Strategy for Global Commercialization of NGVs

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ABSTRACT

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The use of natural gas vehicles (NGVs) is expanding rapidly around the globe, motivated by a combination of factors, including favorable fuel economics, abundances of natural gas supply, environmental concerns and energy security. In any country or region where NGVs are achieving commercial success, four conditions have existed: 1)Favorable fuel price differential between natural gas and traditional fuels (gasoline or diesel); 2) Availability of NGV technologies (underhood and fueling stations); 3) Support from fuel suppliers, specifically the natural gas industry; and 4) Favorable government policies. Concern about the environment, whether formally recognized by legislation and/or regulation or motivated by public concern, has been an important factor in the U.S. and, to a lesser degree, in Scandinavia, and will become more significant to worldwide NGV commercialization in the future.

The existence of these conditions in a country does not necessarily **guarantee** commercial success for NGVs. There are additional intra-national and international issues that must be addressed to ensure a smooth transition to the commercialization of NGVs. These include the development of compatible codes and standards; the adoption of more globally accepted environmental regulations; the development of reliable, fully warranted NGV equipment from original equipment manufacturers (vehicles and engines); coordination of research and development activities; and general recognition of favorable market conditions by the world-wide NGV industry that will help motivate international trading of information and equipment.

The NGV Coalition has developed a strategic plan for NGV commercialization in North America. It is based upon actions and goals in the areas of: technology development; market development; government relations (legislative and regulatory); and public relations and communications. The approach is being advocated for NGV infrastructure development by the federal government and within individual U.S. states. The focus is on creating favorable laws, organizing gas utility support and creating local networks of natural gas fueling stations. The same methods that twill achieve commercial success in the U.S. can be adapted and implemented within other countries as well as to larger international regions.

This paper provides a theoretical framework and an action plan for international commercialization of NGVs. As the NGV markets are identified and evaluated, NGV equipment suppliers can take advantage of business opportunities that eventually will lead to more widespread worldwide use of NGVs. Ultimately, such market expansion will lead to a more balanced us of worldwide fossil resources and cleaner air.

STRATEGY FOR GLOBAL COMMERCIALIZATION OF NGVs

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The use of natural gas vehicles (NGVs) is expanding rapidly around the globe. An estimated 600,000+ NGVs exist today, supported by a growing network of private and public fueling stations where compressed natural gas (CNG) is available.

In North America, the Washington, D.C. based NGV Coalition was created to provide a 'rifle shot' in the market place to commercialize NGVs. The cross cutting membership represents natural gas utilities, pipelines and producers, as well as original equipment manufacturers, components and parts manufacturers, and NGV service organizations. The Coalition and its members have developed a strategic plan for NGV commercialization in North America. It is based upon actions and goals in the areas of: technology development; market development; government relations (legislative and regulatory); and public relations and communications. The focus is on creating favorable laws, regulations and standards, organizing gas utility support, and creating local networks of natural gas fueling stations that will expand and form a nationwide infrastructure. The same methods that will achieve commercial success in the U.S. and Canada -- assuming similar conditions -- can be implemented within other countries and regions of the world, to realize the global commercialization of NGVs.

Commercializing NGVs is like building a ladder, and then jumping up the ladder two feet at a time. One side strut of the ladder represents the equipment availability; the other side the fueling infrastructure. Each rung is a new technology or process that contributes to the viability and choices of vehicles and equipment in the marketplace. Critical to the ladder, however, are the connections between the rungs and the ladder struts. These are the codes and standards that are required to hold the entire structure together. Commercializing NGVs is challenging at best; precarious at worst; but definitely a process that requires long term commitment.

CONDITIONS LEADING TO NGV COMMERCIALIZATION

In any country or region where NGVs are achieving commercial success, four conditions have existed:

- Favorable Economics. The low price of natural gas relative to the traditional fuels -- gasoline and diesel -- is the single, most important long term factor in successful NGV commercialization.[1]

- Availability of NGV technologies. Vehicle technology (under-hood and storage systems) and refueling technology all are critical to the commercial success of NGVs. Vehicle performance -- emissions and power -- must compete with gasoline vehicles, be they bi-fuel retrofits or factory-produced, original equipment manufactured (OEM) products.

- Support from fuel suppliers. Support from the fully integrated natural gas industry -- local distribution companies, pipelines, and producers -- is essential to the commercial success of NGVs. Vertical integration of these interests to support NGV market growth is more difficult in countries where the gas industry is privatized and/or segmented (as in the U.S.), while countries with a more centralized, nationalized gas industry may be more likely to focus support for NGVs.

- Favorable government policies. National governments must take a leading role in NGV (or generic alternative fuels) commercialization. Countries where commercialization is advancing (Canada, Argentina, and now the United States, etc.) have federal policies favoring and supporting NGV or alternative fuel development. The U.S. with its Clean Air Act (CAA) and National Energy Strategy (NES) legislation is about to leap forward in NGV commercialization now that government policies are being developed to support alternative fuels.

Also important in the U.S., and with growing importance world-wide, is the emergence of emission standards that challenge the existing fuels and traditional transportation technologies to produce lower levels of pollutants. While the U.S. leads the world in the development of stringent emission standards for vehicles, concerns about air pollution and, moreover, the codification of standards internationally, will bring about a much more rapid advancement of NGV commercialization. In the United States, emission vehicle standards will lead to one of the most rapid advancement of NGVs.

Typically, governments -- federal, state, provincial or local -- can play an important role in shaping the conditions favoring commercialization. Six major opportunities for governments to foster NGV (and alternative fuel) commercialization include, but may not be limited to:

- Providing Incentives. These can take the form of tax relief for vehicle or fuel purchases (or taxing traditional fuels more heavily); exempting NGVs and other alternative fuels from restrictions such as parking limitations or high occupancy commuter vehicle lanes; or subsidizing the production of NGVs or alternative fuel vehicles (AFVs).

- Enforcing Mandates. In the U.S., for example, AFVs are mandated for certain fleet vehicles in specific 'dirty air' cities starting in 1998. In Buenos Aires, NGV taxis were required beginning in 1990.

- Leadership by Example. Government purchases of NGVs provide a strong motivation for manufacturers to produce NGVs, and to set examples by leadership for private and public use of NGVs.

- Standards Development. Standards for emissions, fuel composition, conversions, fuel connectors, and vehicle and cylinder safety, are key to legitimizing NGV technologies in the marketplace.

- RD&D Funding. Public sector funding of long term research, development, and demonstration (to supplement private sector investment) can be a cornerstone of new technology commercialization.

- Communications & Education. 'Selling' the concept of NGVs (and alternative fuels) can be an important element of a government policy, to spread consumer knowledge of new technology availability.

ACTION PLAN FOR DEVELOPING AN NGV INFRASTRUCTURE

The existence of the above conditions in a country does not necessarily guarantee commercial success for NGVs. There are additional intra-national and international issues that must be addressed to ensure a smooth transition to the commercialization of NGVs. Developing an infrastructure for NGVs and fuel requires a coordinated, multidisciplinary group of special interests working together within a country and across international boundaries. Each of the participants must have some economic or social benefit -- the sale of equipment, fuel, or fulfillment of larger national goals such as air pollution reduction or increased reliance on **domestic** fuel. Typically a private/public partnership is required to ensure the ultimate success of the NGV commercialization venture.

Regional vs. Country Approach

Size of national land mass, proximity to other countries, and the degree of regional economic and social integration all will have an effect upon NGV commercialization. For example, in North America, the NGV Coalition embodies interests in both Canada and the U.S. The ability to share NGV research goals, standardization of fueling connectors, and the development of similar equipment and emissions standards is enhanced by the close proximity, similar languages, and most recently, a free trade agreement.

European community integration will enhance NGV commercialization there, but the task of dealing with different languages, different natural gas systems, and the close proximity of so many individual nations present

barriers unlike those in North America. South America, though less challenged by multiple regional languages than Europe, must deal with different economies, gas distribution systems, and somewhat less international integration than the European community. Stability of individual South American countries' economies and monetary systems overlays yet another challenge to NGV commercialization not faced by the Europeans or North Americans.

Developing a 'Core' NGV Organization

While every country and international region has different sets of challenges and opportunities depending upon economic, social, and natural gas network integration, a focused, core NGV commercialization organization and movement must be created as a precursor to NGV expansion. The elements of the organization's focus must include, as has been done in the North American NGV Coalition, objectives associated with government affairs (legislative, regulatory, and standard setting), market development, technology development, and public relations and communications. As such, an organized NGV commercialization strategy must be created to address these specific issues, and actions need to be taken to resolve the numerous challenges that face every national or regional NGV commercialization effort.

Elements of the Plan

Specific strategic NGV commercialization efforts must include a number of tasks that will be accomplished by the prime mover organization's membership. These 'tasks' can be assigned to various participants in the infrastructure-building process or handled directly by the lead NGV organization. (The tasks identified below are not in a specific order of progression, but rather must be coordinated and consolidated over time.)

TASK 1: Organizing Natural Gas Utility Industry Interests

Some utilities provide the 'cutting edge' of NGV market development. For some segments of the industry, however, the gas company often is its own worst enemy. ('We have met the enemy, and the enemy is us.') Dominated by traditional residential, commercial, and

industrial markets, opening a new transportation market for natural gas is unlike any other utility marketing or technology development effort. Often it is difficult to convince gas industry leaders that the transportation sector is a high value, potentially profitable market, and that a natural gas meter can look like a typical gasoline fuel pump.

One of the principle activities of the U.S. NGV Coalition is to add membership and support of the divergent natural gas industry groups nationally -- utility (distribution) companies, pipelines, and gas producers. Within companies individually, however, gaining support for NGV market development activities is essential, and requires motivation from the chief executive officer and from the leading officers involved in marketing, government relations, utility operations (i.e. the fleet people), finance and rates, research, and communications -- virtually the leadership of the entire company.

In countries with a nationalized, more unitary natural gas industry, the 'utility mentality' aversion to developing a new transportation market still may present barriers to NGV commercialization. Once a decision is made to move into the NGV market, however, it could be done relatively swiftly. This is especially true if a country's federal government controls large (or all) segments of the nation's natural gas industry.

TASK 2: Developing a Vehicle Market Profile

It is essential to identify the number of commuter vehicles, fleets, and fleet vehicles nationally, and within individual states, provinces, and cities where a fueling network is to be established. This baseline data provides the basis for short and long term market planning as well as fueling station infrastructure planning and development. Information would include, but not be limited to:

- Number and concentration of commuter vehicles;
- Number of fleet operators and location;
- Number of fleet vehicles and types;

- Driving patterns (most popular roads/routes);
- Existing vehicle fueling station network.

TASK 3: Evaluation of Existing Legal and Regulatory Issues

Issues that typically need to be addressed will vary by country and international region. Some of these issues include, but are not limited to:

- Prohibitions to the non-utility company sale of natural gas as a vehicle fuel;
- Development of an NGV rate at which to sell gas;
- Utility company opportunities and methods to expense the cost of developing a fueling network, or supporting the privatization of a fueling network. Issues associated with 'who shall pay', the private or public sector, are critical to NGV commercialization and distributing fuel at the fueling station.
- Bridge, tunnel, marine, harbor, or other restrictions to the use of compressed (or liquefied) natural gas as it travels the byways of a country or international region. (Is natural gas considered a 'hazardous material'? What restrictions to its transport apply?)
- Insurability of NGV conversion centers and fueling stations.
- Fuel taxes and potential tax relief opportunities for vehicles and fueling stations.

TASK 4: Coordination of Political Decision Makers

Having identified legal and regulatory issues and barriers, the national (and regional international) political actors --legislators and regulators -- must be brought into the infrastructure development process. Engaging support from all levels of political entities and organizations helps sell the NGV concept and promotes a favorable legislative and regulatory environment for NGV development. This is important nationally at

federal, provincial (state), or local government levels. Across international boundaries the challenge of coordinating national policies is even more complex but no less crucial. (See below, dealing with international institutions.)

TASK 5: Target Marketing of Vehicle Conversions and Sales

Using information in the national vehicle profile, utility and NGV marketers need to segment the various fleet and private vehicle markets (i.e. light duty vs. heavy duty; commuter vs. fleets; municipal/state vs. private; etc.). Fundamental decisions about focusing on fleet markets and/or commuter markets must be made. Market penetration goals will be determined by issues such as distances to be driven and annual fuel consumption, overall fuel efficiency of the vehicle population, ability to consolidate a public fuel network versus a private network for fleets only, and most importantly, the price of the traditional fuels in comparison to natural gas.

TASK 6: Identify Siting of Public Fueling Stations for NGVs

The optimum siting of fueling stations -- either at private fleet locations or public access -- must be evaluated relative to the national and local distribution of vehicles and their travelling patterns. Such a vehicle siting analysis is useful to market the vehicle owners -- commuters or fleets, public or private. Three broad strategies to opening public or publicly accessible fueling stations include:

- Utility owned fueling stations (sited at their current fleet facilities, or opened independent of fleets for sole retail sales);
- Siting of fueling stations at private fleet locations that also may be opened to other NGV users (publicly accessible);
- Siting of public fueling stations, either at existing gasoline/diesel retail outlets or creating dedicated NGV fueling facilities.

TASK 7: Development of Conversion and Servicing Infrastructure

Vendors to support NGV conversions must be identified, with an eye toward opening 'one-stop-shop' conversion, servicing, and fueling stations. As original equipment manufacturers NGVs are developed and marketed, this task will be easier since the OEMs will provide training and support to their service outlets.

TASK 8: Encourage Involvement of Original Equipment Manufacturers

If a potential market of significant proportions is established, OEMs will enter the market with factory produced NGVs, for both light and heavy duty vehicles. In North America, all three major car manufacturers and a number of engine manufacturers and vehicle body builders (chassis, urban buses, and school buses)[2] are involved in different stages of research, development, demonstration, and marketing of factory-built NGVs. Internationally this trend is expanding as NGV market potential and growth develop. European vehicle manufacturers are entering the market too, attempting to assess the longer term potential and prepare for the advent of a growing alternative fuels market.

Though the ultimate market for NGVs will be a dedicated, natural gas-only vehicle, a decade or more of a bi-fuel 'bridge strategy' approach to vehicles is required until a sophisticated network of compressed natural gas stations is created. (This will happen at different rates on a national basis; internationally the interconnection of the fueling network is the ultimate goal.) Three potential strategies for achieving OEM involvement include:

- Early market entry of OEM dedicated NGVs, to help motivate the rapid expansion of the fueling infrastructure.

- Involvement of specialty vehicle manufacturers, typically smaller companies that may or may not use equipment supplied by OEMs, (i.e. manufacturers of small buses, taxis, etc. that use OEM engines and chassis).

- Aftermarket conversion of OEM equipment, with support from the OEM, with the OEM supplying the warranty, distribution, and possible service support, and the NGV conversion vendor supplying NGV equipment, servicing, warranty, and training support.

TASK 9: Analysis of Emissions Impacts of NGVs

While the U.S. has been the most aggressive nation in developing strict vehicle emission standards, many other nations are looking toward the development of emissions standards. Ultimately emission standards are likely to be required in all developed and developing nations as a matter of public policy, to preserve people's health and the overall global environment. Though the stringency of these standards will be different (typically due to local air quality as well as the economic and social infrastructure to support different vehicle technologies), air quality will be a driving force for NGVs due to their inherent low emission characteristics.

As NGVs proliferate, it is important that all nations and international regions identify and evaluate specific air quality benefits of NGVs relative to gasoline and diesel vehicles on an area-by-area, country-by-country basis. Though economics will be the ultimate driver toward NGV commercialization, the emissions benefits will be of growing importance as more nations awake to the importance of reducing air pollution.

TASK 10: Selling the NGV Concept: Communications and Public Relations

Most people (consumers or businesses) do not realize that natural gas is a viable fuel alternative to gasoline or diesel. Messages about price, fuel availability, safety, and clean burning, low emissions characteristics of NGVs are critical to the success of NGV commercialization. "Name recognition" of NGVs is critical to widespread consumer acceptance in individual countries and internationally.

Leading national NGV organizations, as well as equipment suppliers, fuel providers, and governments all play an important role in promoting the NGV concept. The

process must be constant and unrelenting. Public relations opportunities can include, but are not limited to:

- National and international rallies and NGV equipment expositions;
- NGV conferences of research, demonstrations, and case studies;
- Press coverage of new technology developments;
- Publicizing NGV fueling station openings.

Involvement of politicians and business leaders in all these events will provide additional public exposure for NGVs. Individual corporate communications and advertising also will enhance public awareness. Multi-media messages should be aimed at all types of NGV customers and 'thought leaders' (decision makers who influence NGV-related policies, practices, or purchase decisions).

The NGV Coalition and the American Gas Association are working jointly to develop and promote an NGV 'mark' -- a symbol recognizable to denote NGVs. The initial attempt is to obtain NGV recognition in North America, for fuel stations, vehicle equipment, and the like. If international acceptance can be gained for such a 'mark' (similar to gasoline fuel pump symbols common on highways around the world) then the NGV community moves closer to global name recognition for NGVs and, ultimately, commercialization.

TASK 11: Involvement and Liaison with Educational Institutions

Linkage to the academic community and business/industry groups developing the NGV infrastructure is an activity that provides longer term growth in the NGV market. Students emerging from colleges and graduate schools who are trained in NGV technology will enter the work place to provide the continued growth of knowledge in the field. Fostering educational opportunities include activities such as basic research, development, and demonstration of NGV equipment and systems; development of emissions testing

facilities for light and heavy duty natural gas engines and vehicles; use of graduates from secondary schools and universities to support NGV conversions, businesses, and other aspects of the infrastructure.

Implementing the Plan

Implementing the action plan requires all of the participants -- NGV businesses, component manufacturers, local and national decision makers, etc. -- to become involved. A single focal organization must be developed, with a designated director to become the key 'point person' to manage and guide the completion of the tasks. With an adequate budget supported by member companies (if indeed a membership-type organization is selected), NGV commercialization activities can be planned and implemented.

The NGV Coalition got its start with 20 'champions' -- natural gas utilities in the U.S. and Canada that each made a financial commitment to create, nurture, and guide its continued growth. Any start-up organization will require such champions if it is to be a success ultimately.

THE GLOBAL NETWORKING PROCESS

There are numerous international institutions that have energy-related components that could be incorporated into the global NGV commercialization effort. Many of these can be brought into the NGV commercialization process.

The International Association for NGVs (IANGV)

The IANGV is positioned as **the** international organization to help foster global NGV commercialization. Its potency and effectiveness will be a synergistic function of its members' activities to commercialize NGVs in various countries and international regions. With designated country representatives, the IANGV council provides the international communications network that will be required to promote NGV commercialization. The bi-annual international conference and exhibition does more than any single event to share technical and marketing information internationally about NGV activities globally.

The breadth of global membership of the IANGV also presents many challenges. Developing working groups, as has been done with a technology committee and the international cylinder standards, is effective but challenging in that the working committee membership is from around the globe. The advent of convenient electronic communications (i.e., Fax and computer modems) facilitates the networking opportunities and sharing of important work that must be accomplished. Committee meetings where members exchange information face-to-face also are a part (albeit expensive and time-consuming) of the work performed by IANGV and its members.

IANGV and its members must continue to foster expanded membership to enhance the global opportunities to share information, technologies, and market opportunities that will lead to eventual global commercialization of NGVs.

Relationships with Existing International Institutions

Other world organizations that can be included in NGV commercialization activities are the World Bank and its affiliate organs, the International Energy Agency, and the United Nations, to name only a few. Each has a specific research or international development function that could be interconnected and marshalled to support NGV developments. At this time these agencies' activities related to NGVs are not necessarily coordinated with the IANGV or its members directly. The World Bank, for example, has funded NGV-related developments in Mexico and Argentina as part of their international development work. Capitalizing on these organizations' knowledge and financial resources just now is beginning, with some IANGV focus included, and needs to be more directly coordinated to ensure that the relatively scant worldwide resources are not spent on duplicative activities and research.

Identifying International NGV Market Opportunities

With expanding NGV technology and services internationally, there needs to be an improved effort to identify new NGV market opportunities for NGV equipment manufacturers and service providers. Likewise, it is important to identify NGV equipment suppliers worldwide

who can fulfill growing market demand.

Market opportunities vary country-by-country depending upon economic and social sophistication of the various markets. Equipment standards as well as physical proximity and trade agreements also will effect the international trading of NGV technology.

For example, the U.S. market for factory-built NGVs will be limited to technology that meets stringent U.S. standards. By the same token, sophisticated U.S. NGV equipment designed to meet emission standards may be unnecessarily expensive to export to countries without emissions standards. Individual country standards for fuel cylinders (or other equipment) also may impede some import/export opportunities internationally.

There exists an opportunity to develop an international market study of NGV potential to help identify where conversion technology, factory-built vehicles, compressors, and subsidiary equipment will be required in the near and distant future, and which companies have the capacity to fill the demand. IANGV could provide the focus for such a study, however, it must be coordinated and include direct participation from each country represented on the Council. Available financial resources could be marshalled to support such an effort or, more appropriately, could be handled as a consulting project sponsored by the IANGV. Alternatively, the cooperation of other international organizations could be solicited to help fund such a market study. (In the U.S. the NGV Coalition will be funding such a market study for the U.S., comparing vehicle fleet data to legislated requirements by the federal and state governments to begin using clean fuels and NGVs.)

Conferences & Communications

As the business potential for NGVs continues to grow, an increasing number of NGV conferences internationally are appearing. Many of these are country-specific; others are regional in nature. The 'conference phenomenon' has occurred in the U.S., with many organizations attempting to capitalize financially on this new market opportunity. While there are many generic alternative fuels conferences appearing (that

typically include many of the same knowledgeable NGV experts), a number of industry groups new to NGVs are including NGV components, such as fleet operators, bakers industry, the truckers association, independent petroleum marketers, and automotive engineers. This proliferation of NGV-related information sharing is indicative that NGV commercialization is progressing, and that NGVs are a technology and market that has expanding potential for a growing number of industries.

INTERNATIONAL LEADERSHIP AND PARTICIPATION IS ESSENTIAL

Leadership

One of the keys to the success of NGV commercialization is leadership, both intellectual leadership and strategic leadership to help motivate and guide NGV developments and activities. Organizational leadership is important for those involved in the NGV business, however, NGVs need specific 'champions' who will carry the industry forward.

Vision

Leadership also requires **vision** to look to the future and harness the potential for all types of NGVs, including marine, rail, and even aeronautical vehicles. (On the smaller scale, the potential even exists for lawnmowers and small, off-road recreational vehicles.)

Financial Commitment

Financial commitment is another key to commercialization, and it always must be with an eye toward profitability. There is inherent risk in making NGV investments, however, the inherent rewards should be enough to motivate growing interest in NGV market potential. Financial commitment, however, must not be short-term, since the NGV market typically will not provide a 'quick profit'.

Hard Work & Perserverence

Last, hard work and indefatigable perserverence is part of the mix of characteristics that will lead to the near term and long term market success of NGVs.

Participation

The growing worldwide community of professionals involved in NGVs requires continued expansion and new participants. While the international market for fuels and vehicles likely will be dominated in the near and distant future by liquid petroleum fuels, the 'market niches' for NGVs and natural gas as a vehicle fuel (CNG or LNG) is substantial and potentially profitable for those positioning themselves to take advantage of the opportunities.

Fortunately, NGVs provide the same motivation worldwide: it is a clean burning, environmentally benign fuel; it is economical by comparison to liquid petroleum fuels and alcohols; is abundant globally; and is among the safest fuels on the road today. NGV promoters and thought leaders must pursue NGV opportunities relentlessly and persistently if NGVs will become commercialized globally. The challenges are enormous but as the ranks of NGV proponents swell, the opportunities to profit from a change in the use of vehicle fuels to natural gas will expand. Future success to make a mark globally will require participation from the believers. The strategy is clear; the actions are apparent; and the forces must be mobilized!

NOTES

1. A 1991 study of fleet operators in the U.S. indicates that the most important concern in their doing business relates to the first cost of fuel, followed by maintenance costs, and first cost of the vehicle. Sensitivity analyses demonstrate that, the wider the cost differential between natural gas and gasoline/diesel, the more acceptable will be the cost differential between an NGV and its gasoline counterpart. (A.G.A./NGVC Fleet Market Study, Arlington, VA. October 31, 1991.)

2. Manufacturers include, but are not limited to: Ford, Chrysler, General Motors, Hercules Engines, Inc., Cummins Engine Co., Inc., Detroit Diesel Corp., Flxible Corp., Bus Industries of America, Blue Bird Body Company, Thomas Built Buses, Inc., Crane Carrier Co., and Clark Material Handling Co.

BUILDING AN INFRASTRUCTURE FOR ALTERNATE FUELS