI 02920 -- JOHN CHARTIER, State Fire Marshal. SCOTT CARON Chief of Inspections. WADE PALAZINI Chief of Plans Review. VINCENT QUINTERNO Fire Safety Training Officer. ALBERT HEROUX JR.Fire Safety Training Officer. RI Fire Safety Code Board of Appeal and Review, Varley Building #46, Cranston, RI 02920 401-462-0940 – Carol A. Marsella, Deputy Director, cmarsella@doa.ri.gov . This Board is charged with the development and administrative review of a comprehensive fire code covering the State of Rhode Island. The Board further evaluates the proposed use of new fire-related technology. The Board provides the State Fire Marshal, other state agencies and over 80 fire departments with legal and technical advice. RI regulations covering propane and LNG: CHAPTER 28.20 STORAGE AND HANDLING OF LIQUEFIED PETROLEUM GAS. CHAPTER 28.33 - STORAGE AND HANDLING OF LIQUEFIED NATURAL GAS.
	1-19	State of Vermont, Department of Public Safety, Division of Fire Safety, Office of the State Fire Marshal, 1311 U.S. Route 302 – Berlin, Suite 600, Barre, VT 05641 – 802-479-7561, http://firesafety.vermont.gov. The Division of Fire Safety requires a one-time plan review for all above ground fuel dispensing and related storage equipment, including dispensing islands (Sheet #49). A state Division of Fire Safety permit is required even if a project has received a local permit. (Except for locations with a municipal inspection agreements that include; Burlington, Bennington, Hartford, and Montpelier) The Div. of Fire Safety's office in Springfield, VT handles issues involving CNG and propane fuels. Michael Desrochers, Division of Fire Safety Director, Division of Fire Safety, Springfield Regional Office, 100 Mineral St., Springfield, VT 05156 – 802-885-8883. Paul Spicer, Fire Prevention Officer, Springfield Regional Office – 802-885-8966 - paul.spicer@state.vt.us.
	National Association of State Fire Marshals	
	1-20	National Association of State Fire Marshals, PO Box 671, Cheyenne, WY 82003 202-737-1226 ext 4
	1-21	New England Association of Fire Chiefs, Association contact: Secretary/Treasurer – Chief Richard K. Wehter, PO Box 497, Hingham, MA 02043-0497 – 781-749-8626, neafc@aol.com or sec_treas@newenglandfirechiefs.org
	National Fire Protection Association	
	1-22	National Fire Prevention Association, 1 Batterymarch Park, Quincy, MA 02169-7471 – 617-770-3000, custserv@nfpa.org. Christian Dubay, Vice President, Codes and Standards and Chief Engineer. Christine M. Ellis, Executive Administrative Assistant to the Vice President, Codes and Standards (ext 7244). NFPA's Electric Vehicle Safety Training project is a nationwide program to help firefighters prepare for the growing number of electric vehicles on the road in the U.S. The project is conducted by the NFPA's Fire Protection Research Foundation and funded by $4.4 million from the U.S. Department of Energy. Purpose: to provide first responders with information to most effectively deal with emergency situations involving electric vehicles. Casey C. Grant is Research Director for the NFPA Electric Vehicle Safety Training Project..Grant is also very familiar with hydrogen and fuel cell safety issues..
	Construction Certification Institute (CCI)	
	1-23	Construction Certification Institute, Inc., PO Box 316, East Sandwich, MA 02537 – 508-833-5207 – admin@statecertification.com. How CCI Got Started:In 1997, three town building commissioners from Cape Cod felt that if recently licensed builders became more knowledgeable in the newly released Massachusetts building code, construction would be more productive by meeting the requirements of the building code and thus minimizing lost time due to rework and re-inspections. They started CCI as a school that gives builders a greater capacity for achieving their business goals while gaining an understanding of the building code.

	1-24	Washington DC Governmental Affairs Office: 500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001 – 888-422-7233 – Dorothy Harris, VP, State and Local Government Relations - dharris@iccsafe.org. Plumbing, Mechanical and Fuel Gas Resource Center: MGResourceCenter@iccsafe.org – Shawn Martin, Director of Plumbing, Mechanical and Gas (PMG) Activities, smartin@iccsafe.org.
	Fire Chiefs - 2 municipalities where CNG stations have been installed	
	1-25	City of Nashua, NH – Installed CNG fueling facilities for municipal vehicles. City Fire Marshal Cynthia Bautista, 177 Lake Street, Nashua NH 03060 -- 603-589-3460. Fire Inspector / Investigator Mark Rapaglia The Nashua Fire Marshal's Office is responsible to review all plans and inspect all work to see that it conforms to city and state building and life safety codes. The City of Nashua is currently utilizing the State Fire Code as the standard which references NFPA 101 Life Safety Code 2009 Edition, NFPA 1 Uniform Fire Code 2009 Edition, NFPA 13 Sprinkler Code 2009 Edition and NFPA 72 Fire Alarm Code 2010 Edition.
	1-26	City of Warwick, RI Fire Department, Edmund Armstrong, Chief, 111 Veterans Memorial Dr., Warwick, RI 02886 wfd.admin@warwickri.com 401-468-4000.
	State of California Zero Emission Vehicle (ZEV) policy plan and implementation	
	1-27	Governor's Interagency Working Group on Zero-Emission Vehicles, Governors Office of Planning and Research, 1400 10th Street, P.O.Box 3044, Sacramento,California 95812-3044, 916-322-2318 www.opr.ca.gov
Section 2 – Permitting and regulation of gaseous fuel		
	License-issuing entities for gaseous fuel dispensing in each of the 5 states	
	2-1	Maine Department of Agriculture, Conservation and Forestry, Quality Assurance and Regulations, 90 Blossom Lane, Augusta, ME 04330, 207-287-3841, http://www.maine.gov/agriculture/qar/index.html, Steve Giguere, Program Manager, steve.giguere@maine.gov .
	2-2	State of Massachusetts, Office of Consumer Affairs and Business Regulation, Division of Standards. Massachusetts General Laws, Part 1, Administration of the Government, Title XV – Regulation of Trade, Chapter 94 – Inspection and Sale of Food, Drugs and Various Articles, Section 295B – licensing of retail dealers: Section 295B. *"No retail dealer shall engage in the business of selling motor fuel or automotive lubricating oil at retail without first procuring from the division a license for each station, store, garage or other establishment at which his said business is to be conducted...(2) The term "motor fuel" shall mean (a) a light distillate of petroleum or allied substance with suitable volatility and other characteristics to be used as a fuel for operating internal combustion engines, whether or not it is mixed with other materials, or (b) any other product or liquid when sold for use as a fuel in any type of internal combustion engine furnishing power to operate a motor vehicle."*
	2-3	New Hampshire Department of Agriculture, Markets and Food, Weights & Measures, PO Box 2042, 25 Capitol Street, State House Annex Concord NH 03302-2042, 603-271-3700 www.agriculture.nh.gov -- Rebecca Malila, Director, rebecca.malila@agr.nh.gov, Elaina DeAngelo, Program Assistant 1 (Licensing) elaina.deangelo@agr.nh.gov
	2-4	Rhode Island Weights and Measures: Department of Labor and Training, Occupational Safety, Weights and Measures Unit, Center General Complex, 1511 Pontiac Avenue, Cranston, RI 02920 – 401-462-8570 – http://www.dlt.ri.gov/occusafe/wmform.htm -- Licensing statute: Rhode Island State Law Chapter 5-24-1
	2-5	Vermont Agency of Agriculture, Food and Markets – 116 State Street Montpelier, VT 05620-2901 -- Contact: Bev Delude, 802-828-2436 (9 V.S.A. Chapter 73, Section 2730) -- The Agency of Agriculture has responsibility for licensing of certain commercial weighing or measuring devices such as devices used for the sale of gasoline, home
	Natural Gas Vehicles for America (NGVAmerica)	
	2-6	Natural Gas Vehicles for America (NGVAmerica), 400 N. Capitol St. NW, Washington, DC 20001 -- 202-824-7364, www.ngvc.org. Jeff Clarke - jclarke@ngvamerica.org . Clarke is the NGV's expert on weights and measures and fuel taxation (highway fund). Stephe Yborra, Director of Market Development, syborra@ngvamerica.org -- Economics and strategies for roll-out of LNG and CNG fueling infrastructure. Local contact: Tom Sheehan, Lovell, ME, 207-925-1136, info@ngvamerica.org
	2-7	National Propane Gas Association, 1899 L St. NW, Suite 350, Washington, DC 20036 -- 202-466-7200, www.npga.org , Jacqueline McCracken, Program Manager, Certification & Technical Services, jmccracken@npga.org , Propane industry representation, advocacy and advisory organization for the full propane gas industry in the US -- Mission: "To advance safety and to increase the use of propane through sound public policy".

	Industry organization for LNG fueling	
	2-8	Natural Gas Vehicles for America (NGVAmerica), 400 N. Capitol St. NW, Washington, DC 20001 -- 202-824-7364, www.ngvc.org. Jeff Clarke, jclarke@ngvamerica.org. Stephe Yborra, Director of Market Development, syborra@ngvamerica.org -- Economics and strategies for roll-out of LNG and CNG fueling infrastructure. National organization representing the interests of growing natural gas fueled vehicles in the US.
	Industry organization(s) for hydrogen fueling (FCHEA and H2USA)	
	2-9	Fuel Cell and Hydrogen Energy Association, 1211 Connecticut Avenue NW, Suite 600, Washington, DC 20036 -- www.FCHEA.org, 202-261-1331. Karen Hall, Senior Technical Specialist, khall@fchea.org -- Karen Hall is the Chief Editor of the Hydrogen and Fuel Cell Safety Report. She also facilitates the coordination of association Regulatory Affairs activities among industry, government, academia, and standards development organizations.
	Code enforcement officers in towns where propane fueling facilities have been installed	
	2-10	City of Ellsworth, Maine Ellsworth City Hall, 1 City Hall Plaza, Ellsworth, ME. Dwight Tilton, Code Enforcement Officer – dtilton@ellsworthmaine.gov. Lori Roberts, Deputy Code Enforcement – lroberts@ellsworthmaine.gov. Fred Troger, Electrical & Building Inspector – code@ellsworthmaine.gov, 207-667-4910.
	2-11	Town of Palmer, MA -- Building Division, 4417 Main Street, Palmer, MA 01069, 413-283-2638., Bonnie Weeks, Building Inspector – bweeks@townofpalmer.com. Gerry Weston, Electrical Inspector. Gerald Nichols, Plumbing Inspector. Gary Stahelski, Gas Inspector. (Permits: Electrical Permit Application, Zoning Board of Appeals, Conversion Permit Application, New Construction Application Part I, New Construction Application Part II, Worker's Compensation Insurance Affidavit, Gasfitting Application, Plumbing Permit Application, Renovation/Repair Permit, Sign Permit Application.)
	2-12	Chepachet (Glocester), RI -- Town of Glocester, RI, Glocester Town Hall, 1145 Putnam Pike, PO Box B, Chepachet, RI 02814-0702. 401-568-6206. Building and Zoning Dept. Carl Riccio, 401-568-6206, ext. 1, Town of Glocester, RI -- permit applications: Building Permit, Electrical Permit, Mechanical Permit, Moving/Demolition Permit, Plumbing Permit, -- Electrical Inspector: James Clarke, Plumbing Inspector: Gary Coyne, Mechanical Inspector: Albert Danti
	Fire chiefs in 3 towns where natural gas vehicle fueling facilities have been installed	
	2-13	City of Warwick, RI, Fire Department, Edmund Armstrong, Chief, 111 Veterans Memorial Dr., Warwick, RI 02886 – wfd.admin@warwickri.com 401-468-4000.
	2-14	Harold Paulsen, Fire Chief, Pembroke Fire Department, 247 Pembroke Street, Pembroke, NH 03275 – tel: (603) 485-3621
	2-15	City of Everett MA, Fire Department, 384 Broadway, Everett, MA – tel: (617) 387-7198 – David T. Butler, Chief of Department
	Compressed natural gas (CNG) fueling stations in the 5-state New England area – ME, MA, NH, RI, VT (2014)	
	2-16	**Publicly accessible CNG fueling facilities in MA** - Feb 2014. Source: www.poweredbycng.com . Alternative Vehicle Service Group -- Tewksbury, 20 Main St., Tewksbury MA 01876 – 617-242-8755. Alternative Vehicle Service Group - Lexington, Route 128 N, Lexington, MA 02421 – 617-242-8755. Clean Energy - Logan International Airport, 81 N Service Rd., Boston, MA 02128 – 617-242-8755. Clean Energy - National Grid Cape Cod, 127 Whites Path, South Yarmouth, MA 02664 -- 800-233-5325. Alternative Vehicle Service Group - Stoneham, 164 Pond St., Stoneham, MA 02180 – 617-242-8755. Alternative Vehicle Service Group - Worcester, 25 N Lake Ave., Worcester, MA 01605 – 617-242-8755. Clean Energy - National Grid, 201 Rivermoor St., West Roxbury, MA 02132 800-233-5325. Alternative Vehicle Service Group - Middleborough, 44 Harding St., Middleborough, MA 02346 617-242-8755. Clean Energy - National Grid, Everett - 14 Rover St., Everett, MA 02149 – 800-233-5325. Alternative Vehicle Service Group – Newton, Route 128 S., Newton, MA 02459 – 617-242-8755. Alternative Vehicle Service Group – Walpole, 533 High Plain St., Walpole, MA, 02081 – 617-242-8755.
	2-17	**Private (not publicly accessible) CNG fueling stations in MA** – Feb 2014 -- source: www.poweredbycng.com Massachusetts Department of Conservation and Recreation - West Springfield, 136 Damon Rd., Northampton, MA 01060. Waste Management - Norton Hauling, 100 Hill St., Norton, MA 02766 PLANNED - not yet accessible. Steamship Authority - Palmer Avenue Station, 276 Palmer Ave., Falmouth, MA 02540. Massachusetts Bay Transit Authority - Cabot Yard, Boston MA, 275 Dorchester Ave,. Boston, MA 02127. Dudley Automotive, 47 Dudley St., Arlington, MA 02476. Massachusetts Bay Transportation Authority - Southampton Street – 240 Southampton St. Boston, MA 02118. Massachusetts Bay Transportation Authority - Cabot Yard -- 275 Dorchester Ave., Boston, MA 02127. Massachusetts Bay Transportation Authority – Arborway – 3600 Washington St., Boston, MA 02130. North Star Arena, 15 Bridle Ln., Westborough, MA 01581. Massachusetts Department of Conservation & Recreation - Salisbury State Park -- 212 Beach Rd., Salisbury, MA 01952. Massachusetts Bay Transit Authority – Arborway - Boston MA, 3550 Washington St., Boston, MA 02130. Clean Energy, 1269 Shawmut Ave., New Bedford, MA 02746 -- PLANNED - not yet accessible.
	2-18	**CNG stations in NH** --: Feb 2014 -- source: www.poweredbycng.com Alternative Vehicle Service Group - Nashua, 11 Riverside St., Nashua, NH – 617-242-8755 Public. Clean Energy, 10 Cooperative Way, Pembroke, NH 03275 PLANNED - not yet accessible. University of New Hampshire, 295 Mast Rd., Durham, NH 03824 Private - Government only. New Hampshire Department of Transportation, 10 Stickney Ave., Concord, NH 03301 Private - Government only.

	2-19	**CNG stations in RI** --: Feb 2014 -- source: www.poweredbycng.com Clean Energy - National Grid - Cumberland, 1595 Mendon Rd., Cumberland, RI 02864 866-278-3674 Public. Clean Energy - National Grid - Providence, 670 Allens Ave., Providence, RI 02903 866-278-3674 Public. AVSG - TF Green Airport, 2000 Post Rd., Warwick, RI 02886 401-737-8222 Public. Rhode Island State Energy Office - Cranston Facility, 1375 Pontiac Ave., Cranston, RI 02920 Private - Government only. Waste Management - Cranston Hauling, 1688 Pontiac Ave., Cranston, RI 02920 Private. University of Rhode Island, 9 Garage Rd., Kingston, RI 02881 Private - Government only.
	2-20	**CNG stations in ME and VT –** Greater Portland Transit District, 91 Saint John St., Portland, ME 04102 Private - Government only. City of Burlington, 645 Pine St., Burlington, VT 05401 802-863-9094 Public. Casella Waste Systems, 220 Avenue B, Williston, VT 05495 Private. Vermont Gas Systems, 85 Swift St., South Burlington, VT 05403 Private.
Section 3 – Permitting and regulation of electric vehicle charging		
	Level 2 electric charging station installers operating in MA and RI	
	3-1	ChargePoint America (Coulomb Technologies), 1692 Dell Ave., Campbell, CA 95008 -- 408-841-4500 www.chargepoint.com -- Scott Miller, Vice President, North America East scott.miller@chargepoint.com -- Largest provider of public EV charging station networking – contracted by the State of Rhode Island to install up to 50 charging stations around the state including for State vehicles, including plug-in hybrids. State of RI Director of Administration, Richard Licht is responsible for the electric hybrid vehicle purchase by the state.
	3-2	Voltrek, LLC, PO Box 2086, Andover, MA 01810-4620, 978.378.0910 -- info@voltrek.com-- Kathleen Rosen, Co-Founder, Chief Executive Officer, Michelle Broussard, Co-Founder, Chief Operating Officer
	3-3	ClipperCreek Inc., information@clippercreek.net, 530-887-1674, Barry Woods, Business Operations Manager, barry@clippercreek.net, 503-504-6492
	3-4	OpConnect, LLC, 3030 SW First Ave., Portland, OR 97201 -- Nathan Isaacs, Sales and Marketing Manager, 503-477-5742 ex.216 nisaacs@opconnect.com www.opconnect.com.
	3-5	ReVision Energy, 7 Commercial Drive, Exeter, New Hampshire 03833 -- 603-679-1777 ReVision Energy, 142 Presumpscot Street, Portland, Maine 04103 -- 207-221-6342
	3-6	T.A. Napolitano, Electrical Contractor, Inc., 968 Broadway, South Portland, ME 04106 – 207-799-0538 – Tim Napolitano – tnapelec@maine.rr.com – cell: 207-831-1031
	DC-Fast-Charge (level 3) equipment manufacturers	
	3-7	Clean Fuel Connection, Arcadia,CA 91006 -- 888-890-GOEV, www.cleanfuelconnection.com, inquiry@cleanfuelconnection.com - Supplier and installer of electric vehicle charging equipment from ChargePoint, Schneider Electric, Eaton, OpConnect. Supplier and installer of modular CNG compression/fueling stations from Galileo.
	3-8	Fuji Electric (25 kW DC/FC) -- Fuji Electric Corp. of America, Edison, NJ -- 877-263-1645 Regional Sales Representative, Larry Butkovich -- 201-490-3914 lbutkovich@fecoa.fujielectric.com -- See http://www.americas.fujielectric.com/sites/default/files/DC%20Quick%20Charging%20-%20FEA%20Comparison%20Study%20%20%2825kW%20vs%20%2050kW%29%207-3-12.pdf
	3-9	Schneider Electric -- http://www.schneider-electric.com/products/us/en/50600-electric-vehicle-charging-stations/50630-fast-charging-electric-vehicle/61150-evlink-dc-quick-charger/ 370 Libbey Parkway Suite 100 Weymouth, MA 02189-3180 -- 781-534-7535
	3-10	OpConnect, LLC, 3030 SW First Ave., Portland, OR 97201 -- Nathan Isaacs, Sales and Marketing Manager, 503-477-5742 ex.216 nisaacs@opconnect.com www.opconnect.com
	Plug In America	
	3-11	Plug In America, 2370 Market Street #419, San Francisco, CA 94114, 415-323-3329, Jay Friedland, Legislative Director.

Section 4 – Equipment and facilities codes, standards and regulations		
	State agencies in all 5 states that administer underground tank licensing	
	4-1	MA Executive Office of Energy and Environmental Affairs oversees the MA Underground Storage Tank (UST) Program. For MA Underground storage tanks regulations and policies: See http://www.mass.gov/eea/agencies/massdep/toxics/ust/ust-owner-and-operator-information.html . Also see http://www.mass.gov/eea/docs/dep/service/regulations/527cmr506.pdf. MA --The Underground Storage Tank (UST) Program is a major component of the Massachusetts groundwater resource protection effort. Massachusetts Department of Environmental Protection implements federal requirements and specific state regulations addressing registration and inspection of UST systems used to store petroleum fuels or hazardous substances. http://www.mass.gov/eea/agencies/massdep/toxics/ust/ust-owner-and-operator-information.html .
	4-2	Maine - Maine Department of Environmental Protection, Bureau of Waste Management, 17 State House Station 28 Tyson Drive, Augusta, Maine 04333-0017 -- Tel: 207-287-7688 – http://www.maine.gov/dep/waste/ust/ . Underground Storage Tank (UST) Questions: Diana McLaughlin, Ted Scharf, Tim Rector Patrick Hennessey or Wayne Paradis 207-287-2651. Above-ground Tanks: Fire Marshall 207-626-3800 (first), David McCaskill, Peter Moulton or Butch Bowie 207-287-2651. The Maine Department of Environmental Protection's underground oil storage tank program is responsible for protecting public health and the environment, in particular groundwater, by preventing oil discharges to the greatest extent possible. The Program Staff provide technical expertise, training, and outreach to UST facility owners and operators. Staff duties include the review of SPCC plans, applications relative to the UST siting law, registering of underground piping associated with above-ground motor fuel tanks, investigations of UST facility leaks and UST/SPCC technical assistance site visits.
	4-3	New Hampshire Department of Environmental Services, Waste Management Division, Underground Storage Tank Program – The purpose of the Underground Storage Tank (UST) Program is to prevent and minimize contamination of the land and waters of the state due to the storage and handling of: motor fuels,heating oils, lubricating oils, Other petroleum and petroleum contaminated liquids, and hazardous substances. The Department of Environmental Services (DES) established rules for registration; permitting; and standards for design, installation, operation, maintenance, and monitoring of UST facilities regulations and permits: Matthew Jones, Coordinator, NHDES Oil Remediation & Compliance Bureau, 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095 -- 603-271-2986, matthew.jones@des.nh.gov . Underground Storage Tanks (USTs) are regulated through the Oil Remediation and Compliance Bureau (603) 271-3644. Bob Daniel, Coordinator, 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095, 603-271-0686, robert.daniel@des.nh.gov NH Underground Storage Tank Program also administers the Stage I and Stage II vapor recovery program.
	4-4	Rhode Island Department of Environmental Management, Bureau of Environmental Protection, Office of Waste Management - Underground Storage Tank (UST) Management Program -- 235 Promenade Street, Providence, RI 02908-5767, Kevin Gillen, Supervisor, 401-222-2797 ext. 7116, kevin.gillen@dem.ri.gov The UST Management Program oversees the registration and modification of Underground Storage Tanks (UST program) as well as the cleanup of Leaking Underground Storage Tanks (LUST program). Links: LUST Operator Certification Requirements, Closure Application, LUST Program Guidance, Testing, Inventory, and Inspection Requirements, Registration Application, Installation-Re-piping Supplementary Information, Installation-Repiping List of Required Paperwork, Installation-Repiping Equipment List Addendum, Certificate of Installation or Modification, Operator Training Stakeholder Meeting Slide Show, Public Record - Summary Info on Motor Fuel USTs, Monthly Inspection Checklist for UST Facilities, Certified Operator Registration Form Other Links: UST Review Board, 2013 UST Compliance Checklist, 2013 UST Compliance Workbook, Aboveground Storage Tank Registration Info
	4-5	Vermont Department of Environmental Conservation, Waste Management and Protection Division and the underground storage tanks (UST) program: State of VT, WMPD/UST, 1 National Life Dr. Davis 1, Montpelier VT 05620-3704. UST Staff: Ted Unkles 802-522-0488, June Reilly 802-522-0231, Sue Thayer 802-522-0487, Jaymi Cleland 802-917-1386. Main office number: 802-828-1138. The Underground Storage Tank (UST) program was created in 1985 to help prevent contamination caused by leaking tanks. Tank owners and operators must comply with state rules for USTs. The goal of the UST Program is to protect human health and the environment by preventing releases of petroleum and hazardous substances from UST systems. The release of these regulated products into the environment threatens groundwater resources and can cause explosive vapors to seep into confined spaces and occupied dwellings.
	Sandia National Laboratory Hydrogen Safety, Codes and Standards program	
	4-6	Sandia National Laboratories, Combustion Research Facility, Hydrogen Safety Codes and Standards Program, Daniel Dedrick, dededri@sandia.gov, 925-294-1552 -- Sandia Livermore Labs, Sandia National Laboratories, California, P.O. Box 969, Livermore CA 94551-0969

Section 5 – Conversion of vehicles to alternative fuels		
	National Highway Traffic Safety Administration (CAFE standards as incentives to build and convert vehicles to alt	
	5-1	2014 Levin and Inhofe (US Senators) proposal to change the CAFE standards (administered by the National Highway Traffic Safety Commission) to remove the cap on auto manufacturers' bonus credits toward meeting their CAFE obligations when "alternative bi-fuel vehicles" are produced and sold by the automakers. Their proposal would also allow alternative fuel vehicles (defined as ??) to use HOV lanes regardless of how many people are in each vehicle. See the Wall Street Journal - Feb. 28, 2014, page A11.
Section 6 – Regulations related to weights, measures and fuel quality		
	Weights and measures (fuel) agencies in each state	
	6-1	Maine Department of Agriculture, Conservation and Forestry, Quality Assurance and Regulations, 90 Blossom Lane, Augusta, ME 04330, 207-287-3841, http://www.maine.gov/agriculture/qar/index.html, Steve Giguere, Program Manager, steve.giguere@maine.gov . http://www.maine.gov/agriculture/qar/index.html. Maine – Does licensing of vehicle fueling stations as well as fuel dispensing measurement certification as well as administering quality standards for gasoline and diesel fuels.
	6-2	State of Massachusetts, Office of Consumer Affairs & Business Regulation, Division of Standards, Weights and Measures -- One Ashburton Place, Room 1115, Boston, MA 02108, 617-727-3480, Director, Charles H. Carroll -- Email: charles.carroll@state.ma.us -- Director Carroll is responsible for overseeing the enforcement of laws, rules and regulations relating to weights and measures within the Commonwealth. The Director supervises the certification of all local weights and measures officials. Director Carroll has also twice served as chairman on the NCWM Specifications and Tolerance Committee, which is responsible for developing standards for commercial weighing and measuring devices. Massachusetts Motor Fuel Law - Section 295A - Definitions Massachusetts Motor Fuel Law - Section 295B - Licensing of retail dealers Massachusetts Motor Fuel Law - Section 295C - Display of price of motor fuel on dispensing devices.
	6-3	New Hampshire Dept. of Agriculture, Markets and Food, Division of Weights and Measures – 603-271-3700 – http://www.agriculture.nh.gov/divisions/weights_measures/. Rebecca Malila, Director, rebecca.malila@agr.nh.gov, Dennis Marquis, Program Specialist 1, dennis.marquis@agr.nh.gov , Elaina DeAngelo, Program Assistant 1 (Licensing) elaina.deangelo@agr.nh.gov.
	6-4	Rhode Island Weights and Measures: Dept. of Labor and Training, Occupational Safety, Weights and Measures Unit, Center General Complex, 1511 Pontiac Avenue, Cranston, RI 02920 – 401-462-8570, http://www.dlt.ri.gov/occusafe/wmform.htm
	6-5	Vermont Agency of Agriculture, & Markets. 116 State Street Montpelier, VT 05620-2901 -- Bev Delude, 802-828-2436. Vermont statute for weights and measures: 9 V.S.A. Chapter 73, Section 2730 -- The Agency of Agriculture is charged with licensing commercial weighing or measuring devices used for the sale of gasoline, home heating fuel, small and medium capacity scales in retail outlets, and heavy duty scales used in sales of concrete, hot mix/asphalt, feed, etc.
	National Conference on Weights and Measures (NCWM)	
	6-6	National Conference of Weights and Measures, 1135 M Street, Suite 110, Lincoln, Nebraska 68508, Phone: 402-434-488, Email: info@ncwm.net Don Onwiler: Executive Director, Jim Truex: NTEP Administrator, Elisa Robertson: Office Manager, Darrell Flocken: NTEP Specialist, Tyler Reeder: Project Coordinator. Relevant committees: Specifications and Tolerances Committee, Laws and Regulations Committee, Fuels and Lubricants Subcommittee (FALS), Packaging and Labeling Subcommittee (PALS), Steering Committee on Natural Gas as a Vehicle Fuel.
	6-7	In 1984, the National Conference on Weights and Measures (NCWM) put itself into the business of influencing control of fuel quality as well as measurement. NCWM adopted Section 2.20 in the “Uniform Regulation for the Method of Sale of Commodities” requiring that motor fuels containing alcohol be labeled to disclose to the retail purchaser that the fuel contains alcohol. This was deemed necessary since motor vehicle manufacturers were qualifying their warranties with respect to some gasoline-alcohol blends, motor fuel users were complaining to weights and measures officials about fuel quality and vehicle performance, and ASTM International (ASTM) had not yet finalized quality standards for oxygenated (which includes alcohol- containing) fuels. The NCWM Motor Fuels Task Force in 1984 developed mechanisms for achieving uniformity in the evaluation and regulation of motor fuels. Their “Uniform Motor Fuel Inspection Law” and “Uniform Engine Fuel and Automotive Lubricants Regulation” required registration and certification of motor fuel as meeting ASTM standards. The regulation defined the ASTM standards to be applied to motor fuel. In 1992, the Petroleum Subcommittee under the Laws and Regulations Committee recommended (and the NCWM later adopted) revisions expanding the scope of regulations to include all engine fuels, petroleum products, and automotive lubricants, and the fuel specifications and method of sale sections were revised to address the additional products. Other changes included sections on retail storage tanks, condemned product, registration of engine fuels designed for special use, and test methods. In 2007, the Petroleum Subcommittee (now referred to as the Fuels and Lubricants Subcommittee) undertook a review of this regulation to update it by eliminating reference to “petroleum products” and to reflect the addition of new engine fuels to the marketplace. In 2008, NCWM changed the Petroleum Subcommittee’s name to the Fuels and Lubricants Subcommittee (FALS) in recognition of its work with a wide variety of fuels including petroleum and biofuels. – See the National Institute of Standards and Technology (NIST) Handbook 130 "Uniform Laws and Regulations in the Areas of Legal Metrology and Engine Fuel Quality"

	6-8	Associated with the NCWM – the Northeastern Weights and Measures Association: James Cassidy, Secretary – (City of Cambridge, MA Weights and Measures Department 617-349-6133 – jcassidy@cambridgema.gov) – John Gaccione, Chairperson, Westchester County, NY Weights and Measures jpg4@westchestergov.com 914-995-2164 – Directors include Mark Coyne – Brockton, MA Weights and Measures, Steve Giguere, Maine Department of Agriculture (2014).
	National Institute of Standards and Technology, Office of Weights and Measures	
	6-9	National Institute of Standards and Technology, Office of Weights and Measures, Gaithersburg, MD 20899-2600, Carol Hockert, Chief.
	Fuel quality certification agency in each of the 5 states (National Council on Weights and Measures - state directors)	
	6-10	Ron Dyer, Maine Department of Agriculture, 28 State House Station, Deering Bldg, Augusta, Maine 04333-0028 – 207.287.3841, Ron.Dyer@maine.gov
	6-11	Charles Carroll, Massachusetts Division of Standards, One Ashburton Place, Room 1115, Boston, MA 02108 – 671-727-3480, charles.carroll@state.ma.us
	6-12	Rebecca Malila, New Hampshire Department of Agriculture: Markets and Food Division of Weights and Measures, 25 Capital Street, Concord, NH 03301 – 603.271.3700 - rebecca.malila@agr.nh.gov
	6-13	John Shaw, Rhode Island Department of Labor and Training, 1511 Pontiac Avenue #70, Cranston, RI 02920 - 401.462.8568 johnshaw@dlt.state.ri.us www.dlt.ri.gov
	6-14	Henry Marckres, Vermont Department of Agriculture, 116 State Street, Montpelier, VT 05620-2901 – 802.828.3458 - henry.marckres@state.vt.us
	National BioDiesel Board (National Biodiesel Accreditation Program)	
	6-15	National Biodiesel Board, 1331 Pennsylvania Ave., Washington, DC 20004, 202-737-8801, Lindsay Fitzgerald, Director of Regulatory Affairs, lfitzgerald@biodiesel.org, -- www.nbb.org -- EPA and regulatory affairs on biodiesel
	6-16	National Biodiesel Accreditation Program, PO Box 104898, 605 Clark Ave., Jefferson City, MO 65101 -- 573-635-3893 www.BQ-9000.org - The key program to maintain credible standards of quality and performance expectations by the market – Sampling, testing, training and certification program to assure that delivered biodiesel fuel meets ASTM D6751 standards which are considered the key
	California Fuel Cell Partnership	
	6-17	Chris White, California Fuel Cell Partnership, 3300 Industrial Boulevard Suite 1000, West Sacramento, CA 95691 – (916) 371-2870, cwhite@cafcp.org
	6-18	Per the California Fuel Cell Partnership -- re. codes for fueling station development/installation: The most common installation for hydrogen stations currently is to add equipment to existing gas stations. The process for permitting and approving a project starts with the California Fire Code (CFC), but specific requirements can vary from city to city. While the codes, standards, and regulations for the equipment and installation have advanced, they still require some development. The CFC has language for hydrogen installations and references 2011 NFPA 2, the Hydrogen Technologies Code. As of January, 2014, California enforces the 2013 CFC. NFPA 2 is under revision and the updated 2015 version will be referenced in the 2016 International Fire Code, and therefore the 2017 CFC.
	6-19	Changes proposed to CA hydrogen fuel dispensing measurement regulations -- for details see http://www.cdfa.ca.gov/dms/pdfs/regulations/ISOR-H2-Device.pdf . CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE DIVISION OF MEASUREMENT STANDARDS has illustrated changes to the original text in the following manner: Title 4, Division 9, Chapter 1, Article 1. National Uniformity, Exceptions and Additions, Section 4001. Exceptions. -- Section 4002. Additional Requirements, Sub-section 4002.9 Hydrogen Gas-Measuring Devices (3.39) 4002.9 Hydrogen Gas-Measuring Devices (3.39).
	6-20	Codes and standards for hydrogen fuel cited on California Fuel Cell Partnership website: Hydrogen – safety: US Department of Labor, OSHA: 29 CFR 1910.103 Hydrogen (United States), AIAA G-095 Guide to Safety of Hydrogen and Hydrogen Systems (United States), CGA Publication P12 Safe Handling of Cryogenic Liquids (United States), ISO TR 15916 Basic Considerations for the Safety of Hydrogen Systems (International), Working Group #16 Basic Considerations for the Safety of Hydrogen Systems (International) Hydrogen - Fuel Specifications: -- CGA Publication G5.3 Commodity Specification for Hydrogen (United States), ISO 14687-2 Hydrogen Fuel - Prod uct Specification, Part 2: PEM fuel cell applications for road vehicles (International), SAE J2719 Hydrogen Fuel Quality for Fuel Cell Vehicles (United States & Other Locales), State of California Regulations Hydrogen Fuel Standard (California), ISO 14687-3 Hydrogen Fuel – Product specification – Part 3: PEM Fuel Cell Application for Stationary Applications (International) Hydrogen - Contaminant Tests: ASTM D7550-09 Standard Test Method for Ion Chromatography Based Determination of Cations in Hydrogen and Other Fuel Cell Feed Gases (United States), ASTM D7606-11 Standard Practice for Sampling of High Pressure Hydrogen and Related Fuel Cell Feed Gases (United States). Hydrogen - Safety: US Department of Labor, OSHA: 29 CFR 1910.103 Hydrogen (United States), AIAA G-095 Guide to Safety of Hydrogen and Hydrogen Systems (United States), CGA Publication P12 Safe Handling of Cryogenic Liquids (United States), ISO TR 15916 Basic Considerations for the Safety of Hydrogen Systems (International), Working Group #16 Basic Considerations for the Safety of Hydrogen Systems (International).

	Nuvera Fuel Cells (Massachusetts-based mfr. of hydrogen fueling station equipment)	
	6-21	Nuvera Fuel Cells, 129 Concord Road, Bldg #1, Billerica, MA 01821 Contacs: Gus Block, 617-245-7500, Wes Hansen, 617-435-7937, 617-245-7590 – whansen@nuvera.com)
Section 7 – Taxation of alternative fuels		
	Fuel tax revenue and taxation office in each of the 5 states	
	7-1	Department of Administrative and Financial Services, Maine Revenue Service - Sales, Fuel & Special Tax Division, 207-624-9693, PO Box 9107, Augusta, ME 04332-9107 sales.tax@maine.gov -- http://www.maine.gov/revenue/fueltax/homepage.html
	7-2	Dept. of Revenue / Child Support Enforcement, Metro Region, 100 Cambridge St., 5th Floor, Boston, MA 02114-9558 617-626-2700 -- Office of Tax Policy Analysis, Kazim Ozyurt, Director, 617-626-2100 - http://www.mass.gov/dor/all-taxes/fuels/ .
	7-3	State of New Hampshire, DEPARTMENT OF SAFETY, DIVISION OF ADMINISTRATION, BUREAU OF ROAD TOLL OPERATIONS, JAMES H. HAYES SAFETY BUILDING, 33 HAZEN DRIVE, CONCORD, NH 03305 603-271-2311 SCOTT R. BRYER, CPA, CGMA CHIEF OF ROAD TOLL OPERATIONS. State of New Hampshire TITLE XXI MOTOR VEHICLES CHAPTER 260 ADMINISTRATION OF MOTOR VEHICLE LAWS Road Tolls Section 260:32 260:32 Levy of Tolls and Exemptions.
	7-4	Rhode Island Division of Taxation, Excise Tax Section, One Capitol Hill, Providence, RI 02908 -- Sales/Use; Motor Fuels; Cigarette/Tobacco Products -- E-Mail donald.englert@tax.ri.gov phone: (401) 574-8955 -- Motor fuels taxation issues: Marc R. Levasseur, Excise Tax section at (401) 574-8811.
	7-5	State of Vermont, Vermont Agency of Transportation, DEPARTMENT OF MOTOR VEHICLES, 120 State Street, Montpelier, Vermont 05603-0001 www.aot.state.vt.us 802-828-2000. Vermont TITLE XXI MOTOR VEHICLES CHAPTER 260 ADMINISTRATION OF MOTOR VEHICLE LAWS Road Tolls - Section 260:32 Levy of Tolls and Exemptions.
	Clean Energy Fuels (CNG and LNG)	
	7-6	Clean Energy Fuels, 49 South Main St., Suite 205, Concord, NH 03301 603-530-2921 www.cleanenergyfuels.com, Drew Drummond, Business Development Manager – ddrummond@cleanenergyfuels.com. Clean Energy Fuels, 9 Seagrass Trail, Plymouth, MA 02360 508-930-5732 www.cleanenergyfuels.com, Mark Slover, New England HD National Truck Team, mslover@cleanenergyfuels.com Working LNG for truck fleet fueling in New England.
	7-7	Clean Energy Fuels, Peter Grace, Senior Vice President, Sales and Finance, Peter works the high-level issues of economics of fuel station installation both CNG and LNG. Brett Barry, Policy and Regulatory Advisor, bbarry@cleanenergyfuels.com, Brett works the regulatory and government policies/statutes issues.
	American Natural Gas (CNG)	
	7-8	American Natural Gas, 125 High Rock Ave., Saratoga Springs, NY 12866 -- 866-264-6220 www.americannaturalgas.com, Drew West, awest@americannaturalgas.com Builds, designs and operates CNG fueling
	Alliance AutoGas (propane vehicle fuel)	
	7-9	Alliance Autogas, Asheville, NC 828-251-0027 www.allianceautogas.com David Finder National Energy Programs Manager dmfinder@blossmangas.com Propane/autogas station and fleet development.
	Alternative Vehicle Support Group (CNG)	
	7-10	Alternative Vehicle Support Group (CNG) Mike Manning, C3 Shipway Place, Boston, MA 02129 – 617-242-8755 mm@avsglp.com .
Section 8 – Property, equipment and casualty insurance		
	Insurance Commission in each of the 5 states	
	8-1	Maine Department of Professional and Financial Regulation, Bureau of Insurance, Property and Casualty Division -- Frank Kimball, Director, 207-624-8451-- Benjamin Yardley, Attorney, 207-624-8537 -- Michael Mayette, Property & Casualty Division Supervisor, 207-624-8407 -- Brian Cawley Senior Rate Analyst, 207-624-8470 -- Keith Fougere, Senior Rate Analyst, 207-624-8432
	8-2	State of Massachusetts, Office of Consumer Affairs & Business Regulation, Division of Insurance, Producer Licensing Department, 1000 Washington Street, Suite 810 Boston MA 02118-6200. Mass Division of Insurance, Producer Licensing staff: Bob Hunter, Supervisor, 617-521-7448 -- Duncan Kayondo, Licensing Administrator, 617-521-7449, Steven Zavackis, Licensing Administrator, 617-521-7428.

	8-3	New Hampshire Insurance Department, 21 South Fruit Street, Suite 14, Concord, NH 03301 - 603.271.2261
	8-4	State of Rhode Island Department of Business Regulation, Insurance Division, 1511 Pontiac Avenue, Cranston, RI 02920 401-462-9520 -- RI Insurance regulation -- All chapters of R.I. General Laws §§27-1, 42-14 and 28-29 through 28-38 and all Insurance Division regulations. Surplus line broker licensing and renewals, Lee-Ann Desilets, 401-462-9611, ldesilets@dbr.ri.gov , For questions on insurers placed on Insurance Division's approved list of surplus line insurers: Jack Kearney at 401-462-9626 – email: jkcvt@dbr.ri.gov .
	8-6	Vermont Department of Financial Regulation, Insurance Division – Producer Licensing, 89 Main Street, Montpelier, VT 05620-3101 - 802-828-3303 dfr.producerlicensing@state.vt.us . Contacts in Vermont DFR Insurance Division: Insurance Company Licensing - dfr.complic@state.vt.us , Insurance Producer Licensing - dfr.producerlicensing@state.vt.us . Vermont Law defines a Surplus Lines Broker to mean an individual who solicits, negotiates or procures a policy of insurance in an insurance company not licensed to transact business in this state which cannot be procured from insurers licensed to do business in this state. See Title 8, §4791.
	8-7	See also - National Association of Insurance Commissioners (NAIC). NIPR developed and implemented the Producer Database (PDB). Website: http://www.naic.org/indexcontact.htm .
	Property and Casualty Insurers Association of America (PCIAA)	
	8-8	PCIAA Headquarters- 8700 West Bryn Mawr Ave., Suite 1200S, Chicago, IL 60631-3512. Tel. 847-297-7800. PCIAA New England Regional Office – One State St., Suite 1500, Boston, MA 02109. Tel. 617-723-1976. Contact person in Boston – Frank O'Brien. PCIAA website: www.PCIAA.net .
	Property and casualty insurance: Charles River Insurance Brokers.	
	8-9	Charles River Insurance Brokerage, 5 Whittier Street, 4th Floor, Framingham, MA 01701. tel. 508-656-1400 www.charlesriverinsurance.com – contact person: Ellen Bohn-Gitlitz, Executive Vice President, Technology – email: ebohn@charlesriverinsurance.com . Charles River, a New England company, and Ellen Bohn-Gitlitz in particular, are very knowledgeable and clever in insuring new technologies including energy-related equipment and facilities.
Section 9 – State-level public utilities' rules, regulations and policies		
	Public utilities regulatory entity in each of the 5 states	
	9-1	Maine Public Utilities Commission -- 101 Second St., Hallowell, ME 04347 -- Postal Address: 18 State House Station, Augusta, ME 04333-0018. Maine PUC contacts: Lucretia Smith (Competitive Supplier Licensing and Reporting), Mitchell Tannenbaum (Rules), Chuck Cohen -- 207 287-1394 wchuck.cohen@maine.gov , or Faith Huntington - (Utility Rate and Rate Plan Information).
	9-2	State of Massachusetts, Executive Office of Energy and Environmental Affairs, Department of Public Utilities,Electric Power Division, 617-305-3575 -- 1 South Station Track 13, Boston, MA -- central phone: (617) 305-3500 -- Electric Power Division, Ben Davis, Director -- 617-305-3637 benjamin.davis@state.ma.us. Massachusetts 940 CMR 19.00 -- 940 CMR 19.00: Retail Marketing And Sale Of Electricity - 19.01: Purpose, 19.02: Scope, 19.03: Definitions, 19.04: Misrepresentations Prohibited, 19.05: Disclosures Required, 19.06: Other Unfair or Deceptive Acts or Practices, 19.07: Severability, 19.01:
	9-3	New Hampshire Public Utilities Commission, 21 South Fruit Street, Suite 10, Concord, NH 03301-2429 603-271-2431 -- Thomas Frantz, Electricity Director, 603-271-2431 tom.frantz@puc.nh.gov .
	9-4	Rhode Island Public Utilities Commission, 89 Jefferson Blvd, Warwick, RI 401-941-4500 -- Nick Ucci, Principal Policy Analyst, 401-780-2106, nucci@puc.ri.gov .
	9-5	State of Vermont, Public Service Department, Planning and Energy Resources Division - 112 State Street Third Floor, Montpelier, VT 05620-2601, Asa Hopkins, Director, 802-828-4082, Kelly Launder, Assistant Director, 802-828-4039, Mike Kundrath, Energy Policy & Program Analyst, 802-828-4081, Anne Margolis, Renewable Energy Development Director, 802-828-3058.

Section 10 – Federal rules impacting state regulations on infrastructure development		
	State air emissions programs related to vapor discharge from fuel storage filling and dispensing	
	10-1	Maine Department of Environmental Protection (DEP), Air Quality, 17 State House Station, Augusta, Maine 04333-0017. (207) 287-7688. http://www.maine.gov/dep/air/toxics/gasoline.html. Maine Statute regulating vapor discharge – Chapter 118, "Gasoline Dispensing Facilities Vapor Control," (06-096 CMR 118).
	10-2	Massachusetts Department of Environmental Protection (DEP) Bureau of Air and Waste, One Winter Street Boston, MA 02108-4746, Martin Suuberg Commissioner. Fact Sheet: Complying with Stage I & Stage II Certification http://www.mass.gov/eea/docs/dep/air/community/s1and2certfs.pdf Effective January 2, 2015, amendments to MassDEP Air Pollution Control Regulations at 310 CMR 7.00 and 310 CMR 7.24 require the removal of Stage II vapor recovery systems and enhancements to Stage I vapor recovery equipment at gasoline dispensing facilities (GDFs) across Massachusetts. The new regulations reflect the fact that between improved Stage I system technology and the widespread adoption of vehicle on-board vapor recovery, Stage II systems are no longer needed. Contact the MassDEP Stage II Hotline at (617) 556-1035, email: aq.stage2@state.ma.us, Program Web site: http://www.mass.gov/eea/agencies/massdep/air/programs/stage-ii-vaporrecovery.html
	10-3	New Hampshire statute and administrative rules: for gasoline vapor recovery: Statute and Administrative Rules Env-Or 500 Recovery of Gasoline Vapors. These Administrative Rules were revised. The revised rules provide that, as of January 1, 2012, new gas dispensing facilities are not required to install stage II vapor recovery systems, and that all existing systems in the state must be decommissioned by December 22, 2015. Facilities that continue to use stage II recovery systems must continue to comply with the stage II requirements until the system has been decommissioned.
	10-4	Rhode Island Department of Environmental Management (RI-DEM), Office of Air Resources, Doug McVay; Chief, 235 Promenade Street, Providence, RI 02908-5767. tel. 401-222-2808. Office of Air Resourced website: http://www.dem.ri.gov/programs/benviron/air/. RI DEM's Air Pollution Control Regulation No. 11 (Stage I & II Vapor Recovery Systems at RI Gasoline Dispensing Facilities) see http://www.dem.ri.gov/pubs/regs/regs/air/air11_13.pdf.
	10-5	State of Vermont, Department of Environmental Conservation (DEC), Air Quality and Climate Division - Douglas R. Elliott (Section Chief) (802) 377-5939 doug.elliott@state.vt.us. Section Tech Staff: Jay Hollingsworth (802) 272-3006, jay.hollingsworth@state.vt.us. Gasoline Vapor Recovery program website: http://www.anr.state.vt.us/air/compliance/htm/Gasoline.htm . Fact-sheet on Vermont vapor recovery rules: http://www.anr.state.vt.us/air/compliance/docs/st1fact.pdf. Beginning with the 1998 model year, a federal law established a phase-in schedule requiring gasoline powered motor vehicles to incorporate on-board equipment to capture the gasoline vapor emissions from refueling. These controls, referred to as on-board refueling vapor recovery (ORVR), have been required on the vast majority of gasoline powered motor vehicles since the 2006 model year. When most of the vehicles on the road are equipped with ORVR, Stage II vapor recovery can be discontinued without a significant impact on emissions.
	Office of U.S. Rep. Michael Capuano (MA) (House Transportation Committee staff)	
	10-6	U.S. Congressman Michael Capuano (D-MA) - Transportation Committee staff - Steve Carlson - steven.carlson@mail.house.gov -- also Jon Lenicheck.
	Office of Senator Ed Markey (MA) Senate Surface Transportation Subcommittee staff)	
	10-7	U.S. Senator Ed Markey (D-MA) - Senate Surface Transportation Subcommittee staff - Patrick Lally - patrick_lally@markey.senate.gov and energy staff person - Kayla Scire - kayla_scire@markey.senate.gov
	Office of Senator Kelly Ayotte (NH) Senate Surface Transportation Subcommittee staff)	
	10-8	U.S. Senator Kelly Ayotte (R-NH) - Senate Surface Transportation Subcommittee staff - Emily Lynch - emily_lynch@ayotte.senate.gov
	US EPA office dealing with Renewable Identification Numbers (RINs)	
	10-9	Janet G. McCabe, Acting Assistant Administrator, Office of Air and Radiation, mccabe.janet@epa.gov, Environmental Protection Agency, 1200 Pennsylvania Ave. NW., Washington, DC 20460–0001 -- 202-564-7400. Under McCabe, fuel policies, including Renewable Fuel Standard (RFS) are administered by the Office of Transportation and Air Quality (OTAQ) 202-566-0495 -- OTAQ Organization: Christopher Grundler, Director - Phone: (202) 564-1682. OTAQ includes: Assessment and Standards Division, Bill Charmley, Acting Director, 734-214-4466 -- Compliance Division, Byron Bunker, Director, 734-214-4155, Testing and Advanced Technology Division, David Haugen, Director, 734-214-4366 -- Transportation and Climate Division, Karl Simon, Director, 202-564-7918.

Section 11 – Incentives to facilitate adoption of alternative fueling		
	Motor Vehicle Registration offices – ME, MA, NH, RI & VT	
	11-1	Maine Office of the Secretary of State, Bureau of Motor Vehicles (BMV). For dealer-related issues: BMV Dealer & Agent Services Section (207) 624-9000 ext. 52143. Email: dealerandagent.bmv@maine.gov .
	11-2	Massachusetts - Registry of Motor Vehicles (RMV), Executive Office of Transportation, 25 Newport Avenue, Quincy, MA -- Mailing Address: P.O. Box 55889, Quincy, MA 02205-5889 -- 857-368-8000 -- Ombudsman Office: 857-368-9455, Registrar's Office 857-368-4636. Website: www.mass.gov/rmv .
	11-3	NH Department of Safety, Division of Motor Vehicles, 23 Hazen Drive, Concord, NH 03305 -- 603-227-4000 -- Richard C. Bailey, Jr., Director -- DMV General Customer Service: (603) 227-4000, Bureau of Registration: 603-227-4030.
	11-4	Department of Revenue, Division of Motor Vehicles, 600 New London Avenue Cranston, RI 02920-3024 -- Main Information - 401-462-4368, Registration Information 401-462-4368, Sales Tax (Motor Vehicles Only) 401-462-5765, Dealership Services 401-462-5746.
	11-5	Vermont Department of Motor Vehicles (DMV), 120 State Street, Montpelier, Vermont 05603-0001. tel: 802-828-2066. DMV Records Officer: Shannon Fassett – email: Shannon.Fassett@state.vt.us .

Appendix 2: Codes and Standards Relevant to HEC GPCOG Alt Fuels Project

Date of last update: Sep 8, 2013

Source: Paul Lenfest, Engineering Reliability Resources, LLC

Code or Standard	Responsible Organization	What fuel/energy type it pertains to	What function it pertains to
API 653	American Petroleum Institute	Biodiesel	storage tank inspection, repair, alteration & reconstruction
API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases	American Petroleum Institute and American Society of Mechanical Engineers	Hydrogen, CNG, LPG	All "unfired pressure vessels" must be built and repaired to ASME code
ASME B31.3	American Society of Mechanical Engineers	All	Process Piping: piping systems design, fabrication & installation
ASME B31.8	American Society of Mechanical Engineers	Hydrogen, CNG	Gas Transmission and Distribution Systems: piping systems design, fabrication & installation
ASME B31.12	American Society of Mechanical Engineers	Hydrogen	Hydrogen Piping Systems: piping systems design, fabrication & installation
ASME B&PV (Boiler & Pressure Vessel) Code, Section VIII	American Society of Mechanical Engineers	Hydrogen, CNG, LPG	All "unfired pressure vessels" must be built and repaired to ASME code. Sections applicable to LNG containers used on vehicles and in fueling stations. Sections applicable to containers used in CNG fueling stations.
ASME B&PV Section IX	American Society of Mechanical Engineers	All	Welding & Brazing requirements for all ASME pressure vessel and B31 piping standards
ASTM D6751	American Society for Testing and Materials	Biodiesel	Specifications for biodiesel fuel blend stocks (B100) to meet 4 performance levels
ASTM D975-09a	American Society for Testing and Materials	Biodiesel	Specification for Diesel Fuel Oils (B1 to B5)
ASTM D7467-08	American Society for Testing and Materials	Biodiesel	Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20)
CGA G-5.4	Compressed Gas Association	Hydrogen	Above & below ground piping systems' installation, maintenance & repair (See CGA publication CGA G-5)
CGA G-5.5	Compressed Gas Association	Hydrogen	Hydrogen vent systems (See CGA publication CGA G-5)
CGA H-1	Compressed Gas Association	Hydrogen	Service Conditions for Portable, Reversible Metal Hydride Systems
CGA H-3	Compressed Gas Association	Hydrogen	Cryogenic hydrogen storage; external piping
CGA H-5	Compressed Gas Association	Hydrogen	Installation Standards for Bulk Hydrogen Supply Systems
CGA H-10	Compressed Gas Association	Hydrogen	Combustion Safety for Steam Reformer Operation
CGA PS-20	Compressed Gas Association	Hydrogen	Direct Burial of Gaseous Hydrogen Storage Tanks
CGA PS-21	Compressed Gas Association	Hydrogen	Adjacent Storage of Compressed Hydrogen and Other Flammable Gases
CGA P-12	Compressed Gas Association	Hydrogen	Safe Handling of Cryogenic Liquids

National Board Inspection Code (NBIC)	National Board Inspection Code (NBIC)	All	Repair requirements for ASME piping & pressure vessels; also certification of repair organizations for the same
NGV 1	CSA (Canadian Standards Association)	CNG	Compressed Natural Gas Vehicle (NGV) Fueling Connection Devices
NGV 3.1	CSA (Canadian Standards Association)	CNG	Fuel System Components for Natural Gas Powered Vehicles
NGV 4.1	CSA (Canadian Standards Association)	CNG	Natural Gas Dispensing Systems
NGV 4.5	CSA (Canadian Standards Association)	CNG	(draft) Priority and Sequencing Equipment for Natural Gas Dispensing Systems
International Building Code (IBC)	ICC (International Code Council)	All	construction, alteration, relocation, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal and demolition of (AFV repair/refueling) buildings or structures
International Fire Code – 2000 (IFC)	ICC (International Code Council)	Hydrogen, CNG	
International Fire Code – 2012	ICC (International Code Council)		Safeguards regarding hazards of fire and explosion related to use, construction/repair/alteration of (AFV repair/refueling) structures, and conditions affecting the safety of emergency responders. “New" fire code - Check with local fire marshal on applicability
International Fuel Gas Code (IFGC)	ICC (International Code Council)	Hydrogen, CNG	installation of (AFV repair/refueling) fuel-gas piping systems, fuel gas appliances, gaseous hydrogen systems and related accessories
International Mechancial Code (IMC)	ICC (International Code Council)	CNG	design, installation, maintenance, alteration and inspection of mechanical systems providing control of environmental conditions within (AFV repair/refueling) buildings
NFPA 1	National Fire Protection Association	All	National Fire Code: general, and pertaining to AFV vehicle refueling & maintenance facilities
NFPA 2	National Fire Protection Association	Hydrogen	Hydrogen technologies
NFPA 30	National Fire Protection Association	Biodiesel, LPG	Flammable and Combustible Liquids
NFPA 30A	National Fire Protection Association	Biodiesel, Hydrogen, CNG	Motor Fuel Dispensing Facilities and Repair Garages – Code for Motor Fuel Dispensing Facilities and Repair Garages -2000 – Applies to facilities dispensing **both** gaseous **and** liquid fuels at the same facility - Includes requirements of 88B.
NFPA 50A	National Fire Protection Association	Hydrogen	Gaseous Hydrogen Systems at Consumer Sites
NFPA 50B	National Fire Protection Association	Hydrogen	Liquefied Hydrogen Systems at Consumer Sites
NFPA 52	National Fire Protection Association	Hydrogen, CNG	Vehicular Gaseous Fuel Systems
NFPA 54	National Fire Protection Association	Biodiesel, LPG (propane)	National Fuel Gas Code
NFPA 55	National Fire Protection Association	Biodiesel, Hydrogen, LPG (propane)	Compressed Gases & Cryogenic Fluids
NFPA 58	National Fire Protection Association	LPG	Liquefied Petroleum Gas Code

NFPA 68	National Fire Protection Association	Biodiesel	Explosion Protection by Deflagration Venting
NFPA 69	National Fire Protection Association	Biodiesel	Explosion Prevention Systems
NFPA 70	National Fire Protection Association	All	National Electrical Code: general, and pertaining to AFV vehicle refueling & maintenance facilities
NFPA 88A (per Marathon)	National Fire Protection Association		Standard for Parking Structures –1998 - Open, enclosed, basement and underground parking structures - No special requirements for NGVs other than reference to NFPA 52 and 57
NFPA 88B	National Fire Protection Association	All	Standards for Parking Structures - Standard for Repair Garages -1997 (subsumed in 30A-2000) - All garages used for major repair and maintenance of motorized vehicles - Has some specific requirements for garages working with NGVs, such as ventilation, electrical requirements near the ceiling, temperature of exposed surfaces on heaters
NFPA 400	National Fire Protection Association	Hydrogen	Hazardous Materials Code
NFPA 495	National Fire Protection Association	Hydrogen	Explosive Materials Code
NFPA 5000	National Fire Protection Association	All	Building Construction and Safety Code: general, and pertaining to AFV vehicle refueling & maintenance facilities
PEI RP200	Petroleum Equipment Institute	Biodiesel	installation of above ground storage systems for motor vehicle fueling
SAE J2600	Society of Automotive Engineers	Hydrogen	Compressed Hydrogen Surface Vehicle Fueling Connection Devices (hardware)
SAE TIR J2601	Society of Automotive Engineers	Hydrogen	Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles (communications) – 2010 standard
SAE J2719	Society of Automotive Engineers	Hydrogen	Hydrogen quality guideline for fuel cell vehicles – 2011 update
SAE J1772	Society of Automotive Engineers	Electrical	physical, electrical, functional and performance requirements for charging of EV/PHEV vehicles
SAE J1773	Society of Automotive Engineers	Electrical	interface compatibility requirements for electric vehicle charging
SAE J2894	Society of Automotive Engineers	Electrical	Power quality requirements for plug-jn electric vehicle chargers
SAE J2293 Parts 1,2	Society of Automotive Engineers	Electrical	Functional requirements and system architecture for Energy Transfer Systems: Electric Vehicles (EV) - Electric Vehicle Supply Equipment (EVSE) - electric Utility Power System
SAE J2847, Parts 1,2,3	Society of Automotive Engineers	Electrical	Communications between Plug-In Vehicles and the Utility Grid/Supply Equipment (EVSE)
SAE J1616	Society of Automotive Engineers	CNG	compressed storage of Natural Gas, and vehicle fuel system performance issues, Recommended Practice for Compressed Natural Gas Vehicle Fuel -1994 – CNG - Recommendations on vehicular fuel composition.
SAE J313	Society of Automotive Engineers	Biodiesel	Diesel fuel quality and characteristics

STI SP001	Steel Tank Institute	Biodiesel	inspection of above ground storage tanks
UL 2245	Underwriters Laboratories	Biodiesel	Below-Grade Vaults for Flammable Liquid Storage Tanks
UL 2080	Underwriters Laboratories	Biodiesel	Fire Resistant Tanks for Flammable and Combustible Liquids
UL 2085	Underwriters Laboratories	Biodiesel	Protected Above Ground Tanks for Flammable and Combustible Liquids
UL 147	Underwriters Laboratories	LPG	Standard for No refillable (Disposable) Type Fuel Gas Cylinder Assemblies