

**U.S. BEST PRACTICE EXEMPLARS  
FOR SUSTAINABLE VEHICLE  
TRANSPORT AND ENERGY  
EFFICIENT MANUFACTURING:  
THE *CAFE* AND *IOF* PROGRAMS**



***CENTER FOR  
ENERGY AND  
ENVIRONMENTAL  
POLICY***

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NEWARK, DE 19716-7381**

**Prepared for  
National People's Congress  
P.R. China**

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**May, 2006**

**U.S. Best Practice Exemplars for Sustainable Vehicle Transport and  
Energy Efficient Manufacturing:  
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## ACRONYMS

AFV	Alternative Fuel Vehicle
BC&S	Building Code and Standard
CAFE	Corporate Average Fuel Economy
CEEP	Center for Energy and Environmental Policy
DOE	Department of Energy
DOT	Department of Transportation
DPA	Department of Public Avocation
EERE	Energy Efficiency and Renewable Energy
EPA	Environmental Protection Agency
FERC	Federal Energy Regulation Commission
HERS	Home Energy Rating System Program
IOF	Industry of Future
LEED	Leadership in Energy and Environmental Design
LEV	Low Emission Vehicle
OIT	Office of Industrial Technology
PUC	Public Utility Commission
PZEV	Partial Zero Emission Vehicle
R&D	Research and Development
SDC	State of Department of Commerce
SDConst	State of Department of Construction
RPS	Renewable Portfolio Standard
SDEP	Department of Environmental Protection
SDT	State Department of Transportation
SEO	State Energy Office
SIP	State Implementation Plan
SULEV	Super Ultra Low Emission Vehicle
VMT	Vehicle Miles Traveled

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## **1. Overview of U.S. Energy Policy Administration**

U.S. policy interest in sustainable energy path defined as energy efficiency and renewable energy dates back to the 1970s. Prior to 1970s, energy policy received little consideration in U.S. The oil embargo of that decade spurred national policy responses aimed at reducing energy intensity in all sectors of the society. Although the U.S. government's overall energy policies are far from consistent, gradual achievements appear to be embedded in the sector in the form of technical improvement and improved conservation awareness.

U.S. energy policy has experienced shifts in focus over the last 35 years. This reflects conflicts in policy philosophies. The level of national effort on energy efficiency and renewable energy development depends upon which philosophy is dominant in a period. In U.S. history, federal government was involved in management of domestic energy use in different extent, through the foundation of federal agencies, passage of laws and accompanying regulations, and support for energy conservation and the use of alternative energy sources.

Energy issues reappeared on the political agenda in U.S. in late 1980s as the nation's dependence on oil imports rose once again and concern began to mount about global climate change. However, until 1990s, the policy began to address the country's continuing energy problems through the efforts to push the public to change its energy habits by higher efficiency standards. The 1992 Energy Policy Act sets higher efficiency standards for electric appliances. Buildings, lighting, plumbing, commercial and industrial motors, and heating and cooling systems. The Act also introduced tax and production incentives for renewable energy development.

The Clinton administration's energy policy centered on the reduction of the energy use and more rapid development of renewable energy voluntary efficiency program were created that included Energy Star and Green Lights. The administration also encouraged automobile manufactures to develop alternative fuel vehicles. Its Clean

Car Initiative helped to promote new low-emission, high efficiency vehicles.

The present administration of Bush announced its idea for America's energy future in a document called "National Energy Policy" (2001). The foundation of the policy is aggressive exploitation of conventional energy resources and technologies. While mention was made of energy efficiency and renewables, the plan was heavily weighted toward increasing supply. The Congress passed the National Energy Policy Act of 2005, which embraces several goals of the 2001 position paper, but it also continues modest commitments to energy efficiency and renewables.

In summary, the U.S energy policy can vary significantly with different administrations. But energy efficiency and renewable energy are gradually being recognized as the nation's long-term interest.

### ***1.1 Introduction of U.S. Energy-related Agencies***

Currently, energy policies are administered by several U.S. federal agencies. Among these agencies, some are distinguished by the geographic and statutory breadth of their energy-related programs, by their size and public prominence. These "super agencies" are usually involved in the formation and implementation of the most important federal energy programs (see Rosenbaum, 1987).

In the U.S., the institutional setting for energy policy making and implementation includes the Federal government, Congress, and agencies but also state governments. For example, State Energy Offices are lead agencies for implementing energy programs and services and serve as the sources of energy information and assistance for consumers, businesses, government agencies, community colleges and schools and the residential, commercial and industrial sectors at the state level. They are dedicated to improving the energy infrastructure, diversifying the sources of energy produced and used, and encouraging the efficient use of energy.

### **1.1.1 Federal Agencies**

**Department of Energy (DOE)** was created in 1977, DOE's overarching mission is to advance the national, economic, and energy security of the US; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex. The DOE has four strategic goals toward achieving the mission—defense strategic goal, energy goal, science strategic goal, and environment strategic goal. In terms of energy, the target of DOE is to promote a diverse supply and delivery of reliable, affordable, and environmentally sound energy.

**The Environmental Protection Agency (EPA)** With a fiscal 1986 budget of about \$4.8 billion and 13,000 employees, EPA is Washington's largest regulatory agency. EPA leads the nation's environmental science, research, education and assessment efforts. EPA works to develop and enforce regulations that implement environmental laws enacted by congress. EPA is responsible for researching and setting national standards for a variety of environmental programs, and delegates to states and tribes the responsibility for issuing permits and for monitoring and enforcing compliance. EPA also provides direct grant support to state environmental programs and research. Many of the regulations and standards are directly related to energy issues. EPA is a non-departmental agency.

**Department of Transportation (DOT)** DOT's mission is to ensure a fast, safe, efficient, accessible and convenient transportation system that meets national interests and enhances the quality of life of the people. National Highway Traffic Safety Administration (NHTSA) of the DOT develops mandatory minimum safety standards for domestic and foreign vehicles sold in the U.S. and establishes fuel efficiency standards for vehicles.

**Federal Energy Regulatory Commission (FERC)** FERC is engaged in Energy Policy Act (EPA) implementation and a number of energy regulatory issues of importance to electric utility industry. FERC is the U.S. Federal agency with

jurisdiction over interstate electricity sales, wholesale rates, hydroelectric licensing, natural gas pricing, and oil pipeline rates. The EPCRA 2005 expanded FERC's authority to impose mandatory reliability standards on the bulk transmission system and to impose penalties on entities that manipulate the electricity and natural gas markets.

### **1.1.2 State Agencies**

**State Energy Office (SEO)** provides informational and technical assistance programs to assist with residential, commercial, governmental, industrial, and transportation conservation and efficiency and to encourage the use of renewable indigenous energy resources; In addition SEO works with the Public Service Commission and other groups to promote appropriate financial incentives for electric and gas utilities to maximize the use of cost-effective demand-side options in meeting future energy needs; promotes the adoption and use of energy efficient building codes and certification procedures for builders, heating and cooling specialists, and building inspectors.

**State Department of Transportation (SDT)** is responsible to plan, design, construct, operate, and maintain state facilities in all modes of transportation. It coordinates and develops comprehensive transportation policy for the state and set state implementation plan to achieve transportation targets or standards.

**Public Utility Commission (PUC)** Almost each state has public utility commission and the main mission of PUC is to regulate public utilities such as electric power, natural gas and other resources and services. PUC mandates the availability of adequate, safe, and reliable utility service to business, industrial, and residential consumers.

**State Department of Environmental Protection (SDEP)** The Department of Environmental Protection is the lead agency in state government for environmental management and stewardship. It is state agency responsible for environment

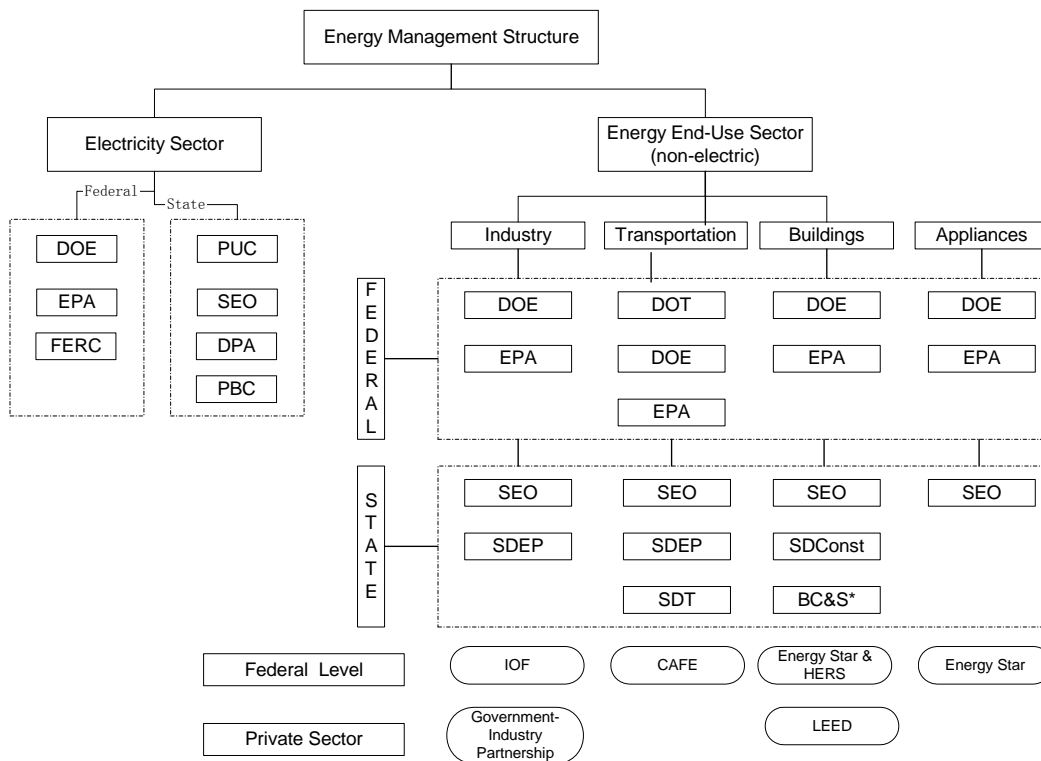


protection and enhancement.

### 1.2 Summary of U.S. Energy Management

Energy federalism is the about the coordination between the federal and local government on energy administration. A national coordination does not mean federal government control, but a process of consultation and guidance leading to positively convergent positions between central, regional and municipal governments.

Currently, components of the U.S. energy regulation system are divided into electric sector and non-electric sectors (industry, transportation, building, etc.). Many of the U.S. energy-related departments and agencies both in federal level and state level are involved in the management of energy issues. The following Figure 1 shows the functions of departments and agencies and how they shape the energy policies.



**Figure 1: Energy Management Structure in the United States**

In U.S., gradual achievements of energy efficiency and renewable energy appear to be embedded in the sector in the form of technical improvements and improved

conservation awareness. Energy efficiency and renewable energy are widely recognized as nation's long-term interest. This report focuses on several successful programs and policy in the U.S. (including Energy Labeling, Energy Star, CAFE and its new century strategies, IOF and renewable energy portfolio standards[RPS])that represent what can be termed a *sustainable energy policy infrastructure* in the U.S. energy and social order.

## **2. Best Practice Case: Strategies for Sustainable Automobile Transport**

Transport sector is the major energy consumer in most countries. The share of transport energy consumption is continuously growing along with economic development. Meanwhile, large amount of transport is causing urban air and noise pollution, and also, climate change. In the U.S., the transportation sector accounts for 28% of annual energy consumption and passenger vehicles, light trucks and SUVs are approximately 55% of the sector's energy use (EIA, 2005). Public policies have been focused on transport sector for a long time. In this section, we will review the CAFE program and strategies in the new century.

### ***2.1 Overview of CAFE Program***

The 1973 Arab oil embargo and the ensuing quadrupling of oil prices by OPEC prompted Congress to enact the Corporate Average Fuel Economy (CAFE) program in 1975 as part of National Energy Policy and Conservation Act. The aim of this program was to reduce the consumption of gasoline and thus the need for oil imports. Beginning with the 1978 auto model year, the program required all auto manufacturers to maintain certain minimum fuel economy averages for their fleets of vehicles sold in the United States. The U.S. fuel economy standards are based on a two-tier system of cars and light trucks as defined by vehicle specifications (not including weight). Under CAFE program, each manufacturer is currently required to meet a fleet average of 27.5 mpg (which was initially set at 18 miles per gallon in

1978) for cars and 20.7 mpg for trucks. The standards for trucks will be increasing to 21.0 mpg in 2005, 21.6 in 2006 and 22.2 in 2007, representing a 7 percent increase over three years (Sauer and Wellington, 2004).

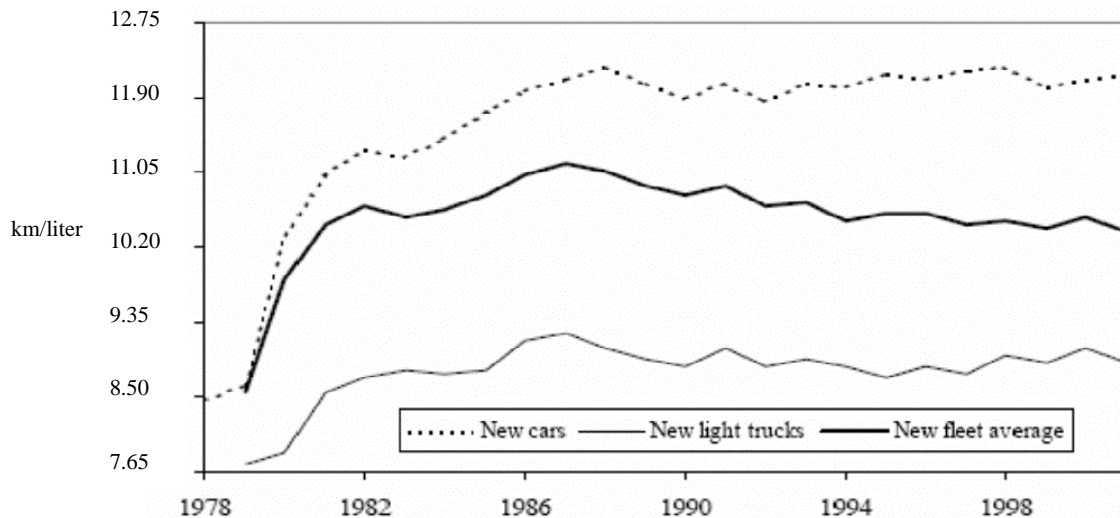
The CAFE standards apply to any manufacturer, domestic or foreign, that sells over 10,000 cars per year in America (NHTSA, 2006a). These manufacturers must satisfy CAFE requirements for each of several vehicle categories. For instance, vehicles manufactured abroad are considered separately from those manufactured in the U.S. Thus, a manufacturer with a 30 mpg average for its combined output of foreign and domestically produced passenger automobiles nonetheless would fall short of CAFE requirements if its domestically built passenger cars taken separately averaged only 25 mpg (NHTSA, 2006a). The standards are the same for foreign and domestic fleets, but different standards apply to different types of vehicles. A lower mpg level is required for light trucks. The mpg performance of each model vehicle is calculated from the combined average of city and highway mileage, according to tests conducted by the Environmental Protection Agency. If a manufacturer's average for a particular fleet falls below the mandated levels, a penalty is imposed amounting to \$5 per vehicle for each one-tenth of a mpg by which the fleet average falls below the required CAFE level (NHTSA, 2006b). The Bryan bill would increase these penalties. Beginning with the 1996 model year it would: 1) index fines for inflation, and 2) double the fine for any manufacturer that failed to meet the applicable standard by one-half mile per gallon or more three years in a row.

CAFE applies to passenger cars and light trucks with a gross vehicle weight rating (GVWR) of 8,500 pounds or less manufactured for sale in the United States (NHTSA, 2006b).

## ***2.2 Program Impacts***

CAFE program has clearly contributed to increase of fuel economy in the United States during the past period. Without CAFE, total U.S. carbon dioxide emissions would be more than 10% higher than they are today. Improved fuel economy has

reduced dependence on imported oil, improved the nation's terms of trade, and reduced emissions of carbon dioxide, a principal greenhouse gas. The CAFE standards, together with significant fuel price increases from 1970 to 1982, led to a near doubling of the fuel economy of new passenger cars and a 50 percent increase for new light trucks (NRC, 1992). CAFE standards have played a leading role in preventing fuel economy levels from dropping as fuel price declined in 1990s. Fuel economy of new and on-road passenger cars and light trucks can be found in figure 2. The high oil prices will act as a stimulus to the production of more fuel-efficient vehicles, for the simple reason that people will demand better fuel economy. In 2003, new standards for light trucks and SUVs were set. The standards gradually increase from the 20.7 mpg in 2003 to 22.2 mpg in 2007. It is estimated that there would be additional 144 million gallons of gasoline each year (NHTSA, 2006a).



**Figure 2: Fuel Economy by Vehicle Model Year**

Source: RFF, 2004

Although fuel economy of vehicle has been improved, under “business-as-usual” policy and trend, the Vehicle Miles Traveled (VMT) will continue increasing. Research shows that by lowering the cost of operating a vehicle, higher CAFE standards would increase VMT roughly 2% for each 10% increase in CAFE stringency (Greene, 1997). This leads to the increase of total fuel consumption and

carbon emission by the transportation sector. Further tightening the CAFE standard will have implication of other external costs that resulting from driving. The Federal and state government try to address these issues from different angles. Compared with CAFE program which focus on improve engine efficiency and change vehicle design, new century policy and program adopts new fuel automobile, alters the fuels itself and change transportation models.

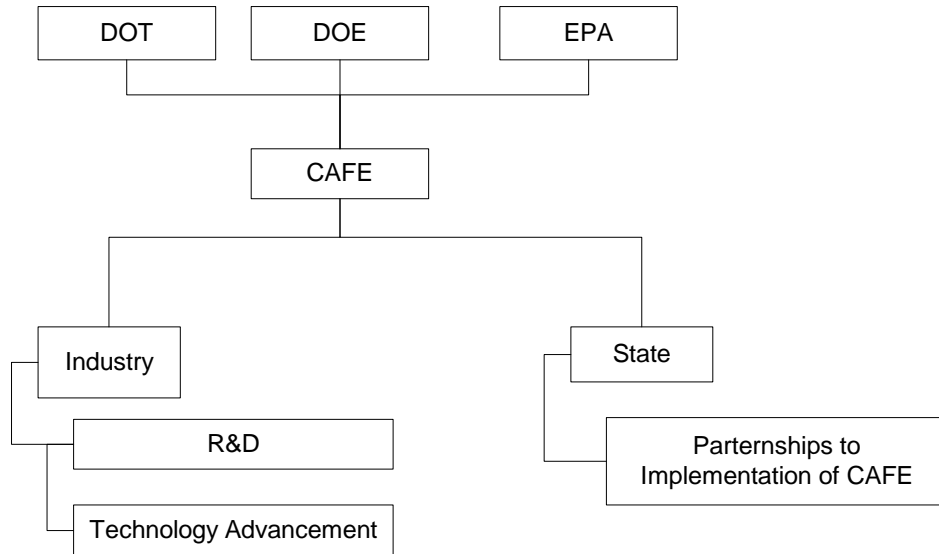
### ***2.3 Program Management***

Federal governments, industrial sector and state governments all play roles in the implementation and management of CAFE program. The Congress enacted the CAFE program to reduce energy consumption by increasing the fuel economy of cars and light trucks in 1975. Regulating CAFE is the responsibility of the Environmental Protection Agency (EPA), and National Highway Traffic Safety Administration (NHTSA), which is part of U.S. Department of Transportation (DOT). NHTSA establishes and amends CAFE standards; promulgates regulations; enforces fuel economy standards and regulations; and provides program incentives. EPA is responsible for calculating the average fuel economy for each manufacturer. EPA will either ask the manufacturer to provide its own fuel economy test data or will obtain a vehicle and test it in its Office of Transportation and Air Quality facility. EPA will provide the fuel economy data that is used by the U.S. Department of Energy (DOE) to publish the annual Fuel Economy Guide. The Internal Revenue Service (IRS) collects gas guzzler taxes for those who violent the CAFE standards. EPA administers the testing program which generates the fuel economy data. Once a year, EPA and DOE publish the Fuel Economy Guide listing the fuel economy estimates of new passenger vehicles. EPA also calculates the average fuel economy for each manufacturer<sup>1</sup>. NHTSA is also responsible for establishing and amending the CAFE standards for trucks. In summary, Congress sets the CAFE standards for cars. EPA

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<sup>1</sup> Not every vehicle is tested for fuel economy. Instead, manufacturers are required to split each model into smaller groups, based upon the various options available that can impact fuel economy (such as vehicle weight, transmission type and engine size). A vehicle from each of these groups with the highest projected sales must be tested.

reports the CAFE results for each manufacturer to NHTSA annually, and NHTSA determines if the manufacturers comply with the CAFE standards and assesses penalties as required (EPA). Figure 3 shows the management of CAFE program.



**Figure 3: Management of the CAFE Program**

#### ***2.4 Environmental Regulation of Vehicle Transport***

The EPA adopted National Ambient Air Quality Standards (NAAQS) in 1980s, which defined the air quality required to prevent adverse impacts on human health, or other elements of the environment such as vegetation. State Implementation Plans (SIPs) focus on attainment and maintenance of the NAAQS. SIPs include state air quality rules, control strategies to attain and maintain the NAAQS, compliance schedules to attain the NAAQS, the new source review program, and visibility protection. Transportation sector plays an important role in the states' commitment to SIPs. It is one essential element in states' plan to attain and maintain their air quality. States adopts policies to promote fuel economy and encourage the switch to clean alternative fuels.

#### ***2.5 Looking Forward – New Century Strategies***

The CAFE program has largely improved vehicle fuel economy. But the continuously

increasing demand of large vehicles as SUVs offset the fuel efficiency improvement. And at the same time, higher energy efficiency tends to encourage vehicle mileage traveled. Therefore, the federal and state government are taking a multi-dimensional strategy to regulate on fuel economy. This includes the requirement on air quality, advanced technologies such as alternative fuels and vehicles.

### **2.5.1 Overview of New Century Strategies**

The U.S. Federal government sets the target of air quality control, enacts laws and incentives related to alternative fuels and vehicles, and other transportation related topics. The Office of Transportation and Air Quality of EPA manages Transportation and Air Quality program which protects public health and the environment by regulating air pollution from motor vehicles, engines, and the fuels used to operate them, and by encouraging travel choices that minimize emissions. Federal government also has financial incentives for the R&D of new vehicles and alternative fuels. On August 8, 2005, President Bush signed the Energy Policy Act (EPAAct) of 2005. EPAAct 2005 sets the target and provides incentives for the development of alternative fuel vehicles. Some major transportation-related issues in EPAAct 2005 include:

- Fleet Vehicle Improvement - Requires federal fleets to use alternative fuels in dual-fuel vehicles unless the Secretary of Energy determines an agency qualifies for a waiver.
- Hybrid Vehicles - Directs DOE to establish a research program to advance the commercialization of hybrid flexible fuel vehicles or plug-in hybrid flexible fuel vehicles. Directs DOE to accelerate efforts to improve technologies (including batteries) used in hybrid vehicles.
- Clean Cities - Establishes a competitive grant program, administered by Clean Cities, to fund up to 30 geographically dispersed advanced vehicle demonstration projects. Grant recipients will be limited to state and local government agencies and metropolitan transportation authorities. Grant funds can pay for Alternative Fuel Vehicles (AFV), fuel cell vehicles, ultra low sulfur diesel vehicles, etc.
- Biofuels - Directs DOE to work with engine manufacturers and fuel injection manufacturers to test biodiesel in advanced diesel fuel engines, determine impacts of different biodiesel blendstocks, and study the emissions and warranty

impacts of different blendstocks

- Hydrogen/Fuel Cell - Requires federal fleets to begin leasing or purchasing fuel cell vehicles and hydrogen energy systems no later than January 1, 2010.
- Alternative Fuel Vehicles (AFVs) - Provides a tax credit to purchasers of new-dedicated AFVs. Provides a base tax credit of \$8,000 for the purchase of light-duty fuel cell vehicles. Provides a fuel economy and conservation credit for light-duty hybrid vehicles and trucks.

On October 22, 2004, President George W. Bush signed into law a bill (also known as American Jobs Creation Act of 2004), which is structured as a federal excise tax credit for biodiesel. It amounts to a penny per percentage point of biodiesel blended with petroleum diesel for first-use oils, like soybean oil, and a half-penny per percentage for biodiesel made from other sources, like recycled cooking oil. The tax incentive will take effect from Jan. 1, 2005, and lasts for two years.

### **2.5.2 Program Impacts**

New technologies include gasoline-electric hybrids or diesel-powered passenger cars and light-duty trucks, use of biofuels, and fuel cell technology are encouraged in the new century strategies. As a result of public policy, these technologies are expected to be heavily promoted through 2020.

Hybrid car sales have risen consistently in the U.S., since the Honda Insight debuted in the American market in 1999. In that year, only a couple of hundred Insights were sold. U.S. hybrid sales have generally doubled every year: 35,000 in 2002; 47,525 in 2003; 88,000 in 2004; 205,749 in 2005, and through April, 70,269 hybrid cars are sold in 2006 (Hybridcars.com, 2006). Similarly, considerable progress is being made in the development of much cleaner diesel engines; this is important because diesel-powered vehicles get 30 percent better fuel economy than conventional internal combustion gasoline engines. If the cost penalty associated with hybrids falls significantly because of larger-than-expected volumes, and if carmakers find a way to produce diesel engines that are capable of meeting tougher emissions standards in California and the rest of the United States for the lifetime of vehicles, things could be



different. That is, it might be possible to meet more stringent fuel economy standards at lower costs for less (Portney, 2005).

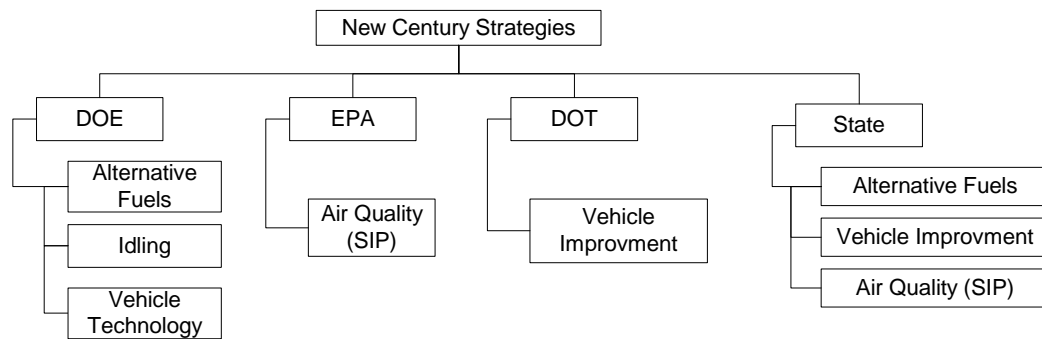
With the potential to become a key of transportation fuel, biofuels take off. Biofuels would be increasingly competitive if crude oil prices keep increasing. The U.S. Department of Energy Biomass Program develops technology for conversion of biomass (plant-derived material) to valuable fuels, chemicals, materials and power, so as to reduce dependence on foreign oil, air and water pollution, and greenhouse gas emissions. Biofuel provides the only renewable alternative for liquid transportation fuel.

With the implementation of American Jobs Creation Act of 2004, the incentive is expected to increase biodiesel demand from an estimated 30 million gallons in fiscal year 2004 to at least 124 million gallons per year, based on a United States Department of Agriculture study. It is estimated that the tax incentive could create up to 50 thousand jobs in the United States over the next ten years (Michigan Soybean Association, 2004). Based on USDA baseline estimates for future soybean production, over a five-year time period the biodiesel tax provisions could add almost 1 billion U.S. dollars directly to the bottom line of U.S. farm income (Lamp, 2004).

### **2.5.3 Program Management**

In the new century, instead of focusing on fuel economy directly, a multi-dimensional approach is adopted in several stages to increase fuel efficiency. The federal government set targets for air quality (for example, State Implementation Plan), regulations on moving to alternative fuel vehicle. The federal government also provides fundamental research and development, and demonstration programs. Financial incentives and cooperation with the auto industries is also available at the federal government. The main role for the auto industry sector over the next 20 years is to further research and development, to advance technology to satisfy the requirements of federal and state government. Each state is in the regulation framework of federal requirements, for example, to meet with the State

Implementation Plan. Management of new century strategies is shown in Figure 4. Each state may have state-level laws and incentives for sustainable transportation. But the state requirements have to be stricter than federal regulations. In California, for instance, California Air Resources Board establishes air quality regulations often stricter than those set by the Federal Government. There are more than 20 state incentives and 23 state laws and regulations to promote application of AFVs and emission reduction.



**Figure 4: Management of New Century Programs**

California is proud of leading policies and regulations for sustainable transportation. In California, there are the excise tax imposed upon compressed natural gas, liquefied natural gas and liquefied petroleum gas vehicle fuels can be paid through an annual flat-fee rate sticker tax based on vehicle weight. In order to equalize the vehicle license fee between AFVs and conventional fuel vehicles, the incremental cost of the purchase of an AFV is exempt from the vehicle license fee (of 2%) when it costs more than the most comparable conventional fuel vehicle, as determined by the California Energy Commission.

#### **2.5.4 Case Studies**

##### ***Case 1: California's Low-Emission Vehicle Program***

California's Air Resource Board (ARB) first adopted Low Emission Vehicle (LEV) standards in 1990, which run from 1994 through 2003. In 1998, ARB amended the LEV regulations, known as LEV II, running from 2004 through 2010, represent continuing progress in emission reductions. These amendments were formally

adopted by the ARB on August 5, 1999, and, after approval by the California Office of Administrative Law on October 28, 1999, became operative November 27, 1999.

When LEV II is fully implemented in 2010, it is estimated that smog-forming emissions in the Los Angeles area will be reduced by 57 tons per day, while the statewide reduction will be 155 tons per day (ARB, 2005).

The LEV II amendments affect passenger cars, light-duty trucks, and medium-duty vehicles. California LEV II Standards are an update to the state's original Low Emission Vehicle program and are an alternative to federal vehicle emissions standards. LEV II sets absolute fleet wide emission caps that cannot be exceeded. It consists of two primary components (Puget Sound Clean Air Agency, 2006):

- The Low Emission Vehicle (LEV) component requires 90% of new cars and light duty trucks meet strict new tailpipe and evaporative emission standards
- The Zero Emission Vehicle (ZEV) component requires 10% of the new vehicles sold in 2005 – 2008 must be zero emitting vehicles, which have typically been electric vehicles. This increases to 16% of the new vehicles by 2020.

Auto manufacturers may substitute certain vehicles such as hybrid electric cars and “Partial ZEVs” for ZEVs. These cars do not get full credit for a ZEV vehicle, so manufacturers must produce and sell more of these vehicles to meet the 10% ZEV requirement. Because of these substitutions, the State of California estimates that 57% of new passenger cars will be Partial ZEVs, including hybrids, by 2010 and 73% by 2020. Table xx shows the advanced technology required in the LEV II program. The State of California estimates LEV II will increase costs an average of \$68 to \$276 per vehicle; longer warranties, such as a 150,000 miles or 15 years, are required on the emission control technologies on the PZEV.

The ZEV requirement will create a large demand for electric vehicles that satisfy consumer needs in terms of vehicle performance and cost. Therefore, California has linked clean fuel requirements with consumer availability for the first time (Totten and Settina, 2006).

Advanced Technology Requirements of the LEV II Emissions Program, 2005–2008				
Category	Vehicle Type	Examples	% of Total Fleet	% of Total Alternative Compliance
Gold	Pure ZEVs	Electric vehicles and fuel cells	2	250 total fuel cell vehicles by 2008
Silver	Advanced technology PZEVs	HEV, CNG vehicles	2	3
Bronze	PZEVs	Super Ultra Low Emissions Vehicle or SULEV (e.g., BMW 325i or Nissan Sentra)	6	6

Note: By 2020 16% of new vehicles sold must be either Gold, Silver or Bronze category. HEV = hybrid electric vehicle

Source: Puget Sound Clean Air Agency, 2004.

The LEV II program will put research and development burdens on automobile manufacturers to produce low emission vehicles. According to the state-specific certification requirements, auto industries have to adjust their internal administration of different warranties, internal accounting changes, monitoring of vehicle distribution, state reporting requirements, legal issues and other related administrative activities. Costs of longer certified warranties might be passed to consumers. Air Resource Board of California would be responsible for tracking and monitoring new vehicle availability and sales and working with automakers to report on how industry is complying with the standards.

### ***Case 2: California’s Hydrogen Highway Program***

California’s Hydrogen Highway Program is a solution to environmental and energy issues. The goal of the California Hydrogen Highway Network initiative is to support and catalyze a rapid transition to a clean, hydrogen transportation economy in California, thereby reducing our dependence on foreign oil, and protecting our citizens from health harms related to vehicle emissions. It is to ensure that by the end of the decade every Californian has access to hydrogen fuel along the State’s major highways, with a significant and increasing percentage of that hydrogen produced from clean, renewable sources.

An early network of only 150 to 200 hydrogen fueling stations throughout the State (approximately one station every 20 miles on the State’s major highways) would make hydrogen fuel available to the vast majority of Californians. This early vision for California’s Hydrogen Highway Network is achievable by 2010 and will help

demonstrate the economic and technical viability of hydrogen technologies (Hydrogen Highway, 2006). Studies by the California Fuel Cell Partnership and others estimate that this initial low-volume fueling network will cost \$75 - \$200 million, the majority of this investment coming from private investment by energy companies, automakers, high-tech firms, and other companies (quoted in Hydrogen Highway, 2006).

By 2007, fuel cell hybrid vehicles, both buses and light-duty vehicles, will be used in demonstration fleets in tandem with early hydrogen fueling infrastructure. Internal combustion hydrogen hybrid vehicles will also be available both in fleet applications and commercially in larger numbers in the 2006-7 time frame. By 2010, automakers have indicated that "tens of thousands" of fuel cells vehicles will be commercially available, provided there is fueling infrastructure in place.

The California Hydrogen Highway Network Action Plan is developing public/private partnerships that will work together to invest in the early infrastructure development, and to address key hydrogen commercialization challenges. The public sector needs to play a role in setting the stage for hydrogen commercialization (incentives, loan guarantees, revenue bond funding, education and training, etc) so that investment by the private sector can take place and the market can develop.

### **3. Best Practice Case: Energy Efficient Manufacturing: Meeting the Needs of Energy Intensive Industries**

#### ***3.1 Overview of the Industry of the Future Program***

The U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) develops and deploys clean energy technologies that save energy and cut pollution. EERE works closely with states through the State Energy Program, providing grants for clean energy technologies.

##### **3.1.1 IOF Program**

The Industries of Future (IOF) program in EERE creates public-private partnerships

that can share the costs of identifying and pursuing opportunities for optimizing energy and materials use and helps the nine most energy-intensive industries—the pulp and paper, agricultural, chemical, petroleum, glass, mining, aluminum, steel, and metal casting industries— reduce their energy use and cut pollution. These nine industries account for 75% of the energy used and 90% of the pollution produced by U.S. industry. IOF is helping to develop new processes and equipment to reduce energy use, increase output for the same energy use, or convert wastes into energy to reduce each industry’s net energy consumption. IOF also helps improve the efficiency of equipment and systems used throughout industry, such as industrial motors, steam and compressed air systems, and combustion technologies. To help industries save energy, 26 Industrial Assessment Centers, located at universities around the country, conduct no-cost energy assessments. To date, more than 8,000 assessments have been performed, resulting in energy efficiency projects that are saving an average of \$55,000 per year for each participant (DOE, 2006).

Since 1994, industries in states throughout the country have participated in the IOF program. Individual state IOF programs have assessed the challenges faced by their industries and established goals for increasing energy and materials efficiency by taking advantage of the large network of efficiency experts and other resources of the U.S. Department of Energy’s Industrial Technologies Program.

Except for the main purpose of delivering energy efficiency, the IOF program also means reducing waste, enhancing environmental performance, lowering production costs and increasing productivity and boosting competitiveness. The IOF strategy seeks to improve industrial energy efficiency and productivity with two primary thrusts.

- 1) Provide support of collaborative R&D and implementation to give industry the advanced technologies it will need in the future and
- 2) Help plants select and implement the best practices and technologies available today-such as enhancing current operations through improved motor and pump systems.

In essential, IOF is a collaboration at the intersection of industry’s long-term needs

and the goal of energy efficiency leading to improved environmental performance and increased productivity, and a partnership of the combined resources of industry, academia, and government to tackle tough technical challenges, requiring advanced science and technology options.

The IOF process is an industry-led process. All parts of an industry come together to define their situation, identify challenges, and describe what they need and want to be like 20 years later in order to be sustainably competitive. Each industry defines its own goals (vision), creates a research agenda (roadmap), and then forms public-private R&D partnerships. The process brings together high-level decision makers-many of them competitors-to identify their common technology challenges. The process underscores shared needs and lays the groundwork for collaboration on mutually beneficial projects. Industry gains a strong voice in the leveraged allocation of federal research dollars. In practice, state governments all over the country are using this model to develop strategies to help strengthen industries with their states and regions.

### **3.1.2 IOF Collaboration with the Industrial Assessment Center**

An industrial assessment is, quite simply, an in-depth assessment of a plant site; its facilities, services and manufacturing operations. This term is used to refer to a process which involves a thorough examination of potential savings from:

- energy efficiency improvements,
- waste minimization and pollution prevention, and
- productivity improvement.

Assessments are performed by local teams of engineering faculty and students from 26 participating universities across the country. The assessment begins with a university-based IAC team conducting a survey of the eligible plant, followed by a one or two-day site visit, taking engineering measurements as a basis for assessment

recommendations. The team then performs a detailed analysis for specific recommendations with related estimates of costs, performance and payback times.

Within 60 days, a confidential report, detailing the analysis, findings and recommendations of the team is sent to the plant. In two to six months, follow-up phone calls are placed to the plant manager to verify recommendations that will be implemented.

The Federal Government has been funding industrial assessments for small and medium sized manufacturing firms under the auspices of the IAC program [formerly called the Energy Analysis and Diagnostic Center (EADC) program] since 1976. The program is funded through the U.S. Department of Energy's Industrial Technologies Program.

As a component of the National Energy Strategy, the IAC program is a major energy conservation initiative of the U.S. Department of Energy. It also addresses the issues of waste reduction and productivity improvements. Assessments are performed at no cost to the manufacturer by teams of faculty and students from engineering schools at participating universities. The program has been highly successful since its inception. Beginning in 1976 with four schools, there are now 26 universities operating IACs. (DOE, 2006).

Manufacturers are not the only benefactors of the IAC program. Students involved in the program have a unique opportunity to see a range of manufacturing operations first hand. This results in both more motivated and highly trained students who more often than not enter energy management as a career field. Faculty have developed ideas for research from their studies of manufacturing processes and have taught courses using experiences gained through their auditing work.

One additional benefit from the program is that the data generated by the assessments provides a unique opportunity to quantify the state of energy, waste and productivity management in small and medium sized industry and the potential of the assessment



process to improve efficiency. Since 1980, the data has been compiled from the assessment performed under this program. The results through the present are currently available in the IAC Database at Rutgers University . This database is maintained by Rutgers University for the U.S. Department of Energy.

The IAC database includes certain information from 11,600 assessments over the last 20 years is available in a database on the web at [iac.rutgers.edu](http://iac.rutgers.edu). Some of the resources available include:

- Typical savings for assessments in different industries
- Individual recommendations made for each assessment
- Rates of adoption of various recommendations
- Sorting by company size, geographical area or cost of energy
- Implementation costs and paybacks for industrial energy projects
- Manuals and other technical documents

### ***3.2 Program Impacts***

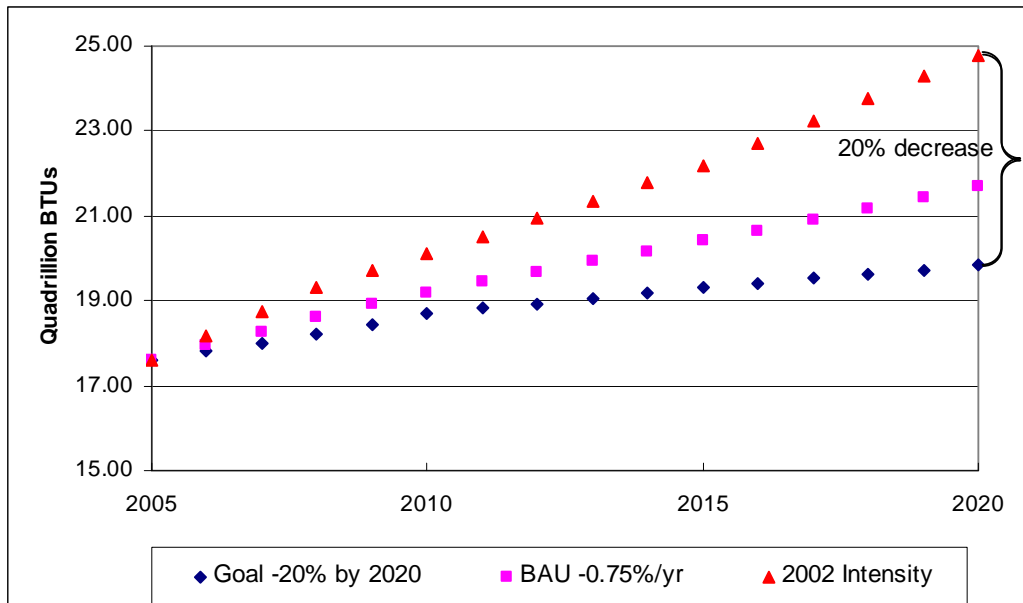
The IOF program works with U.S. industry to improve industrial energy efficiency and environmental performance. The program invests in high-risk, high-value R&D to reduce industrial energy use while stimulating productivity growth. This program turns out to be very successful in energy and cost saving. The ITP programs have cumulatively reduced emissions of carbon by 94.9 million tons, nitrogen oxides by 747 thousand tons, and sulfur oxides by 1.47 million tons by 2004, as Table 1 shows (DOE, 2006).

Between 2002 and 2020, with the assumption of 20 percent versus 0.75 percent reduction (BAU) in energy intensity in the energy-intensive industries, the total energy savings of IOF program would be 0.94 Quads by 2010 and 3.80 Quads by 2020; correspondingly, the cost savings are \$5.0 billion by 2010 and \$17.8 billion by 2020 (see Figure 5).

**Table 1 : Energy Savings from IOFs in United States**

Sectors	Cumulative Energy Savings (10 <sup>12</sup> Btu)	2004 Energy Savings (10 <sup>12</sup> Btu)	Cumulative Pollution Reductions (10 <sup>3</sup> tons)				
			Particulates	VOCs	SOx	NOx	Carbon
Aluminum	11.374	2.756	0.026	0.039	1.281	1.592	202.712
Chemicals	10.72	1.689	0.01	9.968	0.524	1.355	178.94
Forest Products	19.443	6.297	0.013	0.067	0.82	2.398	320.315
Glass	-	-	-	-	-	-	-
Metal Casting	0.091	0.085		0	0.02	0.015	1.78
Mining	4.271	1.713	0.019	0.015	0.921	0.6617	83.82
Steel	1.678	0.691	0	0.006	0.019	0.201	27.057
others	1012	98	8	4	586	168	22885
Commercial Technologies Total	1060	111	7.98	14.5	590	174	23700
Industrial Assessment Centers Total	1130	133	5.41	4.08	354	173	22400
Best Practices Total	322	122	1.55	1.18	103	49.3	6400
Historical Technologies Total	2210	0	8.2	6.72	426	351	42400
Total	4720	366	23.1	26.5	1470	747	94900

Source: DOE, 2006



**Figure 5 : Energy Savings Projection of IOF Program from 2002 to 2020**

Source: DOE, 2003

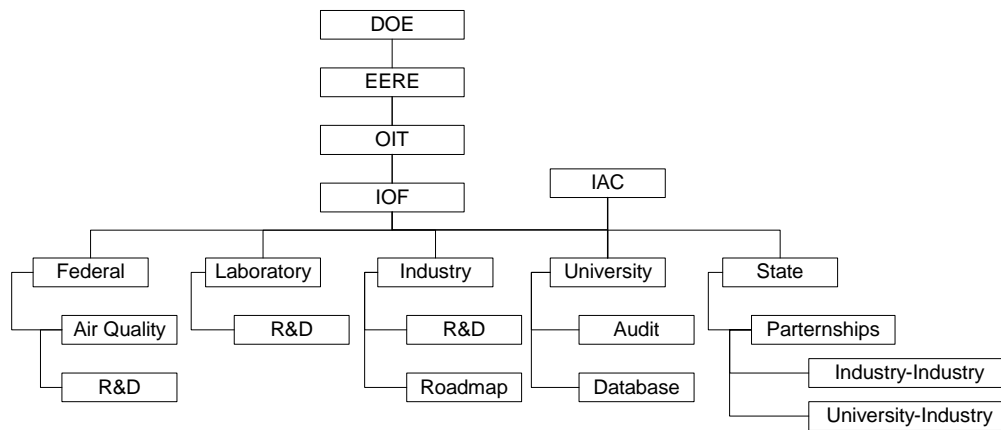
### 3.3 Program Management

The national IOF program is managed by the USDOE OIT. IOF has become a model of how the Federal government can partner with industry to effectively plan and implement a robust, comprehensive R&D agenda. Industry concerns frequently occur on a state or regional basis. The state IOF programs can incorporate a state's particular industry profile, economic development needs, and research strengths.

The state IOF programs will be customer driven and will identify issues particular to the industry, location and state issues. Each industry faces its own challenges; however there are cross-cutting issues that will be addressed through joint meetings/workshops. Opportunities for collaborative research between industry, universities and National Laboratories will be identified and developed.

OIT programs (such as Best Practices) will be made available through the state program. Information about meetings and workshops will be broadly distributed to encourage regular interaction between government, universities and industry.

The organization of IOF program is briefly shown in the following Figure 6.



**Figure 6: IOF Program Management**

Source: DOE, 2005.

### 3.4 Best Practice: Case Study of the Delaware Chemical Industry IOF Program

The Delaware Industries of the Future program focuses on the Chemical and Renewable Bioproducts Industries of the State. The Delaware Energy Office

determines near- and long-term strategies for improving energy efficiency, waste management and competitiveness. The project will be a collaboration of the Delaware Energy Office, the Delaware Manufacturing Extension Partnership, the Delaware Economic Development Office, the Center for Energy and Environmental Policy of the University of Delaware, and the Delaware Biotechnology Institute.

To implement IOF program in Delaware, DOE chose the chemicals and renewable bioproducts industries due to their short- and long-term importance to the economic vitality of the state. This case study mainly focuses on the strategy and implementation of IOF program in Delaware's chemical industry.

The Delaware IOF Chemicals Industry Partnership is a network of participants and leaders from industry, government, and academic organizations. The overall goal of the partnership is to optimize the energy and resource efficiencies of manufacturing processes by improving the chemical industry's manufacturing processes and business operations. By becoming more energy efficient, the industry will reduce operating and manufacturing costs and improve the long-term economic vitality and diversity of Delaware's chemical industry. The overall objectives of the Delaware IOF Chemical Industry Partnership are:

- Develop a Delaware IOF consortium consisting of members from state agencies, industrial partners, and others.
- Build industry support for the IOF program through partnership-building activities, workshops, and one-on-one technical assistance.
- Develop a Delaware Industries of the Future website dedicated to the dissemination of information.

#### **3.4.1 Major Achievements of Delaware IOF**

Research by CEEP using the U.S. Department of Energy's IAC database found significant energy efficiency opportunities for chemical companies in Delaware. CEEP filtered the database's 84,000 efficiency measures from 11,600 assessments performed by the IAC program through 2003 to find effective measures that fit

Delaware's small and medium sized chemical industrial profile.<sup>2</sup> The results of this analysis are shown in Table 2.

**Table 2: Potential Energy Saving Measures for Delaware Chemical Industries**

Measures	Energy Savings (%)	Payback Period (Yr)	CCE (Cents/kWh)
<b>Air Compressor</b>	15.1	0.1	0.2
<b>Combustion and Steam</b>	17.5	0.7	1.3
<b>Heat Recovery and Containment</b>	19.1	1.2	1.4
<b>Space Conditioning</b>	9.3	0.5	0.8
<b>Lighting</b>	9.1	2.2	3.0
<b>Motors</b>	11.9	0.03	0.03
<b>Operation</b>	10.3	0.0	0.0

Source: CEEP, 2004.

As part of the Vision and Roadmap development, energy audits were performed for small and medium sized chemical companies in Delaware by the Industrial Assessment Center at Lehigh University. Aggregate results from assessments performed at one facility in 2003 by Lehigh University are shown in Table 3.

**Table 3: Selected Energy Efficiency Recommendations from IAC Audits**

Measures	Implementation Cost (\$)	Annual Energy Savings	Annual Cost Savings (\$)	Payback Period (Yr)
Repair Compressed Air Leaks	\$600	231,209 kWh	\$11,914	0.05
Insulate Process Heating Equipment	\$1,472	426,331 kWh	\$17,785	0.08
Boiler Tuning	\$750	1,114 MMBTU	\$7,543	0.10
Heat Recovery and Containment	\$16,336	3,539 MMBTU	\$26,797	0.61
Lighting	\$170,580	314,116 kWh	\$23,550	7.24
Energy-Efficient Cog Belts	\$0	35212 kWh	\$2,072	0
Operational Changes	\$2,500	15,306 kWh	\$5,713	0.44
<b>TOTAL</b>	<b>\$192,238</b>		<b>\$95,374</b>	<b>2.02</b>

<sup>2</sup> IAC 2004 version was used.

The IAC recommended efficiency measures involve commonly used equipment including compressed air systems, boilers, motors, process heating and lighting. In most cases, pay back periods are much less than one year, and efficiency measures are simple, low cost retrofits or operational changes. In aggregate, the average pay back period for all measures is slightly over two years, which meets or exceeds the investment criteria for most companies. The IAC audits performed at these two facilities also confirm that there are significant opportunities for saving energy in the industrial sector in Delaware, particularly for smaller companies.

### **3.4.2 State R&D Roles in the Delaware IOF Program**

A DEIOF Steering Committee was established, members include leaders from large chemical companies in Delaware, participants in the DEIOF partnership from small and medium sized companies, representatives from a local utility, state legislators, and representatives from the Delaware Manufacturing Extension Partnership and the Center for Energy and Environment Policy at the University of Delaware.

The main objective of the Steering Committee was to support the DEIOF partnership by providing expertise and guidance in the activities of the DEIOF and in the formulation of the Vision& Roadmap.

Best practice workshops were organized to inform participants of opportunities, strategies, and challenges in implementing efficiency measures.

Several focus group meetings were held with small and medium sized chemical companies. At these focus group meetings representatives from different companies were able to share unique and common goals as well as challenges and barriers to becoming more energy efficient.

To increase industry participation “one-on-one” interviews were conducted in a format similar to the focus groups with participants expressing interest in the DEIOF partnership but were unable to attend a focus group meeting. In addition to focus group meetings and results from survey response, free energy audits provided by regional Industrial Assessment Centers (IAC) were offered to participants in the

DEIOF partnership.

Finally, focus group, survey and interview data were assembled, reviewed and analyzed, and a draft Vision and Roadmap was developed for review by the participants.

The Delaware Chemical IOF Partnership investigated a Technology Showcase strategy for the dissemination of information to members for the purpose of learning how new technologies might enter the manufacturing sector in the near- and long-term. A Technology Showcase was actually conducted on September 23, 2004 at Conectiv Power Delivery's Conference Center. The Showcase was attended by approximately 150 people from the industrial and utility sectors in Delaware, along with equipment vendors and representatives of the U.S. Department of Energy and the Delaware Energy Office. The Showcase focused on near-term, cost-effective energy efficiency technologies (CEEP, 2004).

#### **4. Summary**

While the United States is much more energy efficient today than it was 30 years ago, there is still significant potential for additional cost-effective energy savings and greater use of alternative energy. CAFE and IOF are the two successful U.S. best practice exemplars. CAFE requires automobile manufacturers to increase the sales-weighted average fuel economy of the passenger car and light-duty truck fleets sold in the United States, and IOF identifies "Grand Challenges" in next generation manufacturing are two successful energy efficient programs in the States.

The CAFE program has clearly contributed to increased fuel economy of the nation's light-duty vehicle fleet during the past decades. High fuel prices and a desire on the part of automakers to reduce costs by reducing the weight of vehicles contributed to improve fuel economy. CAFE standards reinforced that effect. Improved fuel economy has reduced dependence on imported oil, improved the nation's terms of trade, and reduced emissions of carbon dioxide, a principal greenhouse gas, relative to

what they otherwise would have been. If fuel economy had not improved, gasoline consumption (and crude oil imports) would be greater than it is today's consumption.

IOF is working well. It focuses on the energy-intensive industries and provides the bulk of the opportunities to improve energy efficiency. The program has been successful because of high level support by government and industry; however, the program needs to be carefully monitored to ensure there is continued high level involvement by industry and government; that it gets results; and that it continues to be in the public's best interest.

In sum, ample opportunities remain for the United States to increase energy efficiency. A next generation of policies will be needed to spur faster movement toward a sustainable energy future.



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