3.5 Technology Introduction

The Technology Introduction subprogram focuses on activities that will accelerate the adoption and use of alternative fuels and advanced technology vehicles to help meet national energy and environmental goals. Widespread introduction and deployment of these fuels and vehicles would help reduce the consumption of petroleum-based fuels thus contributing to achieving the overall FCVT program goal. This subprogram consists of the following activities which logically follow and complement successful research by industry and government:

- Legislative and Rulemaking;
- Clean Cities; and
- Advanced Vehicle Competitions.

Primary functions are in support of the Energy Policy Acts of 1992 and 2005 (EPAct 1992 and EPAct 2005) alternative fuel and fleet activities, voluntary community-based partnerships to promote deployment of vehicle technologies and alternative fuels that can reduce petroleum consumption, and providing educational opportunities for university students to learn and use real-world engineering skills while demonstrating the performance of critical vehicle technologies.

3.5.1 Legislative and Rulemaking

3.5.1.1 External Assessment and Market Overview

The U.S. transportation sector is currently 97 percent dependent on petroleum, with a growing portion of this fuel needing to be imported into the country. To improve this situation, there are three major ways identified to reduce petroleum consumption in transportation:

- Reduce vehicle miles traveled through use of mass transit or elimination of trips;
- Replace petroleum fuels with non-petroleum replacement fuels, either completely through use of alternative fuels in alternative fuel vehicles or partially through the use of non-petroleum fuels in blends with petroleum fuels for use in conventional vehicles; and
- Increase the efficiency with which petroleum fuels are used in the transportation sector, through both more efficient vehicle technologies (like hybrids and improved diesel engines), and traffic congestion reduction.

There has been strong bipartisan support for alternative and replacement fuels, especially for biofuels like ethanol and biodiesel. Similarly, there has been continued support for fleet programs like the EPAct fleet activities. In particular, Congress has demonstrated interest in and support for these types of fleet programs to serve as leadership opportunities–using fleets to introduce new technologies.

3.5.1.2 Internal Assessment and Activity History

The fleet provisions of the Energy Policy Act of 1992 (P.L. 102-486) and the Energy Policy Act of 2005 (P.L. 109-58) focused on the replacement of petroleum in certain types of fleets, using both mandatory and voluntary means. Mandatory programs involved requiring larger light-duty vehicle fleets located in major metropolitan areas to acquire AFVs. The related voluntary efforts sought to bring together both regulated and unregulated fleet operators, and also incorporated medium- and heavy-duty vehicles. Thus, EPAct's fleet programs included the following major elements:

- **Federal Fleet** Acquisitions of alternative fuel vehicles (starting 1993) – this effort focused on both specific acquisition requirements as well as the leadership role the Federal government could take. Executive Order 13149, signed in 2000, reinforced the commitment of the Federal government to meeting the EPAct AFV acquisition requirements, and added a petroleum reduction requirement of 20 percent by FY 2005, compared to a FY 1999 baseline.
- **State and Alternative Fuel Provider Fleet** acquisitions of AFVs (starting 1997) – unlike the Federal fleet, which Congress specifically directed to acquire AFVs, this provision directed the DOE to develop regulations (through a rulemaking process) to implement the acquisition requirements. Fuel provider fleets include organizations such as electric utilities, natural gas companies, and propane providers. More than 40 states have fleets that must also comply with the regulations. DOE has enforcement authority over both state and fuel provider entities.
- **Other provisions**, which covered activities such as the designation of new fuels as alternative fuels; replacement fuel goals; determination of whether to impose AFV acquisition requirements on private and local government fleets; and various reports to Congress, such as the Section 506 technical and feasibility analysis. In addition, all these areas require a great deal of both legislative and regulatory analysis to ensure that all requirements are accurately and completely met.
- A related effort, also spawned by EPAct, involved voluntary programs, which resulted in the establishment of the National Clean Cities activity in 1993. Under this activity, all necessary partners in a given geographic area are brought together to form the "critical mass" necessary to ensure that AFVs and alternative fuels can succeed. The partners include fleets, fuel providers, vehicle manufacturers, and state and local governments. The Clean Cities activity currently numbers 88 designated cities across the country, including several international efforts that span U.S. borders.

Together, these fleet programs have resulted in the acquisition of nearly 200,000 AFVs, of which more than 150,000 are on the road. In addition, approximately 2.75 percent of U.S. motor fuel is now alternative or replacement fuel.

3.5.1.3 Federal Role

Reducing U.S. dependency on imported petroleum is clearly a national issue, one that demands national leadership from the Federal government. Also required is an important coordination role for the Federal government, one that transcends all levels of government and in partnership with industry. Many of the activities in this area are driven by statute. One example is that EPAct directed DOE to adopt and implement certain measures for fleets, as described above.

3.5.1.4 Approach

As discussed above, there are three major ways to reduce the demand for petroleum motor fuels. First, there are measures to reduce vehicle miles traveled, such as through mass transit programs. This area has been traditionally led by the U.S. Department of Transportation, and particularly the Federal Transit Administration. The second element is improved efficiency. This can be accomplished by regulation, as done by Corporate Average Fuel Economy (CAFE) requirements implemented by DOT's National Highway Traffic Safety Administration with testing certified by the Environmental Protection Agency. Improved efficiency can also be accomplished by development of more efficient vehicle technologies, as is currently being performed by other parts of the FCVT Program. The third element is the use of replacement fuels, including both alternative fuels in AFVs as well as other non-petroleum fuels in blends with petroleum fuels for use in conventional vehicles. It is this third element that has been the primary focus of the Legislative and Rulemaking activities. Whether focused on alternative or replacement fuels or efficient technologies, the key is basically the same. The idea is to use early adopters, like the fleets the Program already works with, to introduce new technologies into the user market, demonstrate readiness of technologies and generate critical data for decision-makers, and create initial market demand to encourage manufacturers to make the new technologies available on a broader scale.

3.5.1.5 Performance Goals

The performance goals for the Legislative and Rulemaking activities are as follows:

- Ease market introduction of new technologies;
- Maximize replacement fuel use through fleet deployment; and
- Maximize compliance with legislation, regulations, and Executive Order requirements:
    - *Federal Fleet* – 75 percent AFV acquisition requirement from EPAct and 20 percent petroleum reduction requirement from Executive Order 13149.

- *State and Alternative Fuel Provider Fleets* – EPAct 75 percent AFV acquisition requirement for State fleets, and 90 percent AFV acquisition requirement for fuel providers.

3.5.1.6 Strategic Goals

The Leglislative and Rulemaking activities focus on two primary strategic goals:

- Maximizing replacement fuel use to achieve replacement fuel goals as written in EPAct section 502(b), or as modified under section 504. The goals provided in EPAct focus on replacing 30 percent of U.S. motor fuel with replacement fuels by 2010.
- Integrating and coordinating current EPAct and related fleet activities among themselves, providing for opportunities to introduce FCVT technologies as they become ready for deployment, and implementing relevant legislative changes that affect fleet programs.

3.5.1.7 Market Challenges and Barriers

There are a number of market challenges and barriers in the area of Legislative and Rulemaking activities:

A. ***Availability of alternative fuel vehicles.*** Over the past few years, the major vehicle manufacturers have backed away from gaseous fuel (natural gas and propane) light-duty vehicles in particular, after having earlier discontinued electric vehicle offerings. Sales of these vehicles have been hampered particularly by incremental purchase prices, which range from $4,000-8,000 for gaseous fuel light-duty vehicles to on the order of $30,000 for light-duty electric vehicles. Large numbers (currently over 1 million) of ethanol (E85) flexible fuel vehicles (FFVs) are manufactured for the U.S. market every year, in sedan and light-truck models, at no or virtually no incremental cost. These vehicles are purchased by individual customers, many of whom don't even know they can use anything other than gasoline in the vehicles. Although auto manufacturers have sold over five million FFV vehicles, there are fewer than 500 E85 pumps in the U.S. which severely limits the ability of FFV owners to use E85 fuel even if they wanted to. Another vehicle-based challenge is that there are still a number of vehicle model/fuel type combinations that are not available, and even where they are, often a fleet will only have a choice of a single model/manufacturer. Thus, a fleet that has a number of vehicles from one manufacturer may have to buy its AFVs from a different manufacturer, possibly increasing the logistical requirements for maintenance and spare parts.

B. ***Availability of alternative fuels infrastructure.*** Under the Legislative and Rulemaking activities, ethanol and biodiesel have emerged as probably the most viable alternatives for most regulated fleets, due to availability of vehicles (ethanol, see above) or ability to use the fuel in blends in conventional vehicles (biodiesel). At this time, however, there are only approximately 400 ethanol refueling stations in the U.S., with about half of those within the state of

Minnesota. There are 250 stations which offer some level of biodiesel blending, although some of these are at levels below the 20 percent blend level required for credit under EPAct requirements. Most of the alternative fuels also face challenges in the areas of supply constraints, production capacity constraints, and the basic lack of infrastructure availability to compete with the fully mature petroleum competitors. In addition, while some alternative fuels may be somewhat lower in cost than petroleum fuels (such as compressed natural gas and sometimes propane), others (such as the biofuels) have historically been more expensive than the conventional competitors. In all cases, however, the regional aspect of the alternative fuels must be noted as a variable. For example, biofuels tend to be cheaper and more available in the mid-west, while gaseous fuels tend to be somewhat more competitively priced and available on the coasts and in the south.

C. ***Perception of potential users.*** Many users, especially fleets focused on bottom-line cost and operational concerns, tend to be reluctant to embrace change or new technologies. While they may, overall, see change as positive, they are much more comfortable adopting technologies after they have been proven for a number of years. In addition, they can also be reluctant to adopt the current new technology offerings due to uncertainties about future transportation technologies. They may be expecting that after adopting one new technology, a few years later they might be pushed in the direction of a completely different technology.

D. ***Lack of adequate information.*** In particular, fleets tend to want detailed data upon which to make purchasing decisions. Often, their desire is to see data specifically from fleets with operations similar to their own, demonstrating cost and operational improvements sufficient to justify changes in purchasing patterns. While FCVT's Field Operations activity does generate exactly this kind of data on new technologies, often a given fleet may feel that the conditions of the study are not sufficiently similar enough to their own to allow for a reasoned decision. In the absence of such information, then, many regulated fleets will attempt to find ways to minimize their compliance actions, while other potential operators (voluntary fleets) will simply do nothing.

3.5.1.8 Technical Challenges/Barriers

There are several key technical challenges and barriers for Legislative and Rulemaking activities:

E. ***Limited regulatory authority.***. While Section 501 of EPAct did allow DOE to require alternative fuel use in AFVs for alternative fuel providers, such authority was not extended to any other fleet type. This meant that some fleets, while needing to meet AFV acquisition requirements, do not necessarily have to use alternative fuel in those AFVs, minimizing the potential impact of the fleet requirements. Similarly, the EPAct fleet programs were limited to light-duty vehicles only, namely those with Gross Vehicle Weight Ratings (GVWRs) of 8,500 pounds or less. Medium- and heavy-duty vehicles typically

use several times the annual amount of fuel of a light-duty vehicle, and therefore could have increased the petroleum displacement potential of these efforts. In addition, given that alternative fuel refueling infrastructure is a key barrier, the medium- and heavy-duty vehicles could have been much more important due to the fact they are more likely to be parked in a central location when not in use, and that their increased fuel demand means that fewer vehicles are needed to support a single refueling location. EPAct fleet rules were also limited to larger fleets in major urban areas, also limiting the universe of vehicles from which petroleum displacement might occur. Finally, the replacement fuel goals themselves were limited solely to replacement fuels (including alternative fuels), with no credit given for petroleum displacement due to efficiency or vehicle miles traveled reductions. As of the passage of the 2005 Energy bill, DOE is required to develop a waver program for covered state and fuel provider fleets to emphasize petroleum redirection. The bill also requires Federal fleets to use alternative fuels in dual fuel vehicles. DOE is given authority to track and report on this activity to Congress.

F. ***Materials compatibility and other technical requirements of the fuels.*** This is true for both onboard vehicles and infrastructure. Just the fact that these fuels have different needs is a barrier, since this may often mean that special purpose or lower volume components may be required. For example, the use of gaseous fuels can result in stations utilizing high-power compression systems to dispense fuel with significantly different designs from those of traditional gasoline stations. Such stations often have to go through a special process for approval by local fire marshals. In addition, in some cases, higher performance components or materials may be required for use with alternative or replacement fuels. For example, alcohol fuels require vehicle fuel delivery systems that are stainless steel, because the alcohol will degrade rubber-based materials. Together, these types of situations generally result in greater logistical hurdles and ultimately higher costs for alternative or replacement fuel components and systems.

3.5.1.9 Strategies for Overcoming Barriers/Challenges

The Legislative and Rulemaking activities are focused on several key strategies for accomplishing the goals. Many are done primarily within the EPAct activity; however, some are also done in cooperation with the Clean Cities activity. These strategies include:

- Working with fleets to maximize compliance;
- Coordinating with voluntary programs;
- Working with vehicle manufacturers to communicate fleet needs for AFVs;
- Working with fuel providers/suppliers to communicate fleet needs;
- Reviewing and analyzing proposed legislation;

- Responding to legislative proposals and changes affecting EPAct fleet activities;
- Implementing program modifications and improvements;
- Conducting necessary education and coordination activities; and
- Identifying technical barriers and working with other Programs and subprograms.

3.5.1.10 Tasks

Table 3.5-1. *Tasks for Legislative and Rulemaking Activities*

Task	Title	Duration	Barriers
1	***Federal Fleet*** Track compliance with EPAct AFV acquisition (section 303) and Executive Order (13149) petroleum reduction requirements including through maintenance of a statistical database (FAST), develop technical tools and programmatic solutions, educate fleets to assist in compliance efforts, and prepare both DOE fleet and Federal Fleet reports on an annual basis.	On-going legislative requirement	A,B,C,D,F
2	***State and Alternative Fuel Provider Fleets*** Track and ensure compliance with EPAct AFV acquisition requirements including through maintenance of a credits and compliance database, process exemption/exclusion requests, develop technical tools and programmatic solutions, educate fleets to assist in compliance efforts, and prepare an annual report. Bring enforcement actions to non-compliant entities.	On-going legislative requirement	A,B,C,D,F
3	***Legislative/Regulatory analysis*** Track proposed and passed legislative and regulatory modifications to EPAct fleet programs, determine impacts, and identify implementation approaches/requirements.	On-going, as required	E

3.5.1.11 Milestones

The Legislative and Rulemaking activities have the following key milestones:

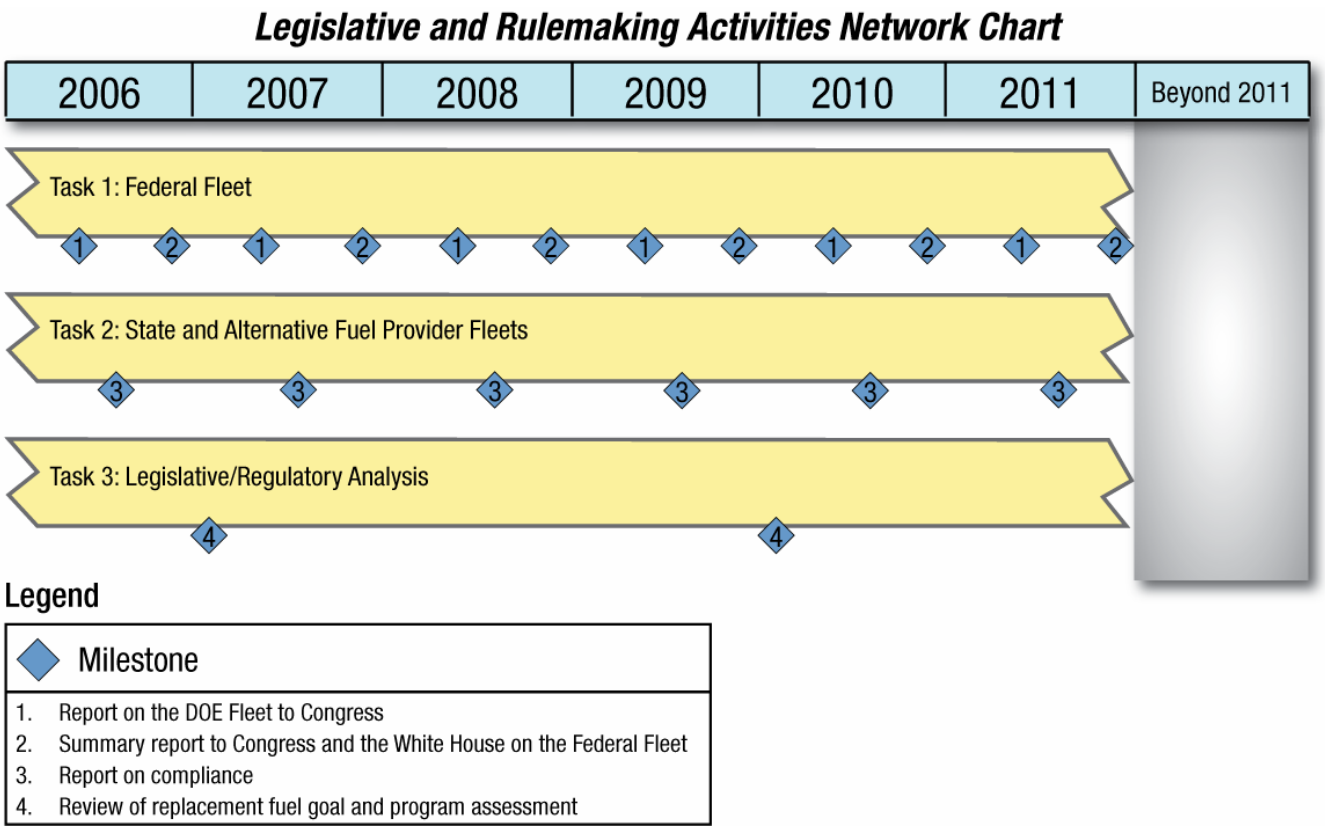


Figure 3.5-1. Network Chart for Legislative and Rulemaking

3.5.2 Clean Cities/Voluntary Technology Deployment

Clean Cities is a technology deployment activity which promotes the voluntary adoption and use of petroleum reduction technologies and practices by working with local Clean Cities coalitions and their stakeholders, industry partners, fuel providers, and end-users such as fleets. Technology focus areas include: alternative fuel vehicles, alternative fuel infrastructure development, idling reduction for commercial trucks and buses, expanded use of non-petroleum and renewable fuel blends, hybrid vehicles, and driving practices and engine/vehicle technologies that maximize fuel economy. The Clean Cities activity provides technical assistance for early adopters of technologies and provides education, training, and workshops to coalitions, public safety officials, and stakeholders related to infrastructure development and targeted niche market opportunities (such as transit, refuse haulers, school buses, delivery trucks, municipal fleets, etc.). It also provides public information on the benefits and costs of the use of alternative fuels in vehicles. This activity supports the development and promotes the use of the legislatively mandated Fuel Economy Guide and its associated website, www.fueleconomy.gov.

3.5.2.1 External Assessment and Market Overview

To help reduce the U.S. dependence on petroleum and increasing oil imports, it is necessary to reduce petroleum fuel (i.e., gasoline and diesel fuel) consumption in transportation or to displace petroleum fuels with alternatives, especially alternative fuels from domestic sources. The most significant barrier to the use of alternative fuels is the lack of fuel production capacity and distribution infrastructure. Consumers are reluctant to purchase alternative fuel-dedicated vehicles for which the availability of fuel is questionable and distribution infrastructure is limited. In addition, because of limited production, alternative fuel-dedicated vehicles tend to be more expensive. An exception is the flexible fuel vehicles that can operate on gasoline blends of up to 85 percent ethanol. Automakers are producing and marketing these vehicles at almost the same price as conventional gasoline vehicles. Other technologies such as auxiliary power units to reduce idling of commercial trucks are available but owner operators have been reluctant to incur additional expenditures when their profitability can be affected adversely. There are fuel savings and maintenance benefits as well as reduction of vehicle emissions to improve air quality that can be taken into consideration to encourage use of the technology.

3.5.2.2 Internal Assessment and Activity History

The Clean Cities activity was launched in 1993 bringing national attention to the potential role of local communities in the deployment of alternative fuel vehicles. Within the 18 months subsequent to the initial launch, 25 local communities volunteered to participate in the activity. Currently, there are nearly 90 designated Clean Cities across the United States, not to mention a few that span U.S. borders. Many of these local communities have links across regional and state boundaries to establish Clean Corridors with refueling infrastructure, to allow easier inter-city travel

with alternative fuel vehicles. In addition, technical information development and dissemination are coordinated under the Clean Cities activity to better reach stakeholders and consumers.

3.5.2.3 Federal Role

Reducing U.S. dependency on imported petroleum is an issue of national importance and is, therefore, in the purview of the Federal government to address. In addition, EPAct 2005 mandates the increase of alternative fuels such as tripling the amount of biofuel (usually ethanol) in gasoline by 2012.

3.5.2.4 Approach

The Clean Cities activity promotes the use of alternative fuels and petroleum-displacement technologies through private and public sector partnerships with state and local governments. It works with local coalitions and their partners, and continues to build national and regional alliances to promote petroleum reduction strategies, and encourage deployment and use of alternative fuels and new vehicle technologies. Through regional collaboration and small grants to local coalitions, Clean Cities facilitates local coalition market development, education, and training, conducts public reviews of potential transportation opportunities. It provides targeted niche market assistance through analysis of market trends, and provides education and training to local coalitions about market opportunities such as in airport, school bus, transit, and municipal fleets.

The Clean Cities activity supports technology transfer, technology exchange meetings, and forums with stakeholders; peer reviews; data collection and dissemination; and technical, market feasibility, economic, and other analyses. Working in conjunction with technology experts at the national laboratories, Clean Cities provides outreach, education, training, and technical assistance related to each technology focus area. It identifies and supports opportunities to showcase commercially available alternative fuels and vehicle technologies. It provides case studies of successful niche markets for various petroleum reduction technologies. Critical tools and information are provided via internet, telephone hotline, publications, and direct interaction with experts.

3.5.2.5 Performance Goals

The goals of the Clean Cities activity are to:

- Ease market introduction of alternative fuels and new vehicle technologies through voluntary efforts in partnership with local communities; and
- Provide technical and educational assistance to support local communities and partnerships that promote better understanding of the benefits of these new technologies.

3.5.2.6 Strategic Goals

The Clean Cities activity supports the Department's Energy Strategic Goal: To protect our national and economic security by reducing imports and promoting a diverse supply of reliable, affordable, and environmentally sound energy.

3.5.2.7 Market Challenges and Barriers

The market challenges and barriers addressed are as follows:

A. ***Availability of alternative fuels infrastructure.*** Most of the alternative fuels face challenges in availability of supply, production capacity, and the lack of fueling infrastructure to compete with the fully mature conventional gasoline and diesel fuels. For example, although auto manufacturers have sold over five million flexible fuel vehicles that can utilize gasoline blends of up to 85 percent ethanol (E85), there are fewer than 800 E85 pumps in the U.S. which severely limits the ability of flexible fuel vehicle owners to use E85 fuel even if they wanted to. In addition, prices in comparison to gasoline and diesel fuel prices tend to vary regionally. For instance, biofuels tend to be cheaper and more available in the mid-west, while gaseous fuels tend to be somewhat more competitively priced and available on the coasts and in the south.

B. ***Availability of alternative fuel vehicles.*** Of the alternative fuel vehicles, only the flexible fuel vehicles which can use E85 are available in large numbers (currently over 1 million every year, in sedan and light-truck models) and at virtually no incremental cost. This is still small in comparison to the total vehicle population. Over the past few years, the major vehicle manufacturers have backed away from gaseous fuel (natural gas and propane) light-duty vehicles in particular. Sales of these vehicles have been hampered particularly by being more expensive to purchase than conventional gasoline vehicles. Natural gas engines are available but better suited for heavy-duty fleet vehicles, especially for intra-city use with a central fueling station.

C. ***Consumer reluctance to purchase new technologies.*** Most vehicle buyers try to make the most out of their purchases and use their vehicles for as long as they can. Hence, they tend to be reluctant to purchase vehicles with new technologies that could potentially be made obsolete sooner, lower resale value, difficult to maintain, and for which fuel availability is uncertain. Manufacturers are adverse to assuming the risk required for the production, promotion, and distribution of advanced energy-efficient vehicle technologies that consumers would be reluctant to purchase.

3.5.2.8 Technical Challenges/Barriers

D. Lack of technical experience with new fuels and vehicle technologies. As with most of new technologies, technical expertise and assistance would need to made available early to users. Also, user experience with the new technologies would be helpful to making other potential users to be more amenable to adapting the new technologies. In addition, technical issues identified need to be addressed.

3.5.2.9 Strategies for Overcoming Barriers/Challenges

The Clean Cities activity is focused on coordinating community-based voluntary programs of private and public sector partnerships to promote the use of alternative fuels and advanced vehicle technologies. In addition, through these activities, information on alternative fuels and advanced vehicle technologies are developed and widely disseminated. Technical expertise is also made available to assist current and potential users of alternative fuels and advanced vehicle technologies.

3.5.2.10 Tasks

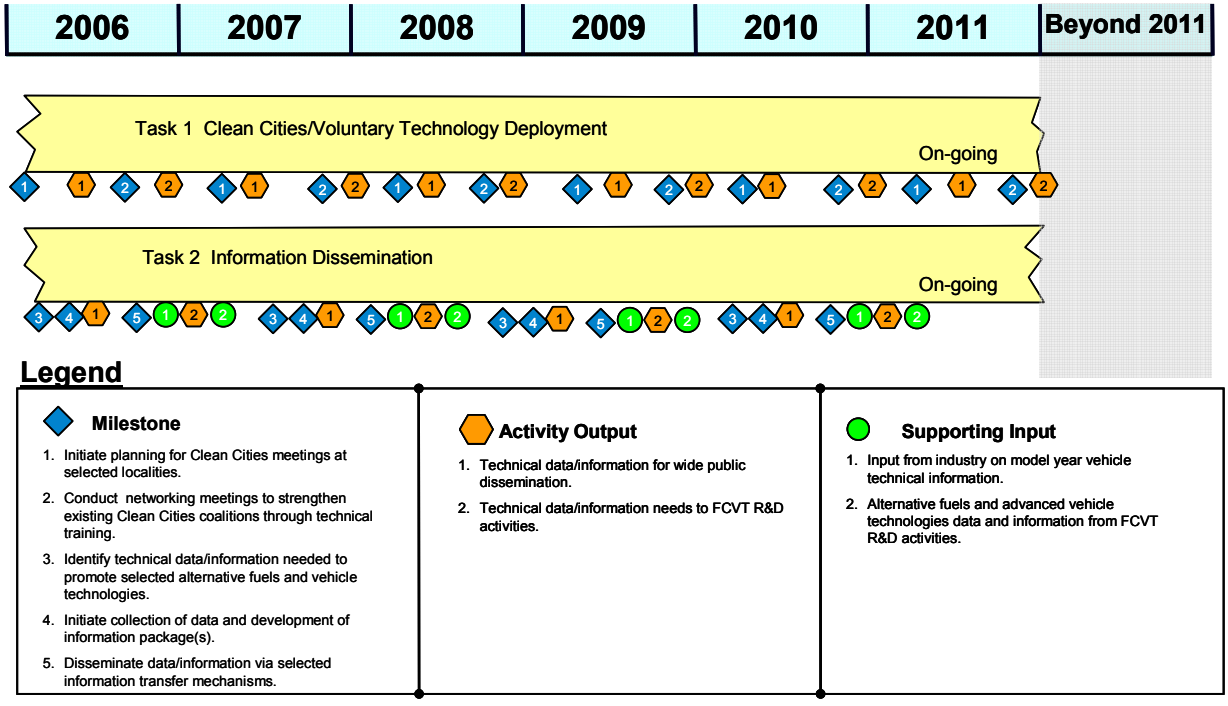
Table 3.5-2. *Tasks for the Clean Cities Activity*

Task	Title	Duration	Barriers
1	***Clean Cities*** Voluntary technology deployment through state and local coalitions	On-going	A,B,C,D
2	***Information Dissemination*** Develop legislatively mandated *Fuel Economy Guide* and maintain associated website Develop informational material for outreach, education, and technical training	On-going	A,B,C,D

3.5.2.11 Milestones

The Clean Cities activity milestones are shown in Figure 3.5-2.

Figure 3.5-2. Network Chart for Clean Cities Activity



3.5.3 Graduate Automotive Technology Education (GATE) and Advanced Vehicle Competitions

3.5.3.1 External Assessment and Market Overview

One factor often overlooked in the external environment that could be a significant barrier to the accelerated commercial introduction of new vehicle technologies is the limited base of personnel trained specifically in the new areas. Shortage has existed for experts to conduct research, and to develop, produce, sell and service the new products, and also, for the educational curricula to train that expertise. The continual demand from the competitive technology, conventional vehicles, and the shift of many technology development activities from auto manufacturers to Tier 1 and 2 suppliers has created a significant, growing need for specialized training of engineers and scientists with knowledge in the key new technology areas.

3.5.3.2 Internal Assessment and Activity History

The twin goals of developing innovative technologies and transferring them to industry led DOE to realize the growing need for people trained in non-traditional, emerging technologies. The advanced technologies being developed by FCVT and the automotive industry require a knowledgeable and experienced workforce to carry them forward into production. To respond to this growing need FCVT has advanced two college-level education efforts to engage some of the best engineering minds in advanced transportation research: Graduate Automotive Technology Education, and Advanced Vehicle Competitions. The two efforts are aimed at more than the development of a new workforce and have the following purposes:

- training and education,
- new technology supporting FCVT goals,
- technology and simulation validations,
- public and consumer education,
- new teaching curricula and programs, and
- graduate research on specific fundamental problems.

Both of these efforts pre-date the FCVT Program, however the efforts have become more focused and strengthened in recent years within FCVT. The first competitions, beginning in 1987, were focused on the use of alternative fuels and were executed as the Methanol, Natural Gas, and Ethanol Challenges. Subsequent competitions, Future Car and Future Truck, evolved to greater focus on attaining the total vehicle efficiency goals. The latter challenge was implemented over a five-year period and concluded in FY 2004. The current Advanced Vehicle Competition effort is ChallengeX: Crossover to Sustainable Mobility. ChallengeX is a three-year collegiate engineering competition sponsored by the FCVT Program and General Motors

Corporation. The competition, which runs from 2004 through 2007, offers college engineering students the opportunity to conduct hands-on R&D with leading-edge automotive propulsion, fuels, materials, and emissions control technologies.

The growing need for the specialized, new workforce coupled with earlier success through the vehicle competitions led DOE to establish the GATE effort in 1998. GATE provides a new generation of engineers and scientists with cross-disciplinary (broader than mechanical or electrical) knowledge and skills in advanced automotive technologies. It supports universities to establish centers in special technology areas with new curricula development, and it provides support for relevant research fellowships. In 1998, the DOE funded 10 proposals to establish graduate automotive technology education (GATE) centers of excellence at nine universities. These Centers addressed the following key technology areas: fuel cells; hybrid electric vehicle drivetrains and control systems; lightweight materials; direct-injection engines; and advanced energy storage. In 2005, the DOE recompeted the GATE effort. The DOE funded eight proposals to establish or expand centers in the following key technology areas: fuel cells; hybrid electric vehicle drivetrains and control systems; lightweight materials; advanced energy storage; and biofuels.

3.5.3.3 Federal Role

Federal support to conduct the R&D of new, advanced vehicle technologies offering petroleum usage reduction is required because of the high risk and long term payoff from such technologies. As momentum develops for the development and commercialization of the technology, the growing need for a trained workforce exceeds the supply capability. Federal support is required to ensure that educational curricula are developed and the specialized workforce is provided in the early phases of the new technology.

3.5.3.4 Approach

To respond to the growing need for an expanded specifically trained workforce, the FCVT Program has structured the two efforts, GATE and Advanced Vehicle Competitions, to be heavily partnered. This is to leverage the government dollar to the utmost and to ensure the maximum usefulness of the results and products. The GATE effort aids in the development of interdisciplinary curricula to train the future workforce of automotive engineers. This is accomplished by setting up GATE Centers of Excellence at universities that have been competitively selected, establishing a focused curriculum, and providing funds for research fellowships. The effort is partnered throughout and for every dollar provided to the Centers from DOE at least $5 is typically received from the universities, industry, and other government sources. The GATE centers receive DOE funding for student fellowships and curriculum development. Each center establishes a graduate engineering education program that offers courses emphasizing that center's technology specialty. Industrial advisory boards help each university to identify and respond to critical research needs. Industry contributions help provide funding for internships, shared research facilities and equipment, research contracts, and fellowships. The fellowship research projects are determined in partnership with industry to ensure great need for the work and

usefulness of the results. The approach of the GATE effort includes conducting forums with university, student, government and industry personnel attending to promote the sharing of knowledge and increase interaction between the automotive industry and the GATE Centers.

Advanced Vehicle Competitions provide educational opportunities for university students while pursuing novel approaches to and demonstrating the performance of critical vehicle technologies identified by DOE and its partners. Students are provided with valuable opportunities to test out their skills and interact with some of the nation's best and brightest engineering minds. Many students who graduate from these vehicle competitions go on to take jobs in the auto industry, where they bring with them an unprecedented appreciation and understanding of advanced automotive technologies. In the current competition of unprecedented scope and approach, ChallengeX, 17 teams will re-engineer a GM crossover sport utility vehicle to minimize energy consumption, emissions, and greenhouse gases while maintaining or exceeding the vehicle's utility and performance. An open-minded, open-ended clean sheet approach giving consideration to 'well-to-wheels' in fuel choice is taken. Participating teams will be given extensive resources to help achieve their objectives, including substantial technical support and mentoring from GM and many other government and industry sponsors. Each team will also receive $10,000 in seed money from GM and is eligible to receive up to $25,000 in additional production parts from GM and considerable software and hardware donations from the other sponsors. At the conclusion of each competition year, teams will come together to undergo extensive judging and evaluation of their work for the year.

3.5.3.5 Performance Goals

The performance goals of this key activity are the following:

- Tap the technical and human resources of U.S. colleges and universities in a comprehensive and integrated manner aiming for involvement of over 120 faculty members by 2011.
- Build a solid foundation of research knowledge and engineering experience including creation of over 40 interdisciplinary courses specializing on advanced automotive technology needs by 2011.
- Accelerate the development of technologies necessary for cost-effective manufacture of highly fuel-efficient, low-emission vehicles with involvement of 125 industry partners by 2011.
- Develop a new workforce of talented, trained individuals who will be instrumental in building our country's future automotive industry with more than 400 students participating in the specialized programs by 2010.
- Provide hands-on experience for teams of students with advanced vehicle system technologies at over 26 universities by 2011.

3.5.3.6 Strategic Goals

The strategic goal of GATE and the Advanced Vehicle Competitions is to contribute to the acceleration of advanced petroleum saving vehicle technologies into the marketplace.

3.5.3.7 Market Challenges and Barriers

A. There is not a sufficient body of engineers and scientists trained in key areas of the advanced energy efficient technologies being developed by the FCVT Program to allow optimal accelerated introduction of these technologies.

3.5.3.8 Technical (Non-Market) Challenges/Barriers

B. Teaching curricula specific to the advanced technologies in the FCVT Program is not available at a sufficient number of universities to sustain a specialized workforce.

3.5.3.9 Strategies for Overcoming Barriers/Challenges

GATE and Advanced Vehicle Competition efforts are aimed at overcoming barriers A and B to accelerated commercialization of the FCVT technologies due to the lack of an optimum workforce of specifically trained engineers and scientists. Primary focus of these two efforts is the sustainable production of the necessary new generation of engineers and scientists. This is accomplished through several means. GATE sponsors the establishment of university centers of excellence specializing in areas of the advanced vehicle technologies. These centers develop new, unique curricula to add to existing subjects to train students in new disciplines. Sometimes as needed there is the addition of faculty to the university. Partnerships between the university and industry or government are formed to identify critical research needs and students undertake the research with the partners. The partners provide resources also and the university moves toward sustainability eventually without FCVT support. Under the competitions effort, teams of students are formed at competitively selected universities to develop full vehicle systems incorporating energy savings technology. FCVT partners with industry and other agencies to provide resources and close technical support to maximize the benefit of the experience for the students.

These two efforts, GATE and Advanced Vehicle Competitions, also contribute to overcoming other barriers throughout the program through the conduct of relevant R&D.

3.5.2.10 Tasks

Table 3.5-3 *Tasks for GATE and Advanced Vehicle Competitions*

Task	Area	Title	Duration & Barriers
1	ChallengeX Competition	Conduct ChallengeX student engineering competition aimed at FCVT goals	36 months, Barrier A
2	Vehicle Competition	Conduct Vehicle Competition	43 months, Barrier A
3	Vehicle Competition	Conduct Vehicle Competition	43 months, Barrier A
4	GATE	Establish GATE centers of excellence at universities and conduct Fellowship research projects	72 months, Barriers A, B

3.5.3.11 Milestones & Decision Points

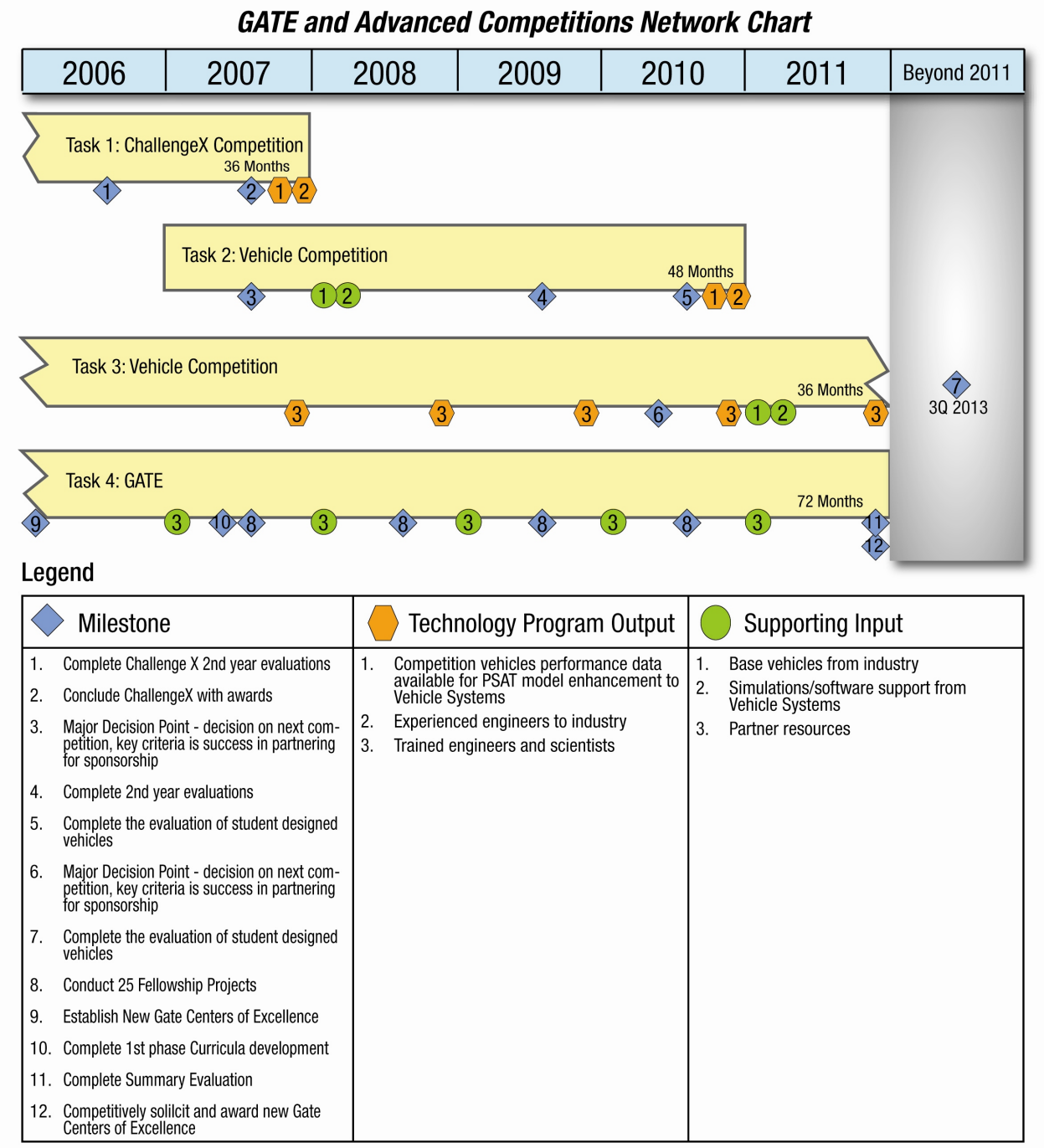


Figure 3.5-3. Network Chart for Gate and Advanced Competitions