Energy Use in the Transportation Sector:
Trends and Strategies for Reduction in Use

Prepared
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Kansas Energy Council (KEC)

by
Kansas University Transportation Center (KUTC)

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FOREWORD

Kansas has a wide variety of options available that will contribute to reducing the energy consumed in the transportation sector. Many of these options are well-tested techniques with documented costs and results. Given the history in the state, its geography, and its current development patterns, Kansas will have to make a commitment to transportation sector to make a significant impact in transportation energy consumed. Much of Kansas is sparsely populated, with long distances between towns. The development patterns in Kansas are similar to those in most of the country, emphasizing accessibility only by motorized vehicles. In addition, Kansas is on major trade routes for goods shipped across the country by either truck or rail. Much of this traffic is through-traffic, but the traffic levels impact the state transportation network.

The principal objective in compiling the material for this report is to present data and information on energy use of the transportation sector in Kansas. This information is obtained from existing resources including professional literature from a variety of disciplines, state and federal reports, and data from state agencies.

This report can be used as a decision making tool by policy-makers to improve the efficiency in the use of energy resources to support transportation needs. Improved efficiency will affect virtually all sectors of society in the state.

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INTRODUCTION

Identifying and quantifying significant transportation energy use trends in the United States and in Kansas is an important first step in determining strategies to reduce vehicle-related energy use in the state. The potential for energy consumption efficiencies exists in alternative-fueled vehicles or other fuel-efficient improvements on vehicles, improvements in the transportation system itself, changes in user behavior, or use of alternative modes.

The purpose of this project is to:

- Collect data associated with energy use in the transportation sector in Kansas and trends in the United States;
- Synthesize the data into a report on trends and strategies for reduction in use in Kansas; and
- Develop a database system to facilitate annual updates and analysis.

The objectives for this project are to:

- Identify strategies to reduce vehicle-related energy use related to cars, trucks, and mass transit in Kansas. The strategies are grouped around the following categories:

    a. Mass transportation – Mode shift from passenger vehicles to mass transportation.
    b. Alternative-fueled vehicles – Opportunities, costs, potential environmental effects, and barriers (policy, technology, economic, and infrastructure) for increasing use of alternative fuels, including low-sulfur diesel fuel.
    c. Vehicle efficiency – impact of increasing use of fuel-efficient vehicles.
    d. Transportation system efficiency – highway and roadway design features to improve efficiency.
    e. Consumer choices – encouraging purchase of fuel-efficient vehicles (evaluate incentives), speed limit compliance (evaluate current degree of compliance, estimated loss of efficiency when traveling above speed limits, and ways to encourage compliance).

- Evaluate the potential to reduce petroleum-based fuel energy consumption in Kansas through increased use of rail service, and increased use of alternative fuels in off-road workplace transportation. The strategies are grouped around two categories:

    a. Changing mode split between freight trucking and rail including short-line rail
    b. Alternative off-road workplace transportation (e.g. forklifts, golf carts, etc.)

- Develop recommendations for strategies to maintain vehicle-related energy use databases.

- Develop a report which provides the substance of the transportation chapter in the state energy plan produced by the Kansas Energy Council. The report focuses on the following major categories:
    - Vehicle Miles Traveled (VMT)

- Alternative Fueled Vehicles (AFV)
- Fuel-Efficient Vehicles (FEV)
- Consumer Choices (CC)
- Highway & Roadway Design (H&R)
- Railroads (RR)
- Off-Road Vehicles (ORV)

Within each category, an overview of the focus area is included followed by specific issues/topics of concern. The “overview” section covers technology trends, current infrastructure/management framework, environmental implications, economic implications, user values & behavior implications, and current policy framework for that specific category. The “issues/topics” section describes the issues, lists existing policies/programs, and policy/program options available with their respective pros and cons.

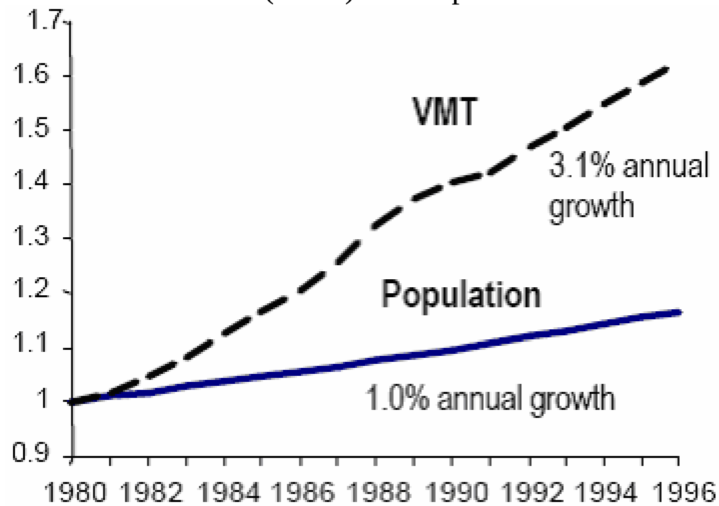
OVERVIEW: VEHICLE MILES TRAVELED

A. Technology Trends

Between 1980 and 1997, the total Vehicle Miles Traveled (VMT) in the United States increased 63%, and more than doubled since 1970. To add to this, the growth of VMT continually exceeds past the growth of population. Between 1980 and 1997, VMT growth was also greater than employment and economic growth. The Federal Highway Administration (FHWA) predicts that the light-duty VMT will grow at an annual rate of 2.16% for the next 20 years, leading to a 53% increase in vehicle miles traveled.

Figure 1

Growth Trend for Vehicle Miles Traveled (VMT) and Population in USA



Scale: 1980 value = 1.0

Sources: U.S. Department of Transportation, Federal Highway Administration. *Highway Statistics (Summary to 1995,* and annual editions, *1996* and *1997),* Washington, DC.

As shown in Table 1, by 2004 the VMT in the U.S. had grown to nearly 3,000,000 million, or 9,954 vehicle miles per capita per year. In Kansas, the VMT is 29,172 million or 10,664 VMT per capita per year. The growth in VMT between 1997 and 2004 was 14 percent in the U.S. and 10 percent in Kansas.

Where applicable, various programs exist across the country in an effort to lessen the growth of VMT. A Single Occupancy Vehicle (SOV) trip exists when there is only one person in the automobile. In order to lessen the amount of these trips, carpools and trip-chains have been suggested. Carpooling is traveling with two or more individuals in one vehicle. Trip-chaining or combining trips consist of travel that combines two or more activities that would generally be separate into one trip. Public transit is a key factor in helping reduce VMT which includes bus, train, light rail, and other government sponsored programs. Alternative work schedules can be implemented in which the number of days worked are reduced when hours are worked each day, or the number of trips during peak hours is reduced. With an increase in technology, there is new emphasis on telecommuting where you perform certain activities at home, thus eliminating the need for a trip.

Different types of rail systems have been used to reduce the amount of VMT in some of the largest U.S. cities, including light rail. Light rail is a form of urban rail transit that utilizes equipment and infrastructure that can allow for exclusive right-of-way, multiple unit train configurations, and signal control of operations. Some of the cities have ‘Legacy’ LRT, which was installed before World War II, including Boston, Philadelphia, San Francisco, and New Orleans. Several cities have incorporated a light rail system since 1981, including Portland, Houston, San Diego, Denver, St. Louis, Dallas, and Sacramento.

Bus Rapid Transit (BRT) has been used in areas where it is not feasible for the installment of a rail system. This is defined as “a flexible, high performance transit mode that combines a variety of physical, operating and system elements into a permanently integrated system with a quality image and unique identity” (Bus Rapid Transit- Implementation Guidelines, TCRP Report 90 Volume II). The system performance of BRT is based on travel time, reliability, identity and image, safety and security, and capacity. Cities that have incorporated BRT into their public transportation include Albuquerque, Boston, Honolulu, Las Vegas, Miami-Dade, Oakland, Orlando, Pittsburgh, Phoenix and, most recently, Kansas City (MO).

Kansas has been consistent with the national VMT growth as every year, the amount of VMT continues to increase. The growth of vehicle miles traveled is exceeding the population growth due to factors such as further separation between job and housing, increased distances between destinations, and induced traffic. Between 1982 and 1996, Kansas City had a population increase of 23%, while the vehicle miles traveled in the area increased by 79%.

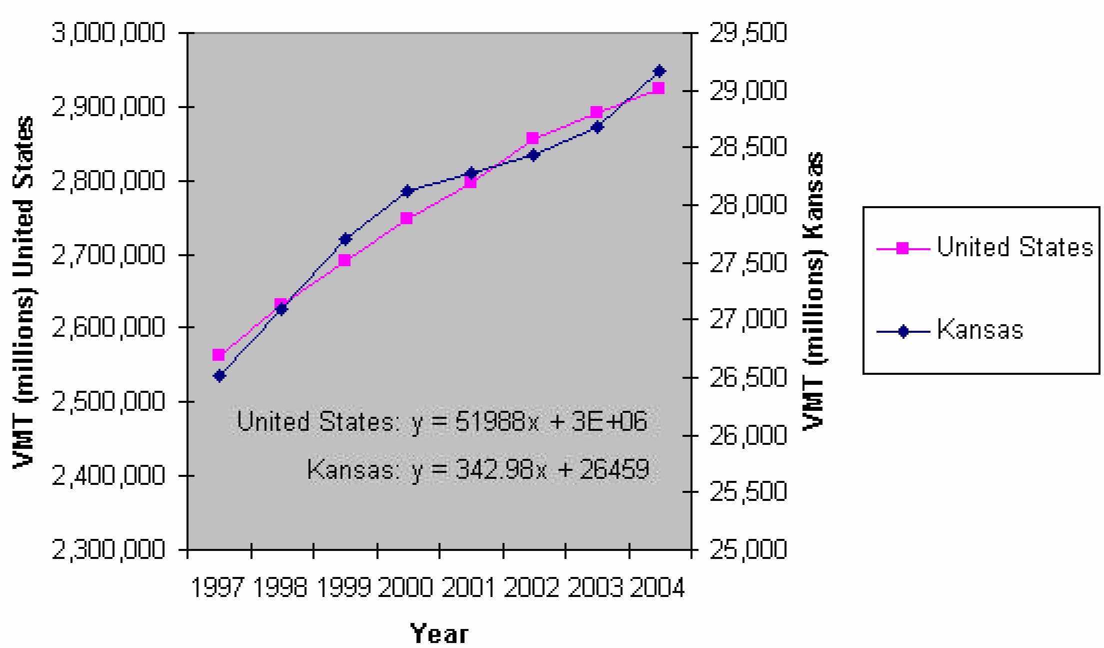
To help reduce the growing VMT in the state, reduce congestion and provide greater mobility to Kansans, Kansas has implemented mass transit where applicable and has studied the feasibility of light rail in the I-35 corridor. The most in-depth analysis was a feasibility study performed by Johnson County in September of 1995 (Johnson County Transit). Part of the reason for using rail along the I-35 route is that KDOT has not recommended adding a lane in both directions to deal with the congestive problems. It was found to be technically feasible to use commuter rail on the existing railroad tracks sharing lines and facilities with freight trains. However, the initial study was performed while Burlington Northern Railroad owned the lines. Burlington Northern merged with Santa Fe Railroad to form Burlington Northern Santa Fe (BNSF), which is the current owner of the lines.

Table 1
Comparison of Vehicle Miles Traveled (VMT) Between United States and Kansas
1997-2004

Year	VMT in USA (millions)	VMT in USA (per capita)	VMT in Kansas (millions)	VMT in Kansas (per capita)
2004	2,923,000	9,954	29,172	10,664
2003	2,891,000	9,942	28,672	10,528
2002	2,856,000	9,919	28,443	10,473
2001	2,797,000	9,811	28,287	10,535
2000	2,747,000	9,737	28,130	10,599
1999	2,691,000	9,644	27,699	10,436
1998	2,632,000	9,541	27,095	10,182
1997	2,562,000	9,397	26,524	10,066

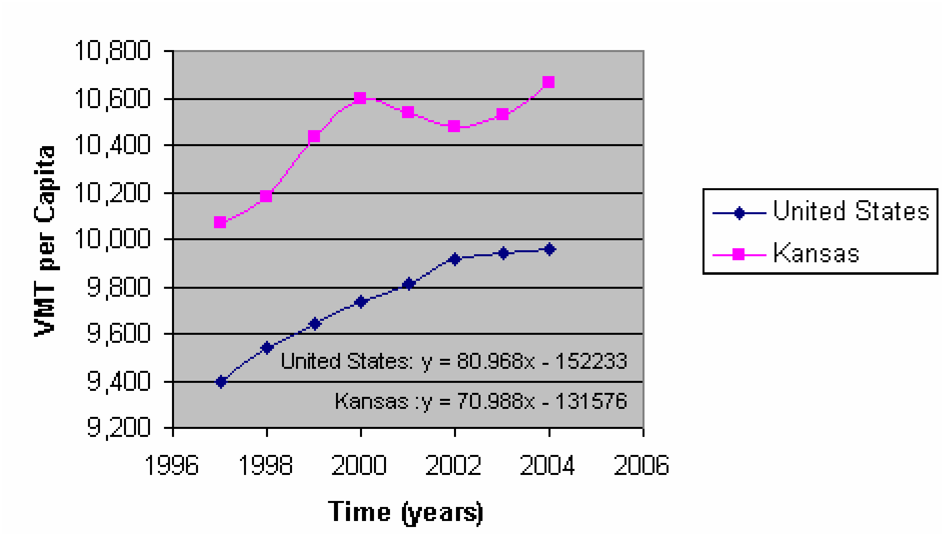
Source: www.bts.gov
Note: Data in Kansas for year 2001 was interpolated.

Figure 2
Comparison of Vehicle Miles Traveled (VMT) in Kansas and the United States
1997-2004



Source: www.bts.gov
Note: Data in Kansas for year 2001 was interpolated.

Figure 3
Comparison of Vehicle Miles Traveled (VMT) Per Capita in Kansas and the United States 1996-2006



Source: www.bts.gov
Note: Data in Kansas for year 2001 was interpolated.

B. Current Infrastructure / Management Framework

1. Public Transit Services in Urban Areas of Kansas

   Urban and rural programs exist to offer public transportation in the state of Kansas. Table 2 is a breakdown of urban transportation. The information did not include data on transportation in Lawrence, KS.

Table 2
Urban Transit Agencies in Kansas

Transit agencies	Modes provided	Urbanized area	Annual unlinked passenger trips (thousands)	Average weekday unlinked trips (thousands)	Operating funds expended ($ millions)	Operating funds expended ($ millions)	Vehicles available for maximum service
KCATA	Bus, demand responsive & vanpool	Kansas City, MO-KS	15,193	51	49	14	435
Wichita Transit	Bus, demand responsive	Wichita	2,749	10	7	<1	79
Topeka Metropolitan Transit	Bus, demand responsive	Topeka	1,317	5	4	<1	80

Authority							
Johnson County Transit	Bus, demand responsive	Olathe	392	1	4	6	77

Source: U.S. Department of Transportation, Federal Transit Administration, National Transit Database, available at http://www.ntdprogram.com/NTD/Profiles.nsf/ ProfileInformation?OpenForm&2000&All as of Dec. 6, 2001. (http://www.bts.gov/publications/state_transportation_profiles/kansas/ , May, 2006)

2. Public Transit in Non-Urbanized Areas of Kansas

Kansas counties have 129 transit providing agencies operating with a fleet of 657 vehicles operating under a structure of fifteen Coordinated Transit Districts (CTDs). The CTDs are comprised of services within one county for one of the CTDs to as many as eighteen counties in the CTD in Northwest Kansas. The purpose of the CTDs is to coordinate funding and services delivered to the district. A majority of the agencies (62 percent) provide service in one county and at least 11 percent provide service within city limits. Approximately 27 percent of the agencies provide service to two or more counties. Forty-five percent of the operating vehicles are more than five years old and at least 22 percent of the vehicles have traveled more than 100,000 miles.

A survey of county service was completed identifying total vehicles in 2005. Total trips and total miles were surveyed in 2000, where data were available. These data are summarized in Table 3.

The majority of public transit services in nonurbanized areas are provided by private non-profit agencies under contract to the Kansas Department of Transportation (KDOT) using funds from the Federal Transit Administration's Section 5311 program, providing capital and operating assistance on a match basis. In a few cases, these services are provided by either county or city government. In addition to the Section 5311 program for public transit in nonurbanized areas, the Section 5310 program provides some additional funding for capital assistance to private non-profit agencies serving persons with disabilities and the elderly.

Table 3
Kansas Public Transportation by County

County	**Total Vehicles (FY 2005)**	**Total Trips (FY 2000)**	**Total Miles (FY2000)**
Allen	34	46,472	119,115
Anderson	14		
Atchinson	10	30,327	94,681
Barber	2		
Barton	16		81,300
Bourbon	35	34,110	93,471

Brown	5	21,240	62,818
Butler	14	19,000	80,000
Chase	15	6,647	13,750
Chautauqua	3	2,030	12,132
Cherokee	32	9,615	27,970
Cheyenne	35		
Clark	3	1,628	4,967
Clay	42	15,376	119,838
Cloud	33	13,532	98,296
Coffey	29	16,421	103,763
Comanche	1		
Cowley	32	124,490	192,393
Crawford	34	56,931	203,856
Decatur	36	5,520	8,500
Dickinson	32	24,091	104,506
Doniphan	16	809	4,780
Douglas	33	11,369	89,710
Edwards	10		
Elk	3	824	17,938
Ellis	39	21,411	81,729
Ellsworth	30	11,890	20,980
Finney	6	43,918	148,404
Ford	14	101,827	42,035
Franklin	13	11,894	127,976
Geary	19	23,400	52,700
Gove	36	393	7,610
Graham	35		
Grant	0		
Gray	1		
Greeley	0		
Greenwood	11	19,200	22,300
Hamilton	2		
Harper	6	13,874	50,171
Harvey	48	73,580	263,794
Haskell	1	8,304	11,508
Hodgeman	0		
Jackson	11	1,451	2,902
Jefferson	14	17,340	94,589
Jewell	31	2,927	26,985
Johnson	35		
Kearny	0		
Kingman	11	13,107	38,491
Kiowa	6	370	3,778

Labette	31	2,391	13,087
Lane	1		
Leavenworth	19	8,103	79,941
Lincoln	28	2,879	20,500
Linn	27	4,046	87,135
Logan	36	6,993	4,338
Lyon	32	106,622	92,004
Marion	46	8,209	78,968
Marshall	18	27,551	106,694
McPherson	49	48,039	180,979
Meade	0	986	6,151
Miami	29	59,238	206,863
Mitchell	31	5,772	56,033
Montgomery	26	10,111	22,619
Morris	10	5,940	16,715
Morton	0		
Nemaha	4	13,987	23,877
Neosho	20	18,534	39,281
Ness	0		
Norton	36	2,662	6,000
Osage	28	8,743	109,447
Osborne	26		
Ottawa	30		
Phillips	36		
Pottawatomie	23		
Pratt	10		
Rawlins	35		
Reno	42	220,501	556,932
Republic	33	21,882	37,598
Rice	12		9,200
Riley	26	1,312	2,575
Rooks	37		
Rush	9		
Russell	4	180	800
Saline	32	46,752	206,137
Scott	1	465	2,981
Sedgwick	174	990,862	1,388,451
Seward	2	53,040	14,617
Shawnee	87	289,847	479,996
Sheridan	37	2,214	20,457
Sherman	36		
Smith	26	11,500	2,000
Stafford	9		

Stanton	0		
Stevens	1		
Sumner	11		
Thomas	37	8,955	10,512
Trego	40	6,269	9,130
Wabaunsee	12	3,144	49,487
Wallace	0		
Washington	19	57,348	245,987
Wichita	0		
Wilson	4		
Woodson	20	4,580	70,695
Wyandotte	25	10,332	31,805

Source: Rural Transit Data Base 2005, Kansas Transit Needs Study, KUTC

3. Vanpool Programs

Vanpools are usually a more formal arrangement among a larger number of interested people than are carpools. If a worker commutes more than 15 miles from home to work each way, the cost savings from joining a vanpool may offset the time involved for multiple pickups and drop-offs.

The public benefit to increased use of vanpools are reduced commuter congestion, reduced energy consumption and related emissions and pollution, and additional mobility options for a segment of the workforce that may not have adequate transportation to and from work. The benefits to employers that promote vanpools are a reduced investment in employee parking facilities. Employee benefits include reduced commuting costs and reliable transportation to and from work.

Vanpools usually are created for up to 15 people, each of whom have a guaranteed seat and share costs. The vanpool driver, frequently a co-worker, usually rides for free since it is his or her responsibility to ensure the smooth functioning of the vanpool.

The three most common categories of vanpools are: third party, employer-sponsored and owner-operated.

Third-party vanpools
In this arrangement, vehicles are owned and operated by a for-profit vendor. The vendor covers maintenance, insurance and administration of the vanpool. The vanpool members take care of promoting their van and collecting fees.

Employer-sponsored vanpools
The least expensive vanpooling option is the employer-sponsored vanpool. Employers purchase or lease the vans and arrange for maintenance, insurance and administration. Fares may also promote the program and help organize the groups. Participation is usually limited to employers of one company.

Owner-operated vanpools
An owner-operated vanpool is owned by one or more of the group's members – sometimes through a corporation in order to protect the owner from personal liability. The owner(s) arrange for maintenance, insurance and billing.

Vanpools benefits for commuters

- Reduces gas, toll and insurance costs
- Reduces depreciation of your vehicle
- Reduces stress of commuting
- Allows you to relax

Vanpools benefits for employers

- Reduces parking needs and costs
- Reduces employee stress; improves productivity
- Improves employee morale
- Reduces absenteeism and late arrival

Vanpools benefits the environment

- Reduce congestion
- Improve air quality
- Conserve energy

Kansas. The Kansas State Vanpool Program consists of nineteen vehicles that are owned and registered by the state. The secretary of administration sets the passenger fee for each vanpool so that it is self-supporting, including but not limited to all operating, servicing, repair, insurance, vehicle replacements, and administrative costs. (http://www.kslegislature.org/enrollbills/approved/2004/senate/501.pdf#search='kansas%20vanpool', May, 2006).

One vanpool drives from Clay Center to Manhattan (40 mi.). All other vanpools in the program have a final destination of Topeka. Origin of trips include Emporia (59 mi.), Holton (33 mi.), Kansas City (60 mi.), Lawrence (27 mi.), Lyndon (32 mi.), Manhattan (58 mi.), Overbrook (27 mi.), St. Marys (179 mi.), and Wamego (44 mi.). Between July and December of 2005, the state of Kansas billed for 165,457 miles for all vanpools (http://www.da.ks.gov/fm/cmp/information/transition/forms/March06VanpoolAccountSheets.xls, May, 2006).

4. Carpooling Programs in Kansas

RideShare in Kansas City is a car-pooling option that offers a free ride-matching service to anyone who works or goes to school within 75 miles of downtown Kansas City. Here's how it works: Prospective carpoolers register with RideShare by calling (816) 842-RIDE or visiting (www.marc.org/rideshare, May, 2006). RideShare will conduct a search in its database of 3,000 commuters and send a match list containing contact information for other prospective carpoolers. Registrants then contact the people on their match lists to make carpool arrangements. Once the carpool is established, members should register it with RideShare to gain eligibility for the Guaranteed Ride Home Program, which provides free emergency taxi rides home to registered carpoolers. Carpoolers can choose the number of days they want to ride together. They can share the driving equally, or one person can do all the driving and get help covering driving expenses. If it is not practical to pick up everyone at home, then carpool members can meet in a public location like a park-n-ride lot and continue their commute together (http://www.marc.org/newsreleases/commuter4-28-05.htm).

The City of Wichita is working to promote the idea of rideshare within individual companies, but does not have a formal program established. It encourages employers to promote incentives for rideshare such as:

- Provide preferential parking for carpools.
- Provide reduced parking fees for carpools.
- Participate in Wichita Transit's discount bus pass program.
- Provide flexible working hours to allow for the formation of carpools.
- Provide advance notice of overtime so employees in carpools may make alternate commuting arrangements.
- Provide time off work to attend rideshare organizational meetings.
- Recognize and commend employees for carpooling or riding the bus.
- Participate in the FTA's Commuter Choice Program, to allow employees a tax-free incentive to commute to work by means other than driving alone.

To better promote the rideshare program, companies in Wichita can:

- Provide Rideshare information and applications in "new hire" employee orientation packets.
- Conduct a commuter survey to determine employee travel patterns.
- Utilize Wichita Transit's free computerized carpool matching service.
- Advertise rideshare and its benefits in a company newsletter.
- Appoint a Transportation Coordinator to assist employees with meeting their transportation needs.
- Conduct raffles and give prizes for ride sharers.
- Establish a transportation information board on which employees may advertise openings in their carpools or their desire to join one.

(http://www.wichita.gov/CityOffices/Transit/Rideshare.htm, May, 2006)

Lawrence to Kansas City Connections.
Currently, there is no formal vanpool program that operates between Lawrence and Kansas City. However, in the summer of 2006, Lawrence will be launching a new service available on the city's transit website called, "Commuter Connection". This is a GIS-based web-program that will serve as a mechanism to link individuals together in Lawrence/Douglas County who are interested in forming informal carpools or vanpools that commute into the KC or Topeka metro areas to save on commuting costs. This new service is a joint venture between the City of Lawrence Transit System, Lawrence/Douglas County Metropolitan Organization (MPO), and Rideshare of the Mid-America Regional Council (MARC) of Kansas City. In addition, the city is interested in

exploring the feasibility of operating inter-city transportation along the K-10 corridor between Lawrence and Johnson County. They have had discussions with KDOT, Johnson County Transit and KU about a possible "Campus Connection" linking the KU Lawrence Campus, KU Edwards Campus and Johnson County Community College. A market analysis is been planned to quantify demand and cost for this service. The analysis also will determine the level of service required (e.g., hours, days, frequency of service and types of vehicles used to operate). Once that is determined a cost analysis can be completed, as well as identifying revenue sources to operate the system.

5. Vanpool Examples from Other States

New Jersey. New Jersey has a state-promoted Vanpool Sponsorship Program which is run by NJ Transit, a transportation services affiliate of the New Jersey Department of Transportation (NJDOT) - (http://www.njtransit.com/db_ep_vanpool.shtml). NJ Transit uses FTA funds to provide eligible vanpools with monthly operating subsidies of $150; these subsidies are divided among each pool's riders. With 144 vanpools and over 1,250 riders in the program, annual subsidy payments total about $260,000 or about $208 per participant per year.

Utah. Utah has UTA Rideshare, which is a quasi-state agency that promotes and provides transportation services in Utah. The Utah Transit Authority (UTA) has two programs that individuals can use to establish and operate vanpools. One program provides vehicles on a lease-basis and one helps individuals purchase vehicles for use in vanpooling (http://www.utarideshare.com/). Under the lease program, UTA uses approximately $540,000 per year in Congestion Mitigation and Air Quality (CMAQ) money to purchase vanpool vehicles. These vehicles are purchased under state contract at prices substantially lower than would be achievable by individual buyers (e.g. $23,000 for a 12-passenger van). UTA then leases these vehicles to groups or individuals for use as vanpools. UTA leases typically cover fuel, insurance, and maintenance.

Connecticut. Easy Street is a statewide commuter vanpool service sponsored by the Connecticut Department of Transportation (http://www.easystreet.org/). The department works with three private, nonprofit companies, which cover various parts of the state to operate its 300-vehicle pool program. CMAQ monies are used to purchase vans and operate the program. Funds are provided basically by an interest-free loan, which is repaid as monthly pool revenues repay the original vehicle purchase price and cover ongoing operating costs. This interest-free feature was important when interest rates were high but it is of virtually no value when commercial rates are low and dealers are offering interest-free financing. The monthly fare for a person traveling a total of 50 round-trip miles each day in a minivan is $112, including fuel. The fare for people traveling the same distance in a 12 or 15 passenger van is $100 per month. Passengers receive a $25-$50 reward for recruiting new passengers. The program also features a traditional guaranteed ride home program.

Michigan. In Michigan, as of June 2005, MDOT had 133 vanpools in operation under its MichiVan program. These pools transported an average of 1,103 riders, up 135 from the preceding quarter. For the quarter, MDOT paid approximately $175,000 to subsidize the operations of these pools plus an additional $73,000 to VPSI to administer the program. Therefore, operational subsidizes equal about $440 per pool per month, or about 46% of the amount required to operate a 50-mile-per-day pool. The cost of the program, including administrative costs, equals approximately $620 per pool per month, or about $75 per rider.

Hawaii. The state of Hawaii has a program very similar to Michigan's. The Hawaii Department of Transportation also contracts with VPSI to run its program and uses CMAQ funds to finance related administrative costs and rider subsidies. Hawaii has approximately 150 vanpools operating in its Vanpool Hawaii program. Monthly fees vary by island. The fee for a person with a 50 mile round-trip commute in a 15-passenger van ranges from $55 to $72, plus fuel (http://www.vanpoolhawaii.com/vanpool/costs/big_isle.htm).

Maine. GO MAINE is a commuter program that has been in operation by the Maine Department of Transportation since the late 1970s (http://www.gomaine.org/vanpool/). MaineDOT is actively involved with the program but it also contracts with the Greater Portland Council of Governments to assist with its implementation and day-to-day operations. As of July 2005, nine pools were operating in the program. Plans call for the addition of three more pools during each of the next five years. MaineDOT uses about $175,000 in federal CMAQ monies and $115,000 in Maine Turnpike revenues each year to finance its GO MAINE program. MaineDOT purchases program vehicles and sets rider fees. Fees are established for each route and do not vary with month-to-month fluctuations in rider numbers. Monthly rider fees are set at a level that is intended to cover the fully allocated cost of running the program's vehicles, exclusive of program administration expenses. The estimated fare for a 50-mile daily round trip is $54 (Kish - 2005).

Idaho. The Idaho Transportation Department provides financial assistance, via FHWA Surface Transportation Program funds, to support four local ridesharing agencies in the state. Assistance totals approximately $67,000 per year and is used by metropolitan planning organizations to promote carpooling and vanpooling and to support ride-matching services (http://itd.idaho.gov/PublicTransportation/aboutus.html); (http://www.ugpti.org/pubs/html/dp-174/pg4.php May, 2006).

6. Bicycle/Pedestrian Program Development to Reduce VMT
*(*Pedestrian and Bicycle Information Center, 2006. http://www.bicyclinginfo.org)

The positive consequences of bicycling and walking can be expressed in terms of the health of as well as the health of individuals who are more physically active. Communities that are conducive to bicycling and walking have demonstrated reduced traffic congestion and improve quality of life. Economic rewards are provided through reduced health care costs and reduced dependency on auto ownership and subsequent reductions in VMT.

Many of the trips that Americans make every day are short enough to be accomplished on a bicycle, on foot or via wheelchair. The 1995 National Personal Transportation Survey (NPTS) found that approximately 40 percent of all trips are less than 2 miles in length – which represents a 10-minute bike ride or a 30-minute walk. A 1995 Rodale Press survey found that Americans *want* the opportunity to walk or bike instead of drive: 40 percent of U.S. adults say they would commute by bike if safe facilities were available.

Bicycling and walking can help to reduce roadway congestion. Many streets and highways carry more traffic than they were designed to handle, resulting in gridlock, wasted time and energy, pollution, and driver frustration. Bicycling and walking require less space per traveler than automobiles. Roadway improvements to accommodate pedestrians and bicycles can also enhance safety for motorists. For example, adding paved shoulders on two-lane roads has been shown to reduce the frequency of run-off-road, head-on, and sideswipe motor vehicle crashes. Finally, a four-mile round trip by bicycle keeps about 15 pounds of pollutants out of the air we breathe. (WorldWatch Institute)

Bicycle/pedestrian facility programs. Bicycle and pedestrian facility funding sources include federal, state, local and private sources. The Transportation Equity Act for the 21st Century, or "TEA-21," the six-year federal transportation funding bill (FY 1998 - FY 2003) authorized $217 billion in Federal gas-tax revenue and other federal funds for all modes of surface transportation, including highways, bus and rail transit, bicycling and walking. More than half of these funds are made available through programs for which bicycling and walking activities are eligible expenditures, however, none of these funds were dedicated solely for bicycle or pedestrian facilities or programs. TEA-21 the successor to "ISTEA," the Intermodal Surface Transportation Efficiency Act provided federal funding for the years 1992-1997 and is viewed as the federal Act that initiated a major policy shift in federal funding priorities making federal funds much more accessible for state and local bicycling and walking facilities and programs. The recently-passed SAFETEA-LU funding bill continues and strengthens this emphasis on funding for bicycling and walking. Among those provisions are requirements to …

In addition to federal funding, every state raises revenue for highway and transportation infrastructure through a state motor-vehicle fuel tax. Some states also raise funds through vehicle licensing fees. In many states, the laws governing how these funds can be spent would make most bicycle and pedestrian projects and programs eligible for these funds, however in other states, use of the funds may be limited to providing paved highway shoulders on state owned and operated roads. Kansas does not have dedicated state funding for bicycle/pedestrian projects.

The following are some examples of dedicated funding for bicycle and pedestrian projects from state transportation revenues:

Oregon. By constitutional amendment, Oregon dedicates 1 percent of state gas-tax revenue to providing improvements for bicycling and walking on state-managed highways. Michigan also has a 1 percent law.

Illinois. Illinois has a long-standing, annual dedication of $1.50 out of the car title transfer tax, for trail and bicycle pedestrian improvements in local communities; raising up to $5 million annually.

California. California annually dedicates $7.2 million from the State Highway Account (gas tax-based) for bicycle transportation improvements, emphasizing projects intended to help bicycle commuters. The money is awarded from the state DOT to cities and counties via a competitive grant program. Maximum grants are $1.8 million. More info at www.dot.ca.gov/hq/LocalPrograms/.

The California state legislature also created the Transportation Development Act, which dedicates .25 percent from the statewide 7.75 percent sales tax to public transit support. The funds are returned to the county of origin where the regional transportation planning agency (often the MPO) may set-aside 2% of the funds for bicycle and pedestrian projects. In San Diego County, where this set-aside has been established, funding levels amount to about $1.7 million per year.

California passed a new state law in 1999 that allocated 1/3 of the federal Hazard Elimination monies (a portion of the 10 percent Safety Set-Aside of Surface Transportation Program funds) to projects that encourage kids to walk and bicycle to school. This amounts to about $20 million annually for the next two years. While this example does not primarily involve use of state revenue, it is a notable state action to further dedicate federal funds.

New Jersey. New Jersey has created a bicycle and pedestrian facility set-aside in its local-aid program by Gubernatorial directive. Municipalities and counties can apply for these funds for local projects. The money comes from the NJ Transportation Trust Fund (mostly state gas taxes and highway toll revenue). Because actual spending of the funds has lagged, and local requests exceed actual awards for projects by several times, advocates are currently pushing for a provision in the Trust Fund reauthorization bill that would require the NJ Department of Transportation to implement 200 miles of bikeways per year during the 4-year life of the new Trust Fund.

New York. The New York State DOT is in the process of creating a grant program for traffic calming projects on Long Island. Towns and villages will apply for the money with specific traffic calming project proposals. The first year of the program will use $3 million of the same federal Hazard Elimination funds.

Indiana. In Indiana, drivers are paying extra for special license plates that benefit greenways, open space, parks and trails. In 1995 about $1.9 million was netted from sale of 75,740 plates. The plates cost an additional $35, of which $25 goes to the Indiana Heritage Trust. Maine and Florida use similar license plate fee add-ons for conservation, parks and bicycle and pedestrian program funding.

Kansas Bicycle/Pedestrian Programs

The Kansas Department of Transportation maintains a Bicycle/Pedestrian program staffed with a half-time coordinator. (http://www.ksdot.org/burRail/bike/default.asp). This office is a member of the team at KDOT working with the Transportation Enhancement program, a federal funding program of SAFETEA-LU, to develop bicycle/pedestrian projects, one of the eligible categories of the Transportation Enhancement Program. The office also provides route and safety information to cyclists in Kansas. As required in SAFETEA-LU, a full-time "Safe Routes to School" coordinator has been designated in KDOT's Bureau of Traffic Safety.

Local Programs in Kansas. There are two communities in Kansas with Bicycle/Pedestrian Coordinators. The Mid-America Regional Council in Kansas City has a full-time bicycle/pedestrian coordinator which include planning and development in Kansas in Wyandotte, Johnson and Leavenworth Counties. The Lawrence/Douglas County Planning Department has a half-time bicycle/pedestrian coordinator position.

MARC promotes walking and bicycling development, supported by the MetroGreen regional greenway plan. Walking and bicycling are supported in the urban environment through MARC's Heartland Sky as alternative transportation modes that help address air quality issues, and through its Creating Quality Places initiative to foster sustainable communities. In addition, MARC supports walking and bicycling through the Transit-Supportive Development initiative focused on finding the proper mix and density of land use to support the region's transit system and to create urban and suburban environments where walking, biking and transit are viable transportation options.

MARC provides a forum to address regional bicycle and pedestrian issues through the Bicycle and Pedestrian Advisory Committee (BPAC), a subcommittee of the Total Transportation Policy Committee (TTPC). (http://www.marc.org/bikeped)

Lawrence. In addition to the half-time bicycle/pedestrian coordination on the Planning Department staff, a seven member Bicycle Advisory Committee appointed by the Lawrence City Commission and Douglas County Commissioners provides a communication linkage between the City Commission and the community on bicycle-related issues. The committee works to improve bicycle safety and awareness through education of motorists and non-motorists; reviews, updates and oversees the distribution of the City's Bike Map; manages the Bicycle Work Program; seeks information from multiple sources on current trends, programs, and facilities outside the local area; and promotes bicycle awareness by coordinating activities with the City, County, the School District, the University of Kansas, and the local bicycle clubs. The BAC makes recommendations to the City Commission concerning issues related to bicycle usage within the community, including:

- location and design of bicycle facilities for all users by integrating bicycle and pedestrian considerations into city projects and plans;
- expenditure of City funds for bicycle facilities and other non-motorized facilities;
- location and design of public streets in relation to bicycle use;
- improvement of bicycle safety and access with minor construction projects and street repairs;
- identification of quick, low-cost improvements on routes that are well used by bicyclists thus creating regular exposure for the program;
- promotion of bicycling by signing selected routes;
- proposal of city resolutions and ordinances concerning bicycle use and safety; and,
- identification and resolution of issues concerning Bicycle-Friendly Community designation.

C. Environmental Implications

Vehicle travel creates unintended consequences that are harmful to the environment as well as a population. Degradation of air quality increases as motor vehicles emit more pollution through fuel combustion.

Table 4
Estimated National Average Vehicle Emissions Rates (Grams Per Mile)
Average of All Vehicles, Gasoline and Diesel

	1997	1998	1999	2000	2001	2002	2003
Exhaust HC	1.43	1.32	1.23	1.15	1.08	0.99	0.91
Nonexhaust HC	0.96	0.94	0.91	0.88	0.85	0.81	0.77
Total HC	2.4	2.25	2.14	2.04	1.93	1.8	1.68
Exhaust CO	24.9	23.4	22	20.94	20.2	19.42	18.27
Exhaust NO_x	3.18	3.12	3.02	2.91	2.78	2.65	2.48
VMT in US (Millions)	2,562,000	2,632,000	2,691,000	2,747,000	2,797,000	2,856,000	2,891,000

KEY: CO = carbon monoxide; HC = hydrocarbon; NO_x = nitrogen oxide; RFG = reformulated gasoline.

Source: (http://www.bts.gov/publications/national_transportation_statistics/2004/html/table_04_38.html, June, 2006)

Table 5
Estimated National Average Vehicle Emissions Rates (Grams Per Year)

	1997	1998	1999	2000	2001	2002	2003
Exhaust HC	3,663,660	3,474,240	3,309,930	3,159,050	3,020,760	2,827,440	2,630,810
Nonexhaust HC	2,459,520	2,474,080	2,448,810	2,417,360	2,377,450	2,313,360	2,226,070
Total HC	6,148,800	5,922,000	5,758,740	5,603,880	5,398,210	5,140,800	4,856,880
Exhaust CO	63,793,800	61,588,800	59,202,000	57,522,180	56,499,400	55,463,520	52,818,570
Exhaust NOx	8,147,160	8,211,840	8,126,820	7,993,770	7,775,660	7,568,400	7,169,680

Source: (http://www.bts.gov/publications/national_transportation_statistics/2004/html/table_04_38.html, June, 2006)

Although the trend for vehicle miles traveled is consistently rising each year, the United States has been able to reduce the amount of vehicle emissions rates on average for all vehicles. However, reduction in vehicle miles traveled could have a large impact on continuation of decreased vehicle emissions.

Water quality can also be affected from air pollutants as a result of vehicle emissions. It is estimated that major East Coast estuaries have had an increase from 5 percent to 50 percent in atmospheric nitrogen input. Greenhouse gas emission threatens to alter the earth's atmosphere since ecosystems cannot keep up with the elevated levels of gases. Noise pollution related to vehicle travel has been estimated to have an annual social cost ranging from $2.7 to $9 billion. Other environmental impacts include about 1.6 million gallons of oil spilled in U.S. navigable waters in 1996 and leaking underground storage tanks estimated to create health costs around $0.12 to $0.59 billion annually.

A study was performed in Portland and Bend, Oregon to analyze the reduction of vehicle miles traveled in single occupancy vehicles. Customized programs were distributed to approximately 100 households emphasizing non-work reduction of VMT and SOV. Sixty four percent (64%) of participants had a reduction in VMT while 50 percent had a reduction in non-work related VMT. The average non-work related savings was 4 percent. A total of non-work related VMT was reduced by 38,494 miles per year for an average of 356 miles a year per household. If you use 25 miles per gallon for vehicles used, the savings relates to 1539.76 gallons of gas per year and 14.24 gallons of gas per household per year.[1]

1 http://www.empowermentinstitute.net/files/VMT_study.html

Table 6
Emission and Gas Savings from a Sample of Carpool from the EPA[2].

Pollutant Problem	**Amount Saved**	**VMT Reduced/Year**	**Pollution Reduced or Fuel Consumption Saved/Year**
Hydrocarbons (Urban ozone [smog] and Air Toxics)	3.5 grams/mile	10,000	77 lbs of HC
Carbon Monoxide (Poisonous gas)	25 grams/mile	10,000	550 lbs of CO
Nitrogen Oxides (Urban ozone [smog] and Acid Rain)	1.5 grams/mile	10,000	33 lbs of NOx
Carbon Dioxide (Global warming)	1.0 pound/mile	10,000	9,900 lbs of CO2
Gasoline	0.05 gallon/mile	10,000	500 gallons gasoline

D. Economic Implications

A 2000 analysis of household transportation expenditures in 28 metropolitan areas found that transportation expenses are greater in low-density areas with few alternatives to the automobile. The study found that families living in low-density areas pay roughly $1300 more per year in transportation expenses than families in compact, mixed use areas[3].

The United States consumed an estimated 20.6 million barrels of petroleum products per day in March 2005, among which 13 million barrels were imported (EIA 2005): an estimated cost of over $3 billion a week. Regardless of the perverse effect that better fuel economy may induce the public to travel more vehicle miles and consequently increase the costs of the associated issues such as congestion and safety, improved fuel efficiency yields economic benefits and may mitigate the dependency of U.S. on energy imports. It is estimated that when both cars and light trucks increase their gas mileage by 3.8 mpg, an overall fuel consumption saving of 10% would be expected, which is estimated as a monetary saving of $3.6 billion per year (Congressional Budget Office, 2003). The California Energy Commission estimates a net effect of reducing light-vehicle fuel consumption by 4% by 2020, saving California drivers $1.3 billion in direct non-environmental costs (which would scale to ~$11 billion nationwide) in present value[4].

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2 http://www.epa.gov/rtp/transportation/carpooling/emissions.htm

3 http://www.transact.org/report.asp?id=36

4 Lovins, A. B., Datta, E. K., Bustnes, O., Koomey, J. G., and Glasgow, N. J. (2005). *Wining the Oil Endgame*. Rocky Mountain Institute

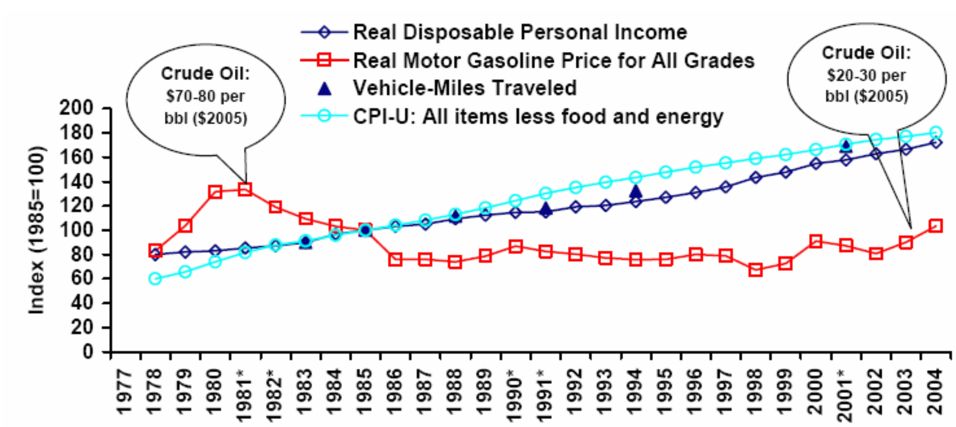
The projected cost for the I-35 Commuter Rail Project is more than $100 million. As of March 2004, the total amount of available federal funds was $4,460,714 and the required local match for those funds was $1,115,179, for a total of $5,575,893.

MAX has been created through a cooperative effort between KCATA and the City of Kansas City, Missouri. The budget for creating MAX is $21 million, with $16.8 million in federal funding and $4.2 million in local funding.

E. User Values and Behavior Implications

The price of gasoline is one factor that can have an effect on the number of highway vehicle miles traveled (VMT). Figure 4 below provides annual indices of VMT against real disposable personal income, real motor gasoline prices and the consumer price index. The figure illustrates the price of crude oil at $70-$80 per bbl in 1979 (2005 dollars), compared to $20-$30 per bbl in 2003 (2005 dollars). Vehicle miles traveled has shown a close relationship to the consumer price index and real disposable personal income.

Figure 4
Annual Indices of Real Disposable Income, Vehicle-Miles Traveled, Consumer Price Index (CPI-U), and Real Average Retail Gasoline Price, 1978-2004, 1985=100



Sources: Energy Information Administration, Annual Energy Review 2004; Bureau of Economic Analysis
*Note * = recession year.*

http://www.eia.doe.gov/emeu/rtecs/nhts_survey/2001/imagees02.html

F. Current Policy Framework

Sections of the Clean Air Act (CAA), the 1993 Climate Change Action Plan (CCAP), and the Congestion Mitigation Air Quality (CMAQ) Improvement Program made the reduction of VMT an official goal of the United States Government policy.

The Corporate Average Fuel Economy (CAFE) specifies fuel economies for all new cars and light trucks sold in the United States. This set standard fuel economy at 27.5 miles per gallon for cars and 20.7 miles per gallon in light trucks.

<u>State Tax Incentives for Commuters</u>

Oregon.
In the state of Oregon, there are tax credits that have been set up for businesses that take part in VMT reduction programs. One incentive is the purchase of bicycles or equipment used to store bicycles so that riders will reduce miles driven a minimum of 45 working days per calendar year. A car-sharing project is a program in which drivers pay to become members in order to have joint access to a fleet of cars, not including car rental agencies. A commuter pool vehicle is a vehicle that is purchased for the purpose of transporting two or more riders to reduce VMT at least 150 days a year. This program is used in communities with populations smaller than 50,000. It is also possible for the state to reimburse the cost of providing transportation services for employees based on the average cost per rider multiplied by the total number of trips provided. Rather than hand out parking permits, companies can be encouraged to give transit passes to their employees.

In April of 2004, a bill was signed into law that maintains the existing vanpool program in Kansas. The program currently operates with 20 large state vans that transport about 250 people between Topeka, Lawrence, the Kansas City area, and other locations.

ISSUE/TOPIC: Mass transportation (including light rail) as a strategy to reduce VMT

A. Topic / Issue Description

In 1999, the transportation sector accounted for 27 percent of energy consumed in the state of Kansas[5]. One way to reduce the amount of energy consumed in the transportation sector is to reduce the amount of vehicle miles traveled. One way of reducing vehicle miles traveled and overall energy used is to provide mass transportation in urban environments. Mass transportation can help reduce emissions as well as congestion on roadways.

Table 1
Vehicles and Conveyances in the U.S.
2005[6]

Vehicles	**Number**
Automobiles registered	826,000
Light trucks registered (Trucks over 10,000 pounds gross vehicle weight rating, including single-unit trucks and truck tractors)	1.3 million
Heavy trucks registered	27,000
Buses registered (Large motor vehicle used to carry more than 10 passengers, includes school buses, inter-city buses, and transit buses)	3,900
Motorcycles registered (A two- or three-wheeled motor vehicle designed to transport one or two people, including motor scooters, mini bikes, and mopeds)	50,000
Numbered boats	103,000

Table 2
Work Commute in the U.S. and Kansas

	Percentage of Workers	
Commuting Mode	**United States**	**Kansas**
Car, truck, or van—drove alone	77.7	82.6
Car, truck, or van—carpooled	10.1	8.8
Public transportation (including taxi)	4.6	0.4
Walked	2	2.8
Other means	1.8	1.1
Worked at home	3.8	4.3

5 http://www.kansasenergy.org/Testimony2003/page2.html (1-24-03)
6 http://www.bts.gov/publications/national_transportation_statistics/2005/html/appendix_d.html

B. Existing Policies / Programs

1. There are five organizations in the state of Kansas that currently offer mass transit in urbanized areas to the public. They include The Jo in Johnson County, the Lawrence Transit System, the Topeka Metropolitan Transit Authority, the Wichita Transit, and the Reno County Area Transit. The Kansas City Area Transportation Authority also has routes that run on both the Missouri and Kansas side of the border within Kansas City.

2. In July of 2005, the Kansas City Area Transportation Authority incorporated bus rapid transit (BRT) into the Kansas City metro area. The route runs north-south with 26 stops including 4 that are only northbound and 4 that are only southbound. Fewer stops allow for faster commutes and global positioning satellite (GPS) technology at the bus stops allows the riders to have instant and constantly updated access to the exact arrival time of each bus.

3. A state vanpool program transports about 250 people daily. One trip runs from Clay Center to Manhattan while all other trips have a destination of Topeka and originate in Emporia, 3 in Holton and Kansas City, 8 in Lawrence, Lyndon, Manhattan, Overbrook, St. Mary's, or Wamego.

4. The only passenger rail in the state of Kansas is through Amtrak. Kansas is serviced by the Southwest Chief, which runs between Los Angeles, CA and Chicago, IL. Boarding/deboarding takes place at: Lawrence, Topeka, Newton, Hutchinson, Dodge City, and Garden City.

5. Rural public transportation services operate in most counties in the state. Many of these services are operated by private non-profit agencies under contract to the Kansas Department of Transportation. Agencies receive operating and capital assistance on a match basis. No administrative assistance funding is provided. The primary ridership groups of these programs are elderly and persons with disabilities, although all must be open to the general public.

6. Bicycle and pedestrian programs exist in some parts of the state to encourage greater mode share for bicycle and walking trips. These programs include development of facilities, education and public awareness.

C. Policy / Program Proposals

1. I-35 Fixed Guideway Project

(a) Description

A feasibility study completed in September of 1995 found that it is technically feasible to utilize the existing railroad line in the I-35 corridor for commuter rail.

(b) Implications of Program Implementation

Pros:

The Mid-America Regional Council (MARC) has recommendations that include the development of commuter rail along I-35 from Olathe to Union Station, and are included as part of the Kansas Comprehensive Transportation Program (CTP).

Commuter rail would help alleviate traffic along I-35, which during peak periods is often running at a Level Of Service of D or worse.

Additional widening of I-35 is not seen as being feasible, therefore, using commuter rail allows for an option with the existing right of way.

Cons:

Large efforts will have to be invested into continual scheduling of lines to deal with commercial use from Burlington Northern Santa Fe (BNSF).

BNSF has stated support of the project if their infrastructure demands are met. They have estimated that the cost to upgrade the rail and signal infrastructure would be approximately $60 million, making the overall cost of the proposed project exceed $100 million.

2. Park and Ride Facility Development

(a) Description

Park and ride programs allow for commuters to meet at a designated location, leave their vehicle and either get on a form of public transportation or to carpool with other commuters to work. KCATA has 37 park and ride locations along various bus routes throughout Kansas City. Some parking lots along the I-70 Turnpike are present, but no formal program exists for the promotion of park and ride facilities.

(b) Implications of Program Implementation

Pros:

Park and ride will allow for reduced congestion on highways and roadways by increasing the occupancy of vehicles on the road.

Carpooling causes a reduction in fuel consumption that leads to reduction in costs of driving.

Park and ride facilities allows vanpooling, carpooling and public transit to be more feasible to support mobility in lower density areas.

Cons:

Parking facilities need to be present for the park and ride system to work. If shopping centers are used, the park and ride participants take away parking from the customers of the local shops.

Shopping center owners are not always amenable to allowing their parking lots to be used for the park and ride purpose nor are they always willing to have larger urban transit buses enter their parking lots for regular service due to perceived wear and tear on the parking lots.

Park and ride is on a first come first serve basis and participants can still be forced to drive themselves when the parking lots fill up early.

3. Public and Private Vanpool Program Development

(a) Description

Vanpools are usually a more formal arrangement among a larger number of interested people than are carpools. If a worker commutes more than 15 miles from home to work each way, the cost savings from joining a vanpool may offset the time involved for multiple pickups and drop-offs.

The public benefit to increased use of vanpools are reduced commuter congestion, reduced energy consumption and related emissions and pollution, and additional mobility options for a segment of the workforce that may not have adequate transportation to and from work. The benefit to employers that promote vanpools are a reduced investment in employee parking facilities. Employee benefits include reduced commuting costs and reliable transportation to and from work.

States that promote vanpool development as an option to reduce VMT to reduce congestion and emissions typically may establish an option to promote commuter options such as vanpools and carpools. The office usually is staffed by a coordinator and may provide subsidy for establishing pools to reduce costs to individual riders as an incentive to participate and to offset perceived inconveniences of vanpooling.

Pros:

Each vanpool established removes up to 14 cars from peak hour travel, reducing fuel consumption and emissions.

Reduced costs associated with building parking facilities, either surface lots or parking garages, particularly in congested downtown environments.

Supports the work force by providing additional mobility options to individuals who may not have reliable transportation for work trips.

Good option in areas that are less dense and are not served as well by public transit.

Cons:
Less convenient to individuals. Education and marketing often is needed to encourage participation.

Public policy decisions about cost allocation; i.e., it is appropriate to use public subsidy to encourage use of vanpools which provide individual benefit but also provide a public benefit?

4. Emphasis on and Coordination of Bicycle and Pedestrian Programs and Facility Development

(a) Description

Communities that are conducive to bicycling and walking have demonstrated reduced traffic congestion and improve quality of life. Economic rewards are provided through reduced health care costs and reduced dependency on auto ownership and subsequent reductions in VMT.

Many of the trips that Americans make every day are short enough to be accomplished on a bicycle, on foot or via wheelchair. The 1995 National Personal Transportation Survey (NPTS) found that approximately 40 percent of all trips are less than 2 miles in length – which represents a 10-minute bike ride or a 30-minute walk. A 1995 Rodale Press survey found that Americans *want* the opportunity to walk or bike instead of drive: 40 percent of U.S. adults say they would commute by bike if safe facilities were available.

States with a well-developed bicycle/pedestrian program are likely to employ at least a full-time coordinator with funding, education, marketing, and technical support to local communities.

(b) Implications of Program Development

Pros:
Potential for reduction of VMT, subsequent emissions, and use of petroleum.

Healthier population associated with benefits of bicycling and walking.

Cons:
Challenges of education of general public to use alternate modes.

Lack of adequate existing infrastructure in the state: additional bike lanes, paths trails, sidewalks and multi-use paths need to provide for safe environment for cyclists and walkers. Sometimes, politically challenging to develop bike/ped facilities, which may be seen to be in competition with highway development.

Difficult to use as a year-round trip reduction strategy in Kansas due to winter weather conditions.

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APPENDIX I

Sample Cost Estimate For
Traffic Signal Modernization at a Typical 4-legged intersection without protected phasing scheme

	Item Description	Unit	Quantity	Unit Price	Total
	Traffic Signal System				
	INTERSECTION DESIGN:				
1	2" Conduit in trench	L.F.	510	$20.00	$10,200.00
2	3" Conduit in trench	L.F.	65	$25.00	$1,625.00
3	4" Conduit in trench	L.F.	227	$30.00	$6,810.00
4	2" Conduit in existing trench	L.F.	200	$10.00	$2,000.00
5	3" Conduit in existing trench	L.F.	292	$15.00	$4,380.00
6	4" Conduit in existing trench	L.F.	165	$20.00	$3,300.00
7	Pull box, Type I	Each	4	$900.00	$3,600.00
8	Pull box, Type III	Each	1	$1,500.00	$1,500.00
9	Concrete Base, Type B8	Each	4	$1,250.00	$5,000.00
10	Concrete Base, Type 332	Each	1	$1,200.00	$1,200.00
11	20 ft Mast Arm Pole	Each	2	$4,500.00	$9,000.00
12	28 ft Mast Arm Pole	Each	1	$5,000.00	$5,000.00
13	28 ft Mast Arm Pole with 10 ft luminaire arm	Each	1	$5,250.00	$5,250.00
14	400W 240V H.P.S. Type III Cobra Head Luminaires	Each	1	$350.00	$350.00
15	7c#14 Stranded Wire	L.F.	1,382	$2.25	$3,109.50
16	5c#14 Stranded Wire	L.F.	1,141	$2.00	$2,282.00
17	2c#14 Stranded Wire	L.F.	1,090	$1.75	$1,907.50
18	3c#10 Stranded Wire	L.F.	53	$2.00	$106.00
19	3c#8 Type U.S.E.	L.F.	174	$2.25	$391.50
20	3c#2 Type U.S.E.	L.F.	525	$2.50	$1,312.50
21	Traffic Signal Heads, 3 section, 12 Inch, LED	Each	12	$700.00	$8,400.00
22	Pedestrian Signal Heads, 12" LED Man and Hand	Each	8	$600.00	$4,800.00
23	Pedestrian Push Buttons with Signs	Each	8	$150.00	$1,200.00
24	2070L Controller System, supply & install, including Cabinet	Each	1	$12,000.00	$12,000.00
25	2070L Controller Software Econolite, per spec's, supplied by the City.	Each	1	$600.00	$600.00
26	Full Video Detection System, including Cables	Each	4	$5,000.00	$20,000.00
27	Supply and install Meter Can & Breaker Box	Each	1	$500.00	$500.00
28	Remove Poles, Guy Wires, Cables and Arms	Each	10	$150.00	$1,500.00
29	Remove Signal Heads including Pedestrian Heads	Each	8	$75.00	$600.00
30	Remove Pull Boxes	Each	1	$200.00	$200.00
31	Remove Controller & Cabinet	Each	1	$250.00	$250.00
32	Street Name Sign on Mast Arm	Each	4	$500.00	$2,000.00
33	Regulatory Signs	Each	2	$350.00	$700.00
	TEMPORARY TRAFFIC CONTROL				
34	Arrow Display Panel Type A	Each	1	$500.00	$500.00
35	Barrels	Each	25	$50.00	$1,250.00
36	Construction Area Signs	S.F.	121	$20.00	$2,420.00
	TOTAL BID (Items 1 through 36)				**$125,244.00**

OVERVIEW: ALTERNATIVE-FUELED VEHICLES

Alternative fuels offer the potential to reduce consumption of petroleum-based fuel and reduce the amount of harmful vehicle emissions. Vehicle life cycle must be analyzed in order to measure how well alternative fuels accomplish these benefits. Vehicle life cycle includes the resources to manufacture and distribute alternative fuel, manufacture the vehicle, operate the vehicle using alternative fuel, and retire the vehicle.

A. Technology Trends

Hydrogen fuel offers the greatest opportunity to reduce petroleum consumption and harmful vehicle emissions; however, it faces serious technological roadblocks. Hydrogen engines are significantly more efficient than conventional engines and their only emissions are heat and water vapor. Many questions remain on how to properly and cost effectively distribute, store, and produce hydrogen. Furthermore, hydrogen fuel and vehicles are very expensive. Years of research and development are anticipated before hydrogen vehicles can begin to make an impact. Experts estimate this time period to be 10-20 years. On the other hand, it is well understood how to produce, distribute, and store compressed natural gas, ethanol, liquefied petroleum gas, bio-diesel, and electricity. The challenge is to use technology to reduce their price. Tables 1 and 2 show alternative fuel characteristics.

Table 1
Alternative Fuel Characteristics

Fuel	Price (September 2005)	Energy Content (British Thermal Units, BTU)	Fuel Source	Disadvantages	Advantages
Compressed Natural Gas	$2.12/gal	33,000 – 44,000	Underground Reserves	- Smaller vehicle range - Higher vehicle purchasing costs - Periodic inspection of fuel tanks - Higher fuel cost per energy unit than gasoline and diesel fuel	- Improved emissions - Lower maintenance costs - Domestically produced
Ethanol (E85)	$2.41/gal	80,000	Corn, sugar cane, grains, and grasses	- Smaller vehicle range - May corrode metallic vehicle components - May degrade rubber vehicle components - May require special lubricants - Higher fuel cost per energy unit than gasoline and diesel fuel	- Improved vehicle emissions - Domestically produced - Petroleum replacement
Liquefied Petroleum Gas	$2.56/gge (gasoline gallon equivalent)	84,000	Petroleum By-Product	- Smaller vehicle range - Higher vehicle purchasing costs - Higher fuel cost per	- Improved emissions - Lower maintenance costs

				energy unit than gasoline and diesel fuel	
Gasoline	$2.77/gal	109,000 – 125,000	Crude oil		
Diesel	$2.81/gal	128,000 – 130,000	Crude oil		
Bio-diesel (B20)	$2.91/gal	117,000 – 120,000	Soybean oil, Rapeseed oil, waste cooking oil, animal fats	- May degrade rubber components in vehicles manufactured before 1992 - Slightly higher fuel cost per energy unit than gasoline and diesel fuel	- Improved vehicle emissions - Little or no vehicle modifications - Domestically produced - Petroleum replacement - Few engine deposits
Bio-diesel (B100)	$3.40/gal	Not Available, but less than B20	Soybean oil, Rapeseed oil, waste cooking oil, animal fats	- May degrade rubber vehicle components in vehicles manufactured before 1992 - Vehicles may become more difficult to start in cold weather - Higher fuel cost per energy unit than gasoline and diesel fuel	- Improved vehicle emissions - Domestically produced - Petroleum replacement - Fewer engine deposits
Electricity	Less than gasoline	Not Available	Coal, Nuclear	- Much smaller vehicle range	- Lower maintenance costs - Easier to control emissions at power plants - Petroleum replacement
Hydrogen	Not Available	Not Available	Natural Gas, Methanol, Water	- Being researched	- Being researched

Table 2
Energy Content per Dollar of Fuel (September 2005)

Fuel	**Energy Content (BTU) Per Dollar of Fuel using September 2005 Fuel Costs**
Diesel	45,900
Gasoline	42,200
Bio-diesel (B20)	40,700
Ethanol (E85)	33,200
Liquefied Petroleum Gas	32,800
Compressed Natural Gas	18,200
Bio-diesel (B100)	Not Available, but less than B20
Electricity	Not Available
Hydrogen	Not Available

1. Bio-diesel: This is a diesel replacement fuel made from specially-processed plant oils and animal fats. Rapeseed and soybean oil are most commonly processed into bio-diesel.

Blends of up to 20% bio-diesel, 80% conventional diesel (B20) can be used in nearly all diesel equipment without engine modification. Pure bio-diesel (B100) can be used, but may require engine modifications.

Bio-diesel costs more per gallon than diesel fuel. The higher the percentage of bio-diesel in the blend, the greater its cost. Bio-diesel has higher lubricity and leaves fewer engine deposits than diesel fuel. It also acts as a solvent to help loosen/remove existing engine deposits and can break down rubber components in vehicles manufactured before 1992. Vehicles switching to bio-diesel may experience fuel filter clogging due to freed engine deposits and a very small decrease in fuel efficiency and power. Finally, bio-diesel tends to gel when temperatures fall below 40 degrees Fahrenheit. This makes starting vehicles more difficult.

Algae can be used to produce biodiesel and by some estimates can produce much more biodiesel than current crops. The per unit area yield of biodiesel oil from algae is estimated to be 7 to 31 times greater than the next best crop, palm. The difficulty using algae is finding algae with a high oil content and fast growth rate that is relatively easy to harvest. Algae-oil processes into biodiesel as easily as oil derived from land-based crops.

Table 3 shows the amount of oil per acre, by plant type, that can be used in bio-diesel production. By analyzing Table 3, it is clear that soybeans as a source of biodiesel is the least productive option of the sources identified.

Table 3
Bio-diesel Oil Production by Plant

Plant	Usable Oil Per Acre
Soybean	40 to 50 gal/acre
Rapeseed	110 to 145 gal/acre
Mustard	140 gal/acre
Palm oil	650 gal/acre
Algae	10,000 to 20,000 gal/acre

Note. It takes about 7.3 pounds of soybean oil to produce a gallon of bio-diesel.
Sources: http://www.oregonbiofuels.com/cost.htm, April 2006.
http://en.wikipedia.org/wiki/Biodiesel, April 2006.

2. Liquefied Petroleum Gas (LPG): This is a by-product of two sources: natural gas processing and crude oil refining. The components of LPG are gases at normal temperatures and pressures, thus the mixture must be liquefied and stored onboard vehicles in pressurized gas tanks. Almost all propane used in the U.S. comes from domestic sources.

   Based on a gasoline gallon equivalent of energy, LPG costs about the same as gasoline. LPG vehicles have similar power, acceleration, and cruising speeds when compared to gasoline vehicles. However, they have a shorter range, about 25% less than a gasoline vehicle. This can be overcome somewhat by adding fuel tanks, but fuel tanks add weight and take up space. Vehicles typically cost $1,000 – $2,500 more to purchase. Furthermore, LPG burns more cleanly than gasoline and diesel fuel, thus LPG vehicles tend to have lower maintenance costs due to less engine wear and tear.

3. Natural Gas: Natural gas is found in conjunction with crude oil production, in underground deposits, landfills, and at sewage treatment plants. It is stored onboard vehicles as either compressed natural gas (CNG) or liquefied natural gas (LNG). CNG is generally used in smaller vehicles such as passenger cars, while both CNG and LNG are used in larger vehicles such as buses. Compared with gasoline and diesel vehicles, natural gas vehicles have safer fuel tanks. Their tanks are thicker and stronger.

   Based on a gasoline gallon equivalent of energy, natural gas costs significantly less than gasoline. Equipping a vehicle to operate on CNG costs between $4,000 and $6,000. In addition, natural gas vehicles have a shorter range, about half that of a gasoline vehicle. This problem can be somewhat remedied by adding fuel tanks, however, tanks take up additional space and add weight. Finally, natural gas burns more cleanly than gasoline and diesel fuel, thus natural gas vehicles tend to have lower maintenance costs due to less engine wear and tear.

4. Ethanol: This is an alcohol-based fuel commonly used to increase octane and improve the emission quality of gasoline. In a purer form it can be used as a gasoline alternative. It can be produced from any biological feedstock that contains significant amounts of sugar or materials that can be converted into sugar. Corn, sugar beets, barley, and wheat are common sources of ethanol. Ethanol can also be produced from "cellulosic biomass" such as trees, grasses, industrial wastes (paper sludge), and municipal waste (waste paper). Ethanol production from biomass has several advantages over corn-based ethanol including: production near end-users, waste remediation, and reduction of the effect of corn prices on ethanol prices.

   Based on a gasoline gallon equivalent of energy, ethanol costs more than gasoline. Ownership and maintenance costs are very similar to gasoline vehicles plus few modifications are necessary to operate a vehicle on ethanol. Ethanol vehicles have a shorter range; range is about 29 percent less than a gasoline vehicle. Some automobile manufacturers have claimed that ethanol content higher than 10% when used in non-modified petroleum engines can cause corrosion of metallic fuel system compounds and premature degradation of plastic or rubber components (http://www.collegesonline.tased.edu.au/Energy/Ethanol/EthanolCaseStudy.htm)

5. Hydrogen (Fuel Cell): A fuel cell produces electricity from the reaction between hydrogen and oxygen. When powered by pure hydrogen, the only by-products of the reaction are heat and water. The heart of a fuel cell is a fuel cell stack, which is made of many thin, flat cells layered together. Each cell produces electricity. Experts estimate that in approximately 10-20 years hydrogen vehicles, and the infrastructure to support them, will start to make an impact. A major obstacle to this is producing and storing pure hydrogen. All hydrogen is found bound with other elements. Therefore, in order to use hydrogen as a fuel, hydrogen must be removed/isolated from current elements such as

water and natural gas. Also, at room temperature hydrogen is not dense, thus it has a low energy-per-volume ratio. This means that to store/transport large amounts of hydrogen it must be compressed which takes energy and requires expensive fuel tanks, cooled to a liquid which takes energy and has evaporation problems, or some other method.

6. Electric Powered: Electric vehicles run on batteries. Batteries are replenished by an on-board charger or by plugging the vehicle into an electrical source. In-home charging can take as long as 8 hours. High-power, fast-charging equipment can reduce charging time to 2-4 hours. Electric vehicles have significantly lower fuel costs per mile than gasoline vehicles. However, electric vehicles cost significantly more to purchase and take numerous hours to recharge. They have limited range, typically a third that of a gasoline vehicle. Electric vehicles are well suited to short-distance, high-use applications—those that demand frequent starts and stops. Even though batteries must be replaced every three to six years, maintenance costs are less than gasoline and diesel vehicles due to fewer moving parts.

7. Hybrid: Hybrid vehicles use multiple fuel sources. Usually they have a gasoline or diesel engine and an electric battery-powered motor. Modern hybrids are not plugged into an electricity source; they recharge their batteries while braking, cruising, and idling.

B. Current Infrastructure / Management Framework

Hydrogen is the only alternative fuel without an extensive storage and distribution system. Research is being conducted to solve problems in these areas. Much like gasoline and diesel fuel, liquefied petroleum gas, bio-diesel, ethanol, and natural gas are delivered to retailers through a pipeline and tanker truck system. Although adding additional capacity may be an issue, few technical barriers restrict the enlargement of these distribution systems. Table 4 shows distribution characteristics of eight alternative fuels.

Table 4
Fuel Distribution Characteristics

Fuel	Difficulty of adding fuel to current retail fueling stations	Current Distribution system
Compressed Natural Gas	Difficult	Extensive
Ethanol	Not Difficult	Extensive
Liquefied Petroleum Gas	Difficult	Extensive
Bio-diesel (B20)	Not Difficult	Extensive
Bio-diesel (100)	Not Difficult	Extensive
Electricity	Somewhat Difficult	Extensive
Hydrogen	Very Difficult	Very Limited
Hybrid	N/A	Extensive

Kansas contains no bio-diesel manufacturing plants. Bio-diesel is purchased from suppliers in states such as Iowa. Once the bio-diesel arrives in Kansas it is blended with diesel fuel based on customer requirements. Kansas contains seven ethanol production plants and one under construction. These plants are located in Russell, Campus, Garnett, Colwich, Garden City, Atchison, and Leoti. Table 5 shows the capacity of these plants.

Table 5
Kansas Ethanol Production
2005

Plant Location	Yearly Output (million gallons per year)
Russell	46
Campus	41
Phillipsburg (under construction)	40
Garnett	35
Colwich	25
Garden City	12
Atchison	9
Leoti	1.5

Source: http://www.ksgrains.com/ethanol/kseth.html, April 2006

1. Bio-diesel: Bio-diesel is chemically very similar to conventional diesel, and could be placed in the existing diesel distribution system with only a few modifications. However, bio-diesel is a more effective solvent than conventional diesel, thus can cause deterioration of rubber and polyurethane materials (e.g. seals).

2. Liquefied Petroleum Gas: LPG is delivered to retailers through a pipeline and tanker truck system. Therefore, an expansion of the LPG supply infrastructure would face few technical barriers. Because the fuel must be kept under pressure, special equipment is required to transfer LPG to vehicles.

3. Natural Gas: An extensive natural gas supply system exists. However, because the technology differs significantly from a gasoline pump, vehicle users or station operators would need to be trained in the use of natural gas pumps. Consumers could fuel their vehicles overnight using in-home slow-fill refueling systems.

4. Ethanol: There is substantial experience with storing and delivering ethanol. Tanker trucks deliver ethanol to terminals for blending with gasoline.

5. Hydrogen (Fuel Cell): There is very little infrastructure for hydrogen production, delivery, and storage.

6. Electric: There are few technical barriers to expanding electric vehicle recharging sites. However, with existing technology, only a few vehicles can access a single charger in one day.

7. Hybrid: Hybrids use the current gasoline and diesel fuel infrastructure.

C. Environmental Implications

Alternative fuel powered vehicles emit fewer harmful emissions than conventional vehicles. When analyzing the environmental effects of a fuel, one must keep in mind the entire process of production, distribution, and consumption. For example, corn plants recycle atmospheric carbon before being processed into ethanol, while previously sequestered underground carbon is released into the atmosphere after gasoline and diesel fuel is burned.

The potential environmental performance of hydrogen fuel could exceed all other alternative fuels. Fuel cells are significantly more efficient than conventional engines, and the only emissions from hydrogen fuel cells are heat and water vapor. However, depending on how hydrogen is produced, fuel cycle emissions from the production of hydrogen fuel could diminish the environmental benefits of the fuel cell. Similarly, electric vehicles have zero emissions, but the power plant that supplied the electric vehicle with electricity has emissions. In spite of that, harmful emissions from electric vehicles are still lower than conventional vehicles. For ethanol and bio-diesel, both of which are mixed with petroleum fuel, the higher the percentage of ethanol or bio-diesel in the fuel, the better the vehicle emissions. Table 6 shows the effectiveness of eight alternative fuels to reduce harmful emissions.

Table 6
Reduction of Emissions Compared to Gasoline

Fuel	Carbon Monoxide	Particulate Matter	Nitrogen Oxide	Volatile Organic Compounds
Compressed Natural Gas	Yes	Yes	Yes	Yes
Ethanol (E85)	Yes	Yes	Yes	Yes
Liquefied Petroleum Gas	Yes	Not Available	Yes	Yes
Bio-diesel (B20)	Yes	Yes	No	Yes
Bio-diesel (100)	Yes	Yes	No	Yes
Electricity	Yes	Yes	Yes	Yes
Hydrogen	Yes	Yes	Yes	Yes
Hybrid	Yes	Yes	Yes	Yes

Note: The higher the percentage of bio-diesel and ethanol in the blend, the greater the effect on vehicle emissions.
Source: http://www.eere.energy.gov/afdc/about.html, April 2006

1. Bio-diesel: The use of bio-diesel blends of 20 percent or higher leads to substantial reductions in harmful emissions. The higher the percentage of bio-diesel in the fuel the better the emissions. Bio-diesel substantially reduces volatile organic compounds, carbon monoxide, and particulate matter emissions (small solid and liquid particles suspended in air). Nitrogen oxide emissions may increase slightly. Also, pure bio-diesel contains no sulfur, thus reduces sulfur dioxide emissions to virtually zero.

The total weight of particulate matter emissions released from vehicles using bio-diesel is less than those released from vehicles using diesel fuel. However, research has shown that vehicles using bio-diesel have a larger number of particulate matter emissions with small diameters. The smaller the diameter of particulate matter the more easily they can be inhaled deeply into the lungs, where they can be absorbed into the bloodstream or remain embedded for long periods of time. Particulate matter is especially harmful to people with lung diseases such as asthma, pneumonia, and emphysema.

The growth of bio-diesel feedstock removes carbon dioxide from the environment. However, production and distribution releases greenhouse gases. Research has shown that bio-diesel results in a reduction of life-cycle emissions of carbon monoxide by approximately 50% and carbon dioxide by 78%.

Bio-diesel can be made from various sources. Table 7 ranks three harmful emissions from heavy-duty vehicles based on the source of the bio-diesel. The lower the ranking, the better the emissions.

Table 7
Ranking of Heavy-Duty Vehicle Emission Based on Source of Bio-Diesel
(The lower the ranking, the lower the emission)

	Nitrogen Oxide	Particulate Matter	Carbon Monoxide
Soybean-based biodiesel	3	2	3
Rapeseed-based biodiesel	2	2	2
Animal-based biodiesel	1	1	1

Source: EPA. http://www.epa.gov/otaq/models/analysis/biodsl/p02001.pdf, April 2006.

2. Liquefied Petroleum Gas: LPG vehicles produce significantly lower ozone-forming emissions. Vehicles emit up to 33% fewer volatile organic compounds, 20% less nitrogen oxides, and 60% less carbon monoxide.

3. Natural Gas: The environmental performance of natural gas vehicles is very good. Greenhouse gas emission are reduced, particulate emissions are virtually eliminated, carbon monoxide emissions are reduced by as much as 65 percent to 95 percent, volatile organic compounds by up to 80 percent, and nitrogen oxide emissions by up to 30 percent.

4. Ethanol: Ethanol vehicles tend to emit 30 to 50 percent less ozone-forming compounds, including significant reductions in carbon monoxide emissions. Ethanol tends to have a much lower content of toxic compounds such as benzene and toluene. However, ethanol vehicles tend to emit more formaldehyde and acetaldehyde, although these can be largely controlled through the use of advanced catalytic converters.

   The growth of ethanol feedstock removes carbon dioxide from the environment. Production and distribution releases greenhouse gases. Research has shown that E85 results in a reduction of life-cycle greenhouse gas emissions of up to 19 percent.

5. Hydrogen (Fuel Cell): Fuel cells are significantly more efficient than gasoline engines and the only emissions are heat and water vapor. Emissions from the production of hydrogen fuel could diminish its environmental performance. For example, if hydrogen is produced from solar energy, harmful emissions could be very low or even zero, but if fossil fuels are burned to generate hydrogen, emissions could equal or exceed that of gasoline and diesel vehicles.

6. Electric Powered: Electric vehicles burn no fuel, thus have no emissions. There are emissions from the facility that produced the vehicles' electricity. Considering emissions given off by electric generation facilities, electric vehicles have significantly better emissions than gasoline vehicles. The size of the environmental benefit depends on the electric production facility emissions.

7. Hybrid: Hybrids have the same type, but lower emissions than gasoline and diesel powered vehicles.

C. Economic Implications

Many of the plants that can be turned into alternative fuel currently are grown in Kansas. As a result, Kansas is a good location for businesses that research, produce, and/or distribute alternative fuel. They would be close to raw materials. From the farmers' point of view, which industry would pay more for his/her crop: the food market or the alternative fuel market? Table 8 shows the acreage of crops planted in Kansas that are commonly used to produce alternative fuel.

Table 8
Crops Planted Per Acre in Kansas

Crop	**Acres Planted**
Wheat	10 million
Grain Sorghum	3.5 million
Corn	3.5 million
Soybeans	3 million
Alfalfa	1 million

Source: http://www.oznet.ksu.edu/kansascrops/, April 2006.

D. User Values and Behavior Implications

Alternative fuels make it possible to reduce petroleum consumption and environmental problems, however policy makers should keep in mind the fuels fossil energy ratio. The fossil energy ratio describes the degree to which an alternative fuel is or is not renewable. It is defined as the ratio of the final fuel energy to the amount of fossil fuel energy (including petroleum fuel) required to produce the fuel.

Fossil Energy Ratio = Final Fuel Energy/Fossil Energy Inputs

The more fossil fuel energy required to make an alternative fuel, the less the alternative fuel is renewable and a petroleum fuel replaced. For alternative fuels to be successful replacements of fossil fuel (including petroleum fuel), they must have a fossil energy ratio greater than 1. For example, it would not make sense to promote the use of an alternative fuel if it takes two gallons of petroleum fuel to produce one gallon of the alternative fuel. A 1998 study by the Department of Energy and the Department of Agriculture found that pure bio-diesel (B100) made from soybean oil has a fossil energy ratio of 3.2, B20 made from soybean oil 0.98, and diesel fuel 0.83. Depending on the ethanol study, ethanol has a fossil energy ratio of 0.7 to 1.5. A 1995 study by the Department of Agriculture found that ethanol made from corn has a fossil energy ratio of 1.24. Table 9 shows the fossil energy ratio of various alternative fuels.

Table 9
Alternative Fuel Fossil Energy Ratios

Fuel	**Fossil Energy Ratio**
Bio-diesel (B100) from soybean oil	3.2
Bio-diesel (B20) from soybean oil	0.98
Ethanol (from corn)	1.24
Diesel	0.84
Gasoline	0.80

Sources: http://www.mda.state.mn.us/ethanol/balance.html, April 2006
http://www.ers.usda.gov/publications/aer721/aer721.pdf, April 2006

Note: The positive fossil energy ratio displayed by (B100) and ethanol and is accounted for by the crops use of solar energy. This energy is considered "renewable." However, fossil fuels are not considered "renewable."

E. Current Policy Framework

Federal and state policies promote the use of alternative fuel four ways. First, they reduce the price of fuel by giving producers and blenders tax credits. Second, they reduce the price of alternative fuel vehicles by giving tax credits to the original purchaser or to the person converting a non-alternative fuel vehicle to an alternative fuel vehicle. Third, they give tax credits to individuals to open alternative fuel fueling stations, and finally, they require that some agencies purchase alternative fuel vehicles.

1. Federal Incentives: There are five identified federal incentives intended to enhance the use of alternative fuels.

    1.1. The Small Ethanol Producer Tax Credit I.R.C. Sec. 40(b)(3):
    The Small Ethanol Producer Tax Credit (SEPTC) allows an eligible small ethanol producer a nonrefundable federal income tax credit equal to $.10 per gallon produced for the first 15 million gallons. This equates to a maximum $1,500,000 federal income tax credit.

A small producer is defined as an ethanol production facility that has a productive annual capacity of less than 60 million gallons. This definition increased to 60 million under the Energy Policy Act of 2005, up from the 30 million gallon capacity established under the original act in 1990. The capacity is measured by the *greater* of the engineered boilerplate capacity of the plant or the actual production during the year.

The Small Ethanol Producer Tax Credit has been in place since 1990.

1.2. The Small Agri-bio-diesel Producer Tax Credit I.R.C. Sec. 40(a)(3):
The Small Agri-bio-diesel Producer Tax Credit allows an eligible small agri-bio-diesel producer a nonrefundable federal income tax credit for producers of $.10 per gallon produced for the first 15 million gallons of agri-bio-diesel. Agri-bio-diesel is defined as bio-diesel derived solely from virgin oils. A small producer is defined as an agri-bio-diesel production facility that has a productive annual capacity of less than 60 million gallons.

1.3. Alternative Fuel Refueling Infrastructure Tax Credit:
The Energy Policy Act of 2005 creates a credit that permits taxpayers to claim a 30% credit for the cost of installing clean-fuel vehicle refueling equipment to be used in the taxpayer's trade or business or installed at the principal residence of the taxpayer on up to $30,000. Under the provision, clean fuels are any fuel of at least 85% by volume of which consists of ethanol, natural gas, compressed natural gas, liquefied natural gas, liquefied petroleum gas, and hydrogen and any mixture of diesel fuel and bio-diesel containing at least 20% bio-diesel.

1.4. Volumetric Ethanol Excise Tax Credit (VEETC):
The Volumetric Ethanol Excise Tax Credit, also known as VEETC, is a Federal tax credit that went into effect January 1, 2005. A credit is given for every gallon of ethanol, agri-bio-diesel, bio-diesel, and renewable diesel blended into gasoline or diesel fuel. The credit for ethanol blended into gasoline is $0.51. For example, an ethanol/gasoline blend of 10% ethanol, 90% gasoline would have a credit available of $.051/gallon, and an 85% ethanol and 15 percent gasoline blend would have a credit available of $.4335/gallon. In the case of bio-diesel not in a mixture (100% bio-diesel or B100), the credit is available to the person selling the bio-diesel in a qualifying retail sale or, if the bio-diesel has not been sold in a qualifying retail sale, to the person using the bio-diesel as a fuel in a trade or business.

A registered blender is the only individual eligible for the credits. The blender may claim the tax credit as either a credit against the excise tax imposed on the fuel mixture, or a refund (payment) from the IRS. The IRS is required to provide refunds within 45 days, or if a claim is filed electronically, the refund must be paid within 20 days. All funds are paid out of the General Fund of the federal budget. Table 10 provides a summary of the volumetric excise tax credit for alternative fuels.

Table 10
Volumetric Excise Tax Credits for Selected Alternative Fuels

Fuel	Volumetric Excise Tax Credit	Requirements
Ethanol	$0.51/gallon	At least 190 proof
Agri-bio-diesel	$1.00/gallon	Made from virgin oils derived from agricultural commodities and animal fats
Bio-diesel	$0.50/gallon	Bio-diesel that is not agri-bio-diesel
Renewable Diesel	$1.00/gallon	Derived from biomass using a thermal depolymerization process

Sources: http://www.ksgrains.com/ethanol/rege85credits.html#VEETC, April 2006.
http://www.ethanolrfa.org/objects/documents/406/rfa_issue_brief_-_renewable_energy_tax_provisions_072805.pdf, April 2006.
http://www.ksgrains.com/ethanol/Ethanol%20Tax%20Brochure.pdf, April 2006.

The volumetric excise tax credit for ethanol is $ .51 per gallon. The ethanol must be a proof of at least 190 to qualify for the tax credit.

The volumetric excise tax credit for Agri-bio-diesel is $1.00 per gallon. Agri-bio-diesel is defined as diesel fuel made from virgin oils derived from agricultural commodities and animal fats.

The volumetric excise tax credit for bio-diesel is 50¢ per gallon. Bio-diesel is defined as bio-diesel other than agri-bio-diesel.

The volumetric excise tax credit for Renewable Diesel is $1.00 per gallon. Renewable diesel refers to diesel fuel derived from biomass using a thermal depolymerization process.

1.5. Fuel Cell Motor Vehicle Credit:

Section 1341 of the Energy Policy Act of 2005 provides a base tax credit of $8,000 for the purchaser of light-duty fuel cell vehicles (<8,501 lb GVWR). The $8,000 credit is valid until December 31, 2009. After 2009, the credit decreases to $4,000. To qualify, the vehicles must meet at least Bin 5 Tier II emission levels. Base tax credits are also available for medium- and heavy-duty fuel cell vehicles. The Internal Revenue Service will determine the credit amount based on a sliding scale by vehicle weight. The credit is available until December 31, 2014. For tax-exempt entities, the credit can be passed back to the vehicle seller. Table 11 provides a summary of the federal incentives for alternatives fuels.

Table 11
Federal Incentives for Use of Alternative Fuel

Incentive	Features	Target Beneficiary
Small Ethanol Producer Tax Credit	Tax credit equal to $0.10 per gallon for the first 15 million gallons	Small ethanol producers
The Small Agri-bio-diesel Producer Tax Credit	Tax credit equal to $0.10 per gallon for the first 15 million gallons	Small Agri-bio-diesel producers
Alternative Fuel Refueling Infrastructure Tax Credit	30% credit (up to $30,000) for the cost of installing clean-fuel vehicle refueling equipment	Installers of clean-fuel vehicle refueling equipment
Volumetric Ethanol Excise Tax Credit	Tax credit given on a per gallon basis to blenders of alternative fuel	Blenders of alternative fuels
Fuel Cell Motor Vehicle Credit	$8,000 Federal tax credit	Purchasers of light-duty fuel cell vehicles

Sources: http://www.ethanolrfa.org/policy/regulations/federal/septc/, April 2006.
http://www.ethanolrfa.org/policy/regulations/federal/septc/, April 2006.
http://www.ethanolrfa.org/objects/documents/406/rfa_issue_brief_-_renewable_energy_tax_provisions_072805.pdf, April 2006.
http://www.eere.energy.gov/afdc/progs/view_ind_mtx.cgi?tech/ALLAF/US/0, April 2006.

2. Kansas Incentives: There are five identified state incentives intended to enhance the use of alternative fuels.

2.1. Alternative Fuel Refueling Infrastructure Tax Credit:
Kansas offers an income tax credit equal to 50% of the cost of constructing or setting up a qualified alternative fuel refueling station (up to $200,000) placed in service on or after January 1, 1996 and before January 1, 2005. For refueling stations placed in service after January 1, 2005, the tax credit may not exceed $160,000. This tax credit should be deducted from the taxpayer's income tax liability for the taxable year in which the expenditures are made. In the event the credit is more than the taxpayer's tax liability for that year, the remaining credit may be carried over for up to three years after the year in which the expenditures were made. (Kansas Statutes 79-32,201.)

2.2. Ethanol Production Incentive:
The Kansas Qualified Agricultural Ethanol Alcohol Producer Fund enables qualified agricultural ethanol alcohol producers to apply to the Department of Revenue for a production incentive. Producers who start production on or after July 1, 2001 and who have sold at least 5,000,000 gallons to an alcohol blender may receive $0.075 for each gallon sold (up to 15,000,000 gallons). (Kansas Statutes 79-34,163.)

2.3. Required State Vehicle Bio-diesel Usage:

A 2% or higher blend of bio-diesel must be purchased for use in state-owned diesel powered vehicles and equipment where available, as long as the incremental price of bio-diesel is not more than $0.10 per gallon compared to the price of diesel fuel. (Kansas Statutes 75-3744a.)

2.4. State Alternative Fuel Vehicle (AFV) Acquisition Requirements:

In model year 2000 and thereafter, 75% of new light-duty (less than or equal to 8,500 lbs. GVWR) motor vehicles acquired by the state fleet and its agencies, which are used primarily within a metropolitan statistical area or a consolidated metropolitan statistical area, are required to be AFVs. (Kansas Statutes 75-4616), Ninety percent of light-duty vehicles acquired by alternative fuel providers must be AFVs. AFV acquisition requirements are determined by multiplying a fleet's number of newly acquired, non-excluded, light-duty vehicles by the applicable percentages. Covered fleets earn credits for each vehicle purchased. Credits earned in excess of their requirements can be banked or traded with other fleets. This system gives fleets managers flexibility in meeting their requirements.

2.5. State Alternative Fuel Vehicle Income Tax Credit:

An income tax credit equal to 40% of the incremental or conversion cost for qualified AFVs placed in service after January 1, 2005:

Table 12
Kansas Alternative Fuel Vehicle Income Tax Credit

Gross Vehicle Weight	**Maximum Credit Amount**
Less than 10,000 lbs.	Up to $2,400
10,000 to 26,000 lbs.	Up to $4,000
Over 26,000 lbs.	Up to $40,000

Source: http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/5169/0, April 2006.

Alternatively, a tax credit in an amount not to exceed the lesser of $750 or 5% of the cost of the alternative fuel vehicle is available to a taxpayer. The credit shall be allowed only to the first individual to take title to such motor vehicle, other than for resale. For motor vehicles capable of operating on E85, this credit is allowed for taxable years after December 31, 1999. The individual claiming the credit must provide evidence of purchasing at least 500 gallons of E85 between the time the vehicle was purchased and December 31 of the next calendar year. This tax credit should be deducted from the taxpayer's income tax liability for the taxable year in which the expenditures are made. In the event the credit is more than the taxpayer's tax liability for that year, the remaining credit may be carried over for up to three years after the year in which the expenditures were made. (Reference Kansas Statutes 79-32,201.) Table 13 provides a summary of the state incentives for alternatives fuels.

Table 13
State Incentives for Use of Alternative Fuels

Incentive	Features	Target Beneficiary
Alternative Fuel Refueling Infrastructure Tax Credit	Income tax credit equal to 50% of construction costs, up to $160,000	Those constructing or setting up a qualified alternative fuel refueling station
Ethanol Production Incentive	Producers who have sold at least 5,000,000 gallons to an alcohol blender may receive $0.075 for each gallon sold (up to 15,000,000 gallons)	Agricultural ethanol alcohol producers
Required State Vehicle Bio-diesel Usage	A 2% or higher blend of bio-diesel must be purchased for state-owned diesel powered vehicles if the incremental price of it is not more than $0.10 per gallon when compared to diesel fuel	Producers, blenders, and retailers of bio-diesel
State Alternative Fuel Vehicle Acquisition Requirements	*75% of new light-duty motor vehicles acquired by the state fleet and its agencies, used primarily within a metropolitan statistical area or a consolidated metropolitan statistical area, must be alternative fuel vehicles *90% of light-duty vehicles acquired by alternative fuel providers must be alternative fuel vehicles	Alternative fuel vehicle manufacturers
State Alternative Fuel Vehicle Income Tax Credit	*Tax credit equal to 40% of the incremental or conversion cost of qualified alternative fuel vehicles OR tax credit not to exceed the lesser of $750 or 5% of the original purchase price of an alternative fuel vehicle *Tax credit ($750) to owners of E85 vehicles that have purchased over 500 gallons of ethanol in one year	Converters of conventional vehicles to alternative fuel vehicles, purchasers of alternative fuel vehicles, and owners of vehicles using E85

Sources: http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/5171/0, April 2006.
http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/4425/0, April 2006.
http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/5756/0, April 2006.
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http://www.ksgrains.com/ethanol/rege85credits.html, April 2006.

ISSUE/TOPIC: Opportunities for alternative-fueled vehicles to reduce consumption of petroleum-based fuel.

A. Issue/Topic Description

Alternative-fuel vehicles offer an opportunity to reduce consumption of petroleum-based fuel in Kansas. Vehicle lifecycle must be analyzed to calculate the reduction of petroleum-based fuel an alternative-fuel vehicle offers. Vehicle lifecycle includes the resources to manufacture and distribute alternative fuel, manufacture the vehicle, operate the vehicle using alternative fuel, and scrap or recycle the vehicle.

The amount of plant oil that can be harvested and manufactured into alternative fuel is important in calculating the reduction of petroleum-based fuel an alternative fuel vehicle offers. For example, if it takes a large amount of petroleum to manufacture an alternative fuel, there may be no net benefit. Table 1 shows the amount of oil per acre, per plant, that can be used in bio-diesel production.

Table 1

Bio-diesel Oil Production by Plant

Plant	Usable Oil Per Acre
Soybean	40 to 50 gal/acre
Rapeseed	110 to 145 gal/acre
Mustard	140 gal/acre
Palm oil	650 gal/acre
Algae	10,000 to 20,000 gal/acre

Note. It takes about 7.3 pounds of soybean oil to produce a gallon of bio-diesel.
Sources: http://www.oregonbiofuels.com/cost.htm, April 2006.
http://en.wikipedia.org/wiki/Biodiesel, April 2006.

Even though alternative-fuel vehicles offer an opportunity to reduce consumption of petroleum-based fuel they face a serious roadblock. Without an accessible and geographically distributed system of refueling stations, refueling is difficult, and without alternative-fuel vehicles being driven and refueled, the number of refueling stations will remain limited.

A major drawback for many alternative-fuel vehicles such as natural gas and liquefied petroleum gas vehicles is shorter vehicle range. One way to circumvent this is to use these vehicles for shorter trips and centrally refuel them. Two options for use include urban bus systems and school bus systems.

B. Existing Policies / Programs

Federal and state policies promote the use of alternative fuel four ways. First, they reduce the price of fuel by giving producers and blenders tax credits. Second, they reduce the price of alternative fuel vehicles by giving tax credits to the original purchaser or to the person converting a non-alternative fuel vehicle to an alternative fuel vehicle. Third, they give tax credits to individuals to open alternative fuel fueling stations. Finally, they require that some agencies purchase alternative fuel vehicles.

1. **Federal Incentives**: There are five identified federal incentives intended to enhance the use of alternative fuels.

   1.1. The Small Ethanol Producer Tax Credit I.R.C. Sec. 40(b)(3):
   The Small Ethanol Producer Tax Credit (SEPTC) allows an eligible small ethanol producer a nonrefundable federal income tax credit equal to $.10 per gallon produced for the first 15 million gallons. This equates to a maximum $1,500,000 federal income tax credit.

   A small producer is defined as an ethanol production facility that has a productive annual capacity of less than 60 million gallons. This definition increased to 60 million under the Energy Policy Act of 2005, up from the 30 million gallon capacity established under the original act in 1990. The capacity is measured by the *greater* of the engineered boilerplate capacity of the plant or the actual production during the year.

   The Small Ethanol Producer Tax Credit has been in place since 1990.

   1.2. The Small Agri-bio-diesel Producer Tax Credit I.R.C. Sec. 40(a)(3):
   The Small Agri-bio-diesel Producer Tax Credit allows an eligible small agri-bio-diesel producer a nonrefundable federal income tax credit for producers of $.10 per gallon produced for the first 15 million gallons of agri-bio-diesel. Agri-bio-diesel is defined as bio-diesel derived solely from virgin oils. A small producer is defined as an agri-bio-diesel production facility that has a productive annual capacity of less than 60 million gallons.

   1.3. Alternative Fuel Refueling Infrastructure Tax Credit:
   The Energy Policy Act of 2005 creates a credit that permits taxpayers to claim a 30% credit for the cost of installing clean-fuel vehicle refueling equipment to be used in the taxpayer's trade or business or installed at the principal residence of the taxpayer up to $30,000. Under the provision, clean fuels are any fuel of at least 85% by volume of which consists of ethanol, natural gas, compressed natural gas, liquefied natural gas, liquefied petroleum gas, and hydrogen and any mixture of diesel fuel and bio-diesel containing at least 20% bio-diesel.

   1.4. Volumetric Ethanol Excise Tax Credit (VEETC):
   The Volumetric Ethanol Excise Tax Credit, also known as VEETC, is a Federal tax credit that went into effect January 1, 2005. A credit is given for every gallon of ethanol, agri-bio-diesel, bio-diesel, and renewable diesel blended into gasoline or diesel fuel. For example, the credit for ethanol blended into gasoline is $0.51. For example, an ethanol/gasoline blend of 10% ethanol, 90% gasoline would have a credit available of $.051/gallon, and an 85% ethanol and 15% gasoline blend

would have a credit available of $.4335/gallon. In the case of bio-diesel not in a mixture (100% bio-diesel or B100), the credit is available to the person selling the bio-diesel in a qualifying retail sale or, if the bio-diesel has not been sold in a qualifying retail sale, to the person using the bio-diesel as a fuel in a trade or business.

A registered blender is the only individual eligible for the credits. The blender may claim the tax credit as either a credit against the excise tax imposed on the fuel mixture, or a refund (payment) from the IRS. The IRS is required to provide refunds within 45 days, or if a claim is filed electronically, the refund must be paid within 20 days. All funds are paid out of the General Fund of the federal budget. Table 2 provides a summary of the volumetric excise tax credit for alternative fuels.

Table 2
Volumetric Excise Tax Credits for Selected Alternative Fuels

S **Fuel**	**Volumetric Excise Tax Credit**	**Requirements**
Ethanol	$0.51/gallon	At least 190 proof
Agri-bio-diesel T h	$1.00/gallon	Made from virgin oils derived from agricultural commodities and animal fats
e Bio-diesel	$0.50/gallon	Bio-diesel that is not agri-bio-diesel
v Renewable Diesel o l	$1.00/gallon	Derived from biomass using a thermal depolymerization process

Sources: http://www.ksgrains.com/ethanol/rege85credits.html#VEETC, April 2006.
http://www.ethanolrfa.org/objects/documents/406/rfa_issue_brief_-_renewable_energy_tax_provisions_072805.pdf, April 2006.
http://www.ksgrains.com/ethanol/Ethanol%20Tax%20Brochure.pdf, April 2006.

The volumetric excise tax credit for ethanol is $ .51 per gallon. The ethanol must be a proof of at least 190 to qualify for the tax credit.

The volumetric excise tax credit for Agri-bio-diesel is $1.00 per gallon. Agri-bio-diesel is defined as diesel fuel made from virgin oils derived from agricultural commodities and animal fats.

The volumetric excise tax credit for bio-diesel is 50¢ per gallon. Bio-diesel is defined as bio-diesel other than agri-bio-diesel.

The volumetric excise tax credit for Renewable Diesel is $1.00 per gallon. Renewable diesel refers to diesel fuel derived from biomass using a thermal depolymerization process.

1.5. Fuel Cell Motor Vehicle Credit:

Section 1341 of the Energy Policy Act of 2005 provides a base tax credit of $8,000 for the purchaser of light-duty fuel cell vehicles (<8,501 lb GVWR). The $8,000 credit is valid until December 31, 2009. After 2009, the credit decreases to $4,000. To qualify, the vehicles must meet at least Bin 5 Tier II emission levels. Base tax credits are also available for medium- and heavy-duty fuel cell vehicles. The Internal Revenue Service will determine the credit amount based on a sliding scale by vehicle weight. The credit is available until December 31, 2014. For tax-exempt entities, the credit can be passed back to the vehicle seller.

Table 3 provides a summary of the federal incentives for alternatives fuels.

Table 3
Federal Incentives for Use of Alternative Fuel

Incentive	Features	Target Beneficiary
Small Ethanol Producer Tax Credit	Tax credit equal to $0.10 per gallon for the first 15 million gallons	Small ethanol producers
The Small Agri-bio-diesel Producer Tax Credit	Tax credit equal to $0.10 per gallon for the first 15 million gallons	Small Agri-bio-diesel producers
Alternative Fuel Refueling Infrastructure Tax Credit	30% credit (up to $30,000) for the cost of installing clean-fuel vehicle refueling equipment	Installers of clean-fuel vehicle refueling equipment
Volumetric Ethanol Excise Tax Credit	Tax credit given on a per gallon basis to blenders of alternative fuel	Blenders of alternative fuels
Fuel Cell Motor Vehicle Credit	$8,000 Federal tax credit	Purchasers of light-duty fuel cell vehicles

Sources: http://www.ethanolrfa.org/policy/regulations/federal/septc/, April 2006.
http://www.ethanolrfa.org/policy/regulations/federal/septc/, April 2006.
http://www.ethanolrfa.org/objects/documents/406/rfa_issue_brief_-_renewable_energy_tax_provisions_072805.pdf, April 2006.
http://www.eere.energy.gov/afdc/progs/view_ind_mtx.cgi?tech/ALLAF/US/0, April 2006

2. **Kansas Incentives:** There are five identified state incentives intended to enhance the use of alternative fuels.

2.1. Alternative Fuel Refueling Infrastructure Tax Credit:

Kansas offers an income tax credit equal to 50% of the cost of constructing or setting up a qualified alternative fuel refueling station (up to $200,000) placed in service on or after January 1, 1996 and before January 1, 2005. For refueling stations placed in service after January 1, 2005, the tax credit may not exceed $160,000. This tax credit should be deducted from the taxpayer's income tax liability for the taxable year in which the expenditures are made. In the event the credit is more than the taxpayer's tax liability for that year, the remaining credit may be carried over for up to three years after the year in which the expenditures were made. (Kansas Statutes 79-32,201.)

2.2. Ethanol Production Incentive:
The Kansas Qualified Agricultural Ethanol Alcohol Producer Fund enables qualified agricultural ethanol alcohol producers to apply to the Department of Revenue for a production incentive. Producers who start production on or after July 1, 2001 and who have sold at least 5,000,000 gallons to an alcohol blender may receive $0.075 for each gallon sold (up to 15,000,000 gallons). (Kansas Statutes 79-34,163.)

2.3. Required State Vehicle Bio-diesel Usage:
A 2% or higher blend of bio-diesel must be purchased for use in state-owned diesel powered vehicles and equipment where available, as long as the incremental price of bio-diesel is not more than $0.10 per gallon as compared to the price of diesel fuel. (Kansas Statutes 75-3744a.)

2.4. State Alternative Fuel Vehicle (AFV) Acquisition Requirements:
In model year 2000 and thereafter, 75% of new light-duty (less than or equal to 8,500 lbs. GVWR) motor vehicles acquired by the state fleet and its agencies, which are used primarily within a metropolitan statistical area or a consolidated metropolitan statistical area, are required to be AFVs. (Reference Kansas Statutes 75-4616), Ninety percent of light-duty vehicles acquired by alternative fuel providers must be AFVs. AFV acquisition requirements are determined by multiplying a fleet's number of newly acquired, non-excluded, light-duty vehicles by the applicable percentages. Covered fleets earn credits for each vehicle purchased. Credits earned in excess of their requirements can be banked or traded with other fleets. This system gives fleets managers flexibility in meeting their requirements.

2.5. State Alternative Fuel Vehicle Income Tax Credit:
An income tax credit equal to 40% of the incremental or conversion cost for qualified AFVs placed in service after January 1, 2005:

Table 4
Kansas Alternative Fuel Vehicle Income Tax Credit

Gross Vehicle Weight	**Maximum Credit Amount**
Less than 10,000 lbs.	Up to $2,400
10,000 to 26,000 lbs.	Up to $4,000
Over 26,000 lbs.	Up to $40,000

Source: http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/5169/0, April 2006.

Alternatively, a tax credit in an amount not to exceed the lesser of $750 or 5% of the cost of the alternative fuel vehicle is available to a taxpayer. The credit shall be allowed only to the first individual to take title to such motor vehicle, other than for resale. For motor vehicles capable of operating on E85, this credit is allowed for taxable years after December 31, 1999. The individual claiming the credit must provide evidence of purchasing at least 500 gallons of E85 between the time the vehicle was purchased and December 31 of the next calendar year. This tax credit should be deducted from the taxpayer's income tax liability for the taxable year in which the expenditures are made. In the event the credit is more than the taxpayer's tax liability for that year, the remaining credit may be carried over for up to three years after the year in which the expenditures were made. (Reference Kansas Statutes 79-32,201.)

Table 5 provides a summary of the state incentives for alternatives fuels.

Table 5
State Incentives for Use of Alternative Fuels

Incentive	Features	Target Beneficiary
Alternative Fuel Refueling Infrastructure Tax Credit	Income tax credit equal to 50% of construction costs, up to $160,000	Those constructing or setting up a qualified alternative fuel refueling station
Ethanol Production Incentive	Producers who have sold at least 5,000,000 gallons to an alcohol blender may receive $0.075 for each gallon sold (up to 15,000,000 gallons)	Agricultural ethanol alcohol producers
Required State Vehicle Bio-diesel Usage	A 2% or higher blend of bio-diesel must be purchased for state-owned diesel powered vehicles if the incremental price of it is not more than $0.10 per gallon when compared to diesel fuel	Producers, blenders, and retailers of bio-diesel
State Alternative Fuel Vehicle Acquisition Requirements	*75% of new light-duty motor vehicles acquired by the state fleet and its agencies, used primarily within a metropolitan statistical area or a consolidated metropolitan statistical area, must be alternative fuel vehicles *90% of light-duty vehicles acquired by alternative fuel providers must be alternative fuel vehicles	Alternative fuel vehicle manufacturers
State Alternative Fuel Vehicle Income Tax Credit	*Tax credit equal to 40% of the incremental or conversion cost of qualified alternative fuel vehicles OR tax credit not to exceed the lesser of $750 or 5% of the original purchase price of an alternative fuel vehicle *Tax credit ($750) to owners of E85 vehicles that have purchased over 500 gallons of ethanol in one year	Converters of conventional vehicles to alternative fuel vehicles, purchasers of alternative fuel vehicles, and owners of vehicles using E85

Sources: http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/5171/0, April 2006.
http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/4425/0, April 2006.
http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/5756/0, April 2006.
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3. **Sample Policies Used in Other States to Encourage Use of Alternative Fuel Vehicles** (http://www.eere.energy.gov/afdc/progs/tech_matrx.cgi)

3.1. Arizona: High Occupancy Vehicle (HOV) Lane Exception - AFVs are required to display special license plates. Once these plates are displayed, AFVs are allowed to use the high occupancy vehicle (HOV) lanes. An $8 administration fee applies. If the Arizona Department of Transportation receives approval from the federal government allowing the use of HOV lanes by hybrid electric vehicles (HEVs), a person may drive a HEV with AFV special plates or an AFV sticker, and a HEV sticker in HOV lanes at any time, regardless of occupancy level, without penalty.

3.2. Arizona: Alternative Fuel Vehicle License Tax - The initial annual vehicle license tax on an AFV is lower than the license tax on conventional vehicles.

3.3. California: Lower-Emission School Bus Grants - The Lower-Emission School Bus Program provides grants to school districts to replace older, higher-emitting school buses with lower-emitting models that meet the latest federal motor vehicle safety standards. The $12.5 million available for new bus purchases for the 2005 - 2006 fiscal year will be targeted at replacing about 100 of the oldest buses that remain on the road (pre-1977 model year buses) and may be used for purchasing either lower-emitting alternative-fuel or diesel buses. In addition to funding for new bus purchases, $12.5 million is available to school districts and private school transportation companies that contract to school districts to retrofit in-use diesel buses with emission control devices.

3.4. California: Alternative Vehicle Acquisition Requirements - On and after January 1, 2006, when awarding a vehicle procurement contract, every city, county, and special district, including a school district and a community college district, is authorized to require that 75% of the passenger cars or light-duty trucks, or both, be acquired be energy-efficient vehicles.

3.5. Connecticut: Parking Benefits in New Haven - The City of New Haven provides free on-street parking on all city streets for HEVs and AFVs registered in New Haven. HEV and AFV vehicle owners must obtain a non-transferable pass from the Department of Traffic and Parking to place on the vehicle's dashboard or hang from the rearview mirror.

3.6. Maine: Alternative Fuel Vehicle and Refueling Infrastructure Loans - The Finance Authority of Maine manages the Clean Fuel Vehicle Fund, a non-lapsing revolving loan fund that may be used for direct loans to finance all or part of any clean-fuel vehicle project. The Authority may also insure up to 100% of mortgage payments with respect to mortgage loans for clean-fuel vehicle projects. (Reference Maine Revised Statutes Title 10, Sections 1023-K and 1026-P)

3.7. Nebraska: Alternative Fuel Vehicle Loans - The Nebraska Energy Office administers the Dollar and Energy Saving Loans Program. The Program makes

low-cost loans available for a variety of alternative fuel projects, with the Nebraska Energy Office's participation.
Eligible projects include the following: the replacement of conventional vehicles with AFVs; the purchase of new AFVs; the conversion of conventional vehicles to operate on alternative fuels; and the construction or purchase of a refueling station or equipment. Dedicated AFVs are eligible, and loans may go towards part of the cost of dual-fuel vehicles. The maximum loan amount is $150,000 per borrower. The interest rate is 5% or less and may be adjusted semi-annually.

3.8. New Jersey: Low Emissions or Alternative Fuel Bus Acquisition Requirement - Beginning July 1, 2007, all buses purchased by the New Jersey Transit Corporation must have improved pollution controls that reduce particulate emissions, or buses powered by a fuel other than conventional diesel. Qualifying vehicles include compressed natural gas vehicles, hybrid electric vehicles, fuel cell vehicles, vehicles operating on ultra low sulfur fuel or biodiesel, or vehicles operating on any other bus fuel approved by the U.S. Environmental Protection Agency.

3.9. New York: Alternative Fuel Vehicle Tax Exemption - New York provides a partial sales and use tax exemption for the incremental cost of new AFVs and for vehicles that are converted to run on alternative fuels.

3.10. Oklahoma: Alternative Fuel Vehicle Technician Training - The Alternative Fuels Technician Certification Act regulates the training, testing, and certification of technicians who install, modify, repair, or renovate equipment used in the fueling of AFVs and the conversion of any engines to alternative fueled engines. This includes OEM manufactured engines dedicated to operate on an alternative fuel.

Table 4 provides a summary of non-Kansas state incentives for alternative fuels.

Table 4
Non-Kansas State Incentives for use of Alternative Fuels

Target Beneficiary	**Incentive**	**State**	**Features**
Owners of alternative fuel vehicles	High Occupancy Vehicle (HOV) Lane Exception	Arizona	Owners of alternative fuel vehicles are allowed to use high occupancy vehicle (HOV) lanes regardless of number of passengers
Owners of alternative fuel vehicles	Alternative Fuel Vehicle License Tax	Arizona	The initial annual vehicle license tax on an AFV is lower than the license tax on conventional vehicles
Owners of alternative fuel vehicles	Parking Benefits in New Haven	Connecticut	Free on-street parking on all city streets for alternative fuel vehicles
Owners of alternative fuel	Alternative Fuel Vehicle Tax Exemption		Partial sales and use tax exemption for the incremental

Target Beneficiary	Incentive	State	Features
vehicles		New York	cost of new AFVs and for vehicles that are converted to run on alternative fuels
Owners of alternative fuel vehicles	Alternative Fuel Vehicle Technician Training	Oklahoma	Regulates the training, testing, and certification of technicians who install, modify, repair, or renovate alternative fuel vehicles
Owners and investors in alternative fuel vehicles and projects.	Alternative Fuel Vehicle Loans	Nebraska	Low-cost loans for a variety of alternative fuel vehicle projects
Community	Alternative Vehicle Acquisition Requirements	California	When awarding a vehicle procurement contract, every city, county, and special district, including a school district and a community college district, is authorized to require that 75% of the passenger cars or light-duty trucks, or both, be acquired as energy-efficient vehicles
Community	Low Emissions or Alternative Fuel Bus Acquisition Requirement	New Jersey	All buses purchased by the New Jersey Transit Corporation must have improved pollution controls that reduce particulate emissions or buses powered by a fuel other than conventional diesel
School districts	Lower-Emission School Bus Grants	California	Program provides grants to school districts to replace older, higher-emitting school buses with lower-emitting models that meet the latest federal motor vehicle safety standards.
Investors in clean-fuel vehicle projects	Alternative Fuel Vehicle and Refueling Infrastructure Loans	Maine	A non-lapsing revolving loan fund that may be used for direct loans to finance all or part of any clean-fuel vehicle project

Source: http://www.eere.energy.gov/afdc/progs/tech_matrx.cgi, April 2006.

Pros:
Increasing the likelihood that consumers will purchase alternative fuel vehicles

Increasing the likelihood that alternative fuel fueling stations are built

Better qualified alternative fuel vehicle maintenance staff (Oklahoma program)

Cons:
Lost tax revenue on state-based tax credit options (i.e. Arizona, and New York)

ISSUE/TOPIC: With the advent of ultra-low sulfur diesel fuel, what are the opportunities for increased use of diesel-fueled vehicles?

A. Issue/Topic Description

Ultra-low sulfur diesel fuel (ULSD) is a cleaner-burning diesel fuel that produces fewer particulate matter (PM) and nitrogen oxide (NO_x) emissions. Particulate matter is tiny particles of solids and liquids suspended in air. The effects of inhaling particulate matter include asthma, lung cancer, and cardiovascular disease. Nitrogen oxide is a smog-forming agent. Ultra-low sulfur diesel fuel also allows the use of improved exhaust treatment devices that reduce particulate matter and nitrogen oxide emissions. These devices can be "poisoned" by the amount of sulfur in conventional diesel fuel. Ultra-low sulfur diesel fuel contains 97% less sulfur than conventional diesel.

B. Existing Policies / Programs

The sulfur content of diesel fuel used in "on-road" vehicles such as trucks and buses, "non-road" vehicles such as construction equipment, and "non-road" vehicles limited to locomotives and marine equipment differ. "On-road" diesel fuel has a sulfur maximum of 500 parts per million (ppm), while the sulfur content of "non-road" diesel fuel is not regulated.

In accordance with the federal Clean Air Act, the EPA establishes fuel quality standards to protect public health and the environment from harmful gas and particulate matter emissions from vehicles. Recently, the EPA has set standards for sulfur content in diesel fuel. These standards help ensure the effectiveness of low emission-control technologies and reduce harmful air pollution.

Table 1 shows the phasing schedule of new regulations regarding the sulfur content of three diesel fuels. The EPA has previously postponed the compliance date due to worries by the fuel distribution industry that ultra-low sulfur diesel fuel would not be available at a small number of retail outlets. Table 1 shows when EPA requirements begin.

Table 1
Sulfur Content of Three Diesel Fuels (in parts per million)

Effective Date	"On-Road" Diesel	"Non-Road" Diesel (excluding locomotive and marine diesel)	Locomotive and Marine Diesel
Current Regulations	500 ppm	Not regulated	Not regulated
October 15, 2006	15 ppm	Not regulated	Not regulated
June 1, 2007	15 ppm	500 ppm	500 ppm
June 1, 2010	15 ppm	15 ppm	500 ppm
June 1, 2012	15 ppm	15 ppm	15 ppm

Note. Some locomotive and marine refiners are exempt from the 15 ppm regulations until June 1, 2014.

Sources: http://www.fueleconomy.gov/feg/lowsulfurdiesel.shtml, April 2006.
http://www.ecy.wa.gov/programs/air/PDFS/DaveKircher_Construction.pdf, April 2006.
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http://www.epa.gov/otaq/diesel.htm

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http://www.ilta.org/Rules&Regs/ulsd.htm

7. Environmental Protection Agency. Provides information on fuel regulations.
http://www.epa.gov/otaq/fuels.htm

ISSUE/TOPIC: Potential environmental effects (both negative and positive) associated with an increased use of alternative fueled vehicles?

A. Issue/Topic Description

When analyzing the environmental effects of an alternative fuel the process of producing, distributing, and using the fuel must be considered. For example, electric vehicles burn no fuel, thus have no emissions. There are emissions from the facility that produced the vehicles' electricity, thus, the environmental benefit depends on the electric production facility emissions. Similarly, emissions from hydrogen fuel cells will be water and heat. However, if fossil fuels are burned or reformed to generate hydrogen, total hydrogen vehicle emissions could equal or even exceed those of gasoline and diesel vehicles.

Carbon dioxide has been identified as a leading cause of global warming. One advantage some alternative fuels (i.e. bio-diesel and ethanol) have over gasoline and diesel fuel is that they recycle instead of add new carbon to the atmosphere. For example, when bio-diesel and ethanol are made from plant oil, plants have taken carbon dioxide out of the air to produce energy. Conversely, when petroleum is refined and manufactured into gasoline or diesel fuel, carbon that was previously sequestered underground will now be added to the atmosphere after the fuel is used.

B. Existing Policies / Programs

The Clean Air Act Amendments of 1990 established the Clean Fuel Fleet Program (CFFP). This program requires cities with significant air quality problems to promote vehicles that meet clean fuel emissions standards. In metropolitan areas in extreme, severe, or serious non-attainment for nitrogen oxide (NOx), volatile organic compounds (VOCs), or carbon monoxide, fleets of 10 light-duty vehicles or more face purchase requirements. Under CFFP, conventional vehicles are admissible if they meet National Low Emission Vehicle (LEV) standards. A vehicle must always be operated on the fuel for which it was certified. For example, if a dual-fuel ethanol vehicle is certified LEV using ethanol, but not using gasoline, the vehicle must be operated solely on ethanol.

The energy Policy Act of 1992 requires that a certain percentage of new light duty vehicles (passenger cars and light trucks) purchased for certain fleets be alternative-fueled. Federal covered fleets are those that operate 20 or more light duty vehicles primarily in a metropolitan area. State covered fleets are those that operate 50 or more light duty vehicles, of which at least 20 operate primarily in a metropolitan area. Furthermore, the fleets must be capable of being fueled at a central location, such as the fleet motor pool. Law enforcement vehicles, emergency vehicles, combat vehicles, non-road vehicles, and vehicles used for testing are exempted from the requirement. Federal, state, and alternative fuel provider fleets are currently required to purchase alternative-fueled vehicles. Table 1 shows the purchase requirements under the Energy Policy Act of 1992.

Table 1
Energy Policy Act of 1992 Vehicle Purchase Requirements

Year	**Percentage of all Acquisitions for Covered Fleets**		
	Federal	State	Alternative Fuel Provider
2001 and Beyond	75%	75%	90%

Sources: http://www1.eere.energy.gov/vehiclesandfuels/epact/state/index.html, April 2006.
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Energy, Environment, and Development Issues, 1/07/2006. Provides information on fuels, vehicles, and legislation.
http://www.cnie.org/nle/crsreports/05Jan/RL30758.pdf

ISSUE/TOPIC: What policy, technology, economic and infrastructure barriers are there to increased use of alternative-fueled vehicles?

A. Topic / Issue Description

1. Policy Barriers: Any policy to support alternative-fuel vehicles must address performance and cost concerns, as well as the issue of fueling infrastructure. A "chicken and egg" problem exists: alternative-fuel vehicles will not become popular without the fueling infrastructure, yet the fueling infrastructure will not expand without new customers to serve. Similarly, because the owners of large networks of fueling stations like Exxon and Mobil do not produce/distribute alternative fuel to the extent they produce/distribute gasoline and diesel fuel, they are less likely to offer alternative fuel at "at the pump."

2. Technology Barriers: Some alternative fuels are similar to conventional fuels (i.e. blends with low concentration of bio-diesel and ethanol) and can be used in conventional vehicles with limited or no vehicle modification. Some alternative fuels are drastically different (i.e. liquefied petroleum gas and natural gas) than conventional fuels and require the use of significantly different engines, drive systems, and refueling systems. Finding qualified maintenance personnel may be an issue. Furthermore, mixtures with high concentrations of bio-diesel and ethanol have been known to break down rubber vehicle components.

   Hydrogen-powered vehicles have the greatest technological barriers to overcome. Storage and delivery of hydrogen is complicated because, at standard temperatures and pressures, hydrogen gas has a very low density. Furthermore, at current prices, a fuel cell for a passenger car is estimated to be 10 times more expensive than a conventional engine. Finally, because hydrogen for fuel use is currently produced in very low quantities, it is considerably more expensive than gasoline and diesel fuel.

4. Economic Barriers: The key economic drawback of all alternative-fuel vehicles is that they have higher fuel and/or vehicle purchase prices, thus are generally more expensive to own than conventional vehicles. Alternative-fuel vehicles have superior environmental performance compared to conventional vehicles, but their performance in terms of vehicle range, cargo capacity, and ease of fueling may not compare favorably with conventional vehicles. Further research is required to address these drawbacks.

5. Infrastructure: Infrastructure to store and deliver alternative fuel differs significantly depending on the fuel. There is considerable experience in storing and delivering bio-diesel and ethanol, plus distribution equipment and the re-fueling technique consumers use to fill their vehicles are similar to those used of conventional fuels. An extensive electricity infrastructure exists, however, with current technology only a few vehicles can access a single electric vehicle charger in one day. An extensive liquefied petroleum gas and natural gas infrastructure exists, however, because both are kept under pressure, special equipment and training is necessary before consumers can safely re-fuel their vehicles. Very little hydrogen fuel infrastructure exists.

B. Existing Policies / Programs

1. Federal Incentives:

1.1. The Small Ethanol Producer Tax Credit I.R.C. Sec. 40(b)(3):
The Small Ethanol Producer Tax Credit (SEPTC) allows an eligible small ethanol producer a nonrefundable federal income tax credit equal to $.10 per gallon produced for the first 15 million gallons. This equates to a maximum $1,500,000 federal income tax credit.

A small producer is defined as an ethanol production facility that has a productive annual capacity of less than 60 million gallons (including denaturant). This is measured by the *greater* of the engineered boilerplate capacity of the plant or the actual production during the year.

1.2. The Small Agri-bio-diesel Producer Tax Credit I.R.C. Sec. 40(a)(3):
The Small Agri-bio-diesel Producer Tax Credit allows an eligible small agri-bio-diesel producer a nonrefundable federal income tax credit for producers of $.10 per gallon produced for the first 15 million gallons of agri-bio-diesel. Agri-bio-diesel is defined as bio-diesel derived solely from virgin oils. A small producer is defined as an agri-bio-diesel production facility that has a productive annual capacity of less than 60 million gallons.

1.3. Alternative Fuel Refueling Infrastructure Tax Credit:
The Energy Policy Act of 2005 creates a credit that permits taxpayers to claim a 30% credit for the cost of installing clean-fuel vehicle refueling equipment to be used in the taxpayer's trade or business or installed at the principal residence of the taxpayer up to $30,000. Under the provision, clean fuels are any fuel of at least 85% by volume of which consists of ethanol, natural gas, compressed natural gas, liquefied natural gas, liquefied petroleum gas, and hydrogen and any mixture of diesel fuel and bio-diesel containing at least 20% bio-diesel.

1.4. Volumetric Ethanol Excise Tax Credit (VEETC):
The Volumetric Ethanol Excise Tax Credit, also known as VEETC, is a Federal tax credit that went into effect January 1, 2005. A credit is given for every gallon of ethanol, agri-bio-diesel, bio-diesel, and renewable diesel blended into gasoline or diesel fuel. For example, the credit for ethanol blended into gasoline is $0.51. For example, an ethanol/gasoline blend of 10% ethanol, 90% gasoline would have a credit available of $.051/gallon, and an 85% ethanol and 15% gasoline blend would have a credit available of $.4335/gallon. In the case of bio-diesel not in a mixture (100% bio-diesel or B100), the credit is available to the person selling the bio-diesel in a qualifying retail sale or, if the bio-diesel has not been sold in a qualifying retail sale, to the person using the bio-diesel as a fuel in a trade or business.

A registered blender is the only individual eligible for the credits. The blender may claim the tax credit as either a credit against the excise tax imposed on the fuel mixture, or a refund (payment) from the IRS. The IRS is required to provide refunds within 45 days, or if a claim is filed electronically, the refund must be paid within 20 days. All funds are paid out of the General Fund of the federal budget.

The volumetric excise tax credit for ethanol is $ .51 per gallon. The ethanol must be a proof of at least 190 to qualify for the tax credit.

The volumetric excise tax credit for Agri-bio-diesel is $1.00 per gallon. Agri-bio-diesel is defined as diesel fuel made from virgin oils derived from agricultural commodities and animal fats.

The volumetric excise tax credit for bio-diesel is 50¢ per gallon. Bio-diesel is defined as bio-diesel other than agri-bio-diesel.

The volumetric excise tax credit for Renewable Diesel is $1.00 per gallon. Renewable diesel refers to diesel fuel derived from biomass using a thermal depolymerization process.

2. Kansas Incentives:

2.1. Alternative Fuel Refueling Infrastructure Tax Credit:
Kansas offers an income tax credit equal to 50% of the cost of constructing or setting up a qualified alternative fuel refueling station (up to $200,000) placed in service on or after January 1, 1996 and before January 1, 2005. For refueling stations placed in service after January 1, 2005, the tax credit may not exceed $160,000. This tax credit should be deducted from the taxpayer's income tax liability for the taxable year in which the expenditures are made. In the event the credit is more than the taxpayer's tax liability for that year, the remaining credit may be carried over for up to three years after the year in which the expenditures were made. (Kansas Statutes 79-32,201.)

2.2. Ethanol Production Incentive:
The Kansas Qualified Agricultural Ethanol Alcohol Producer Fund enables qualified agricultural ethanol alcohol producers to apply to the Department of Revenue for a production incentive. Producers who start production on or after July 1, 2001 and who have sold at least 5,000,000 gallons to an alcohol blender may receive $0.075 for each gallon sold (up to 15,000,000 gallons). (Kansas Statutes 79-34,163.)

2.3. State Alternative Fuel Vehicle Income Tax Credit:
An income tax credit equal to 40% of the incremental or conversion cost for qualified AFVs placed in service after January 1, 2005.

Table 1
Kansas Alternative Fuel Vehicle Income Tax Credits

Gross Vehicle Weight	**Maximum Credit Amount**
Less than 10,000 lbs.	Up to $2,400
10,000 to 26,000 lbs.	Up to $4,000
Over 26,000 lbs.	Up to $40,000

Source: http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/5169/0, April 2006.

Alternatively, a credit in an amount not exceeding the lesser of 5% of the cost of the vehicle, or $750, shall be allowed to a taxpayer who purchases a motor vehicle equipped by the vehicle manufacturer with an alternative fuel system and who is unable or elects not to determine the exact basis attributable to such property. The credit shall be allowed only to the first individual to take title to such motor vehicle, other than for resale.

OVERVIEW: FUEL-EFFICIENT VEHICLES

In 2004, more than 237 million vehicles traveled more than 2.9 trillion miles (FHWA, 2006), a 2.5 percent increase over the 2003 total vehicle miles traveled (VMT). Vehicles in the United States consume 65 percent of the 20.6 million barrels/day of petroleum products (U.S. Department of Energy, 2006a). In Kansas, it is estimated that vehicles account for more than 29 billion vehicle-miles traveled and 1.7 billion gallons of fuel (gasoline and diesel) consumption every year (KDOT, 2006). The use of more fuel-efficient vehicles could significantly reduce energy consumption, both statewide and nationwide.

A. Technology Trends

Developments of more efficient, environmentally friendly transportation include 1) efficient fuel alternatives, and 2) fuel-efficient vehicle designs. For the latter, the two most productive technologies include hybrid-electric vehicles (HEV) and Fuel cell vehicles (FCV).

1. Hybrid-Electric Vehicles: HEVs combine the benefits of gasoline engines and electric motors to obtain improved fuel economy (FuelEconomy.gov 2006b). Incorporated with advanced technologies such as regenerative braking, electric motor drive/assist, and automatic start/shutoff, some HEVs have achieved gas mileages double those of traditional vehicles and early emission tests showed very low levels of criteria pollutants.

2. Fuel Cell Vehicles: Not expected on the mass market before 2010, FCVs represent an even more advanced vehicle technology trend. FCVs are propelled by electric motors that obtain electricity produced onboard through a chemical process using hydrogen fuel and oxygen from the air. FCVs produce much lower level of air pollutants, yet can be twice as efficient as similarly sized conventional vehicles (FuelEconomy.gov 2006c).

3. Other Technologies Improving Fuel Economy: For traditional vehicles, up to 85 percent of the energy generated by fuel is lost to engine and driveline inefficiencies, and idling. Improving engine and transmission performance can yield higher fuel efficiency. As listed in Table 1, some of the current engine technologies are Variable Valve Timing and Lift, Cylinder Deactivation, Turbochargers and Superchargers, Integrated Starter/Generator (ISG) Systems, and Direct Fuel Injection. Some advanced transmission technologies currently available include Continuously Variable Transmissions (CVTs) and Automated Manual Transmissions (AMTs) (FuelEconomy.gov 2006d).

B. Current Infrastructure / Management Framework

The sales of hybrid vehicles totaled more than 86,200 in 2004, a 60% increase from 2003. The U.S. sales of hybrid vehicles since 1999 have totaled nearly 200,000 (R. Barnitt, and L. Eudy, 2005). In addition, a sharp increase was observed for heavy-duty hybrid electric vehicles over the past few years for transit applications. Statistics show that there have been 184 hybrid buses in active service as of January 1, 2004, with 614 on order and a potential for 228 more (R. Barnitt, and L. Eudy, 2005). Studies have shown that hybrid diesel-electric buses could improve fuel economy by 10 percent compared to standard clean-diesel buses although significant improvements in gaseous emissions (carbon dioxide, carbon monoxide, oxides of nitrogen, and unburned hydrocarbons) and particulate matter emissions were not observed (Connecticut Academy of science and engineering 2005). Figure 1 lists the major HEV models (2005) and their engineering parameters.

State of Kansas Vehicle Fleet

The State of Kansas fleet has 8,086 vehicles (Table 2), among which are 5,657 light duty vehicles and 2,417 are trucks (Kansas Department of Administration 2006).

Table 1
Fuel-Efficient Vehicle Technologies

Technology	**Characteristics**	**Fuel Efficiency**	**Advantages**	**Disadvantages**
Hybrid-Electric Vehicles	Combine of gasoline engine and electric motor	Up to 66 miles per gallon	High fuel efficiency and low emission	Higher price
Fuel Cell Vehicles	Propelled by electricity produced by hydrogen fuel	Do not use petroleum based fuel	Low emission; high efficiency	Technique difficulties; high price?
Other Engine Technologies				
Variable Valve Timing and Lift	Optimizes the flow of fuel and air into the engine	5% average efficiency increase	Optimum engine timing	
Cylinder Deactivation	Deactivates cylinders when they are not needed	7.5% average efficiency increase	Higher engine efficiency	Can not be used on 4 cylinder engines
Turbochargers and Superchargers	Fans that force compressed air into an engine's cylinders	7.5% average efficiency increase	Higher engine efficiency	
Integrated Starter/ Generator (ISG) Systems	Automatically turn the engine off when the vehicle is stopped	8% average efficiency increase	Energy saving	
Direct Fuel Injection	Directly inject fuel into the cylinder to better control the timing and shape of the fuel mist	11-13% average efficiency increase	Higher compression ratio; more efficient fuel intake	
Other Transmission Technologies				
Continuously Variable Transmissions (CVTs)	Provide seamless acceleration and improved fuel economy	6% average efficiency increase	Seamless acceleration; no frequent downshifting or "gear hunting" on hills; better fuel efficiency	
Automated Manual Transmissions (AMTs)	Combine the efficiency of manual transmissions with the convenience of automatics	7% average efficiency increase	Fewer energy losses	

Figure 1: 2006 Hybrid Vehicles in U.S. Domestic Market

Vehicle	Trans Type / Speeds	Eng Size / Cylinders	MPG City / Hwy	Annual Fuel Cost	Battery Size / Type
TWO SEATERS					
HONDA					
Insight	AV	1.0/3	57/56	$591	144 V, Ni-MH
	M5	1.0/3	60/66	$525	144 V, Ni-MH
COMPACT CARS					
HONDA					
Civic Hybrid	AV	1.3/4	49/51	$660	158 V, Ni-MH
MIDSIZE CARS					
HONDA					
Accord Hybrid	A-5	3.0/6	25/34	$1,178	144 V, Ni-MH
TOYOTA					
Prius	AV	1.5/4	60/51	$601	202 V, Ni-MH
STANDARD PICKUP TRUCKS 2WD					
CHEVROLET					
C15 Silverado Hybrid 2WD	A-4	5.3/8	18/21	$1,736	42V, Lead-acid
GMC					
C15 Sierra Hybrid 2WD	A-4	5.3/8	18/21	$1,736	42V, Lead-acid
STANDARD PICKUP TRUCKS 4WD					
CHEVROLET					
K15 Silverado Hybrid 4WD	A-4	5.3/8	17/19	$1,835	42V, Lead-acid
GMC					
K15 Sierra Hybrid 4WD	A-4	5.3/8	17/19	$1,835	42V, Lead-acid
SPORT UTILITY VEHICLES 2WD					
FORD					
Escape Hybrid 2WD	AV	2.3/4	36/31	$1,000	330 V, Ni-MH
LEXUS					
RX 400h 2WD	AV	3.3/6	33/28	$1,099	288 V, Ni-MH
TOYOTA					
Highlander Hybrid 2WD	AV	3.3/6	33/28	$1,099	288 V, Ni-MH
SPORT UTILITY VEHICLES 4WD					
FORD					
Escape Hybrid 4WD	AV	2.3/4	33/29	$1,066	330 V, Ni-MH
LEXUS					
RX 400h 4WD	AV	3.3/6	31/27	$1,138	288 V, Ni-MH
MAZDA					
Tribute Hybrid 4WD	AV	2.3/4	33/29	$1,066	330 V, Ni-MH
MERCURY					
Mariner Hybrid 4WD	AV	2.3/4	33/29	$1,066	330 V, Ni-MH
TOYOTA					
Highlander Hybrid 4WD	AV	3.3/6	31/27	$1,138	288 V, Ni-MH

(Source: Fuel Economy Guide 2006, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, http://www.fueleconomy.gov/feg/FEG2006.pdf)

Table 2
Kansas State Fleet Statistics

Vehicle Type		Number of Vehicle
Light Duty	Motorcycle	25
	Two Door Sedan	14
	Four Door Sedan	1,895
	Station Wagon	84
	Pick Up	2,382
	Multi Passenger Vehicle <10	1,020
	Delivery Van	237
	Subtotal	**5,657**
Trucks	Motor Home	3
	Multi Passenger Vehicle 10+	108
	Bus	63
	Truck	1,074
	Trailer	1,135
	Tractor Truck	34
	Subtotal	**2,417**
Other		12
Total		**8,086**

C. Environmental Implications

Highway vehicles are a major contributor to air pollution in the U.S., producing a significant percentage of key chemicals including carbon monoxide (CO – 63%), nitrogen oxides (NOx – 36%), and hydrocarbons (29%) that cause smog and health problems. In the United States, 146 million people live in counties where monitored air pollution levels in 2002 reached unhealthy levels (FuelEconomy.gov, 2006e).

Better fuel economy had little effect on the pollutant emissions considering that vehicle emissions are regulated in the U.S. on a grams-per-mile basis rather than a grams-per-gallon-of gasoline basis, and that better fuel economy actually induces more vehicle miles to be traveled (Portney et al., 2003; Litman, 2005). However, if VMT remains constant, improved fuel economy would reduce gas usage and ultimately decrease the total traffic emission.

D. Economic Implications

The United States consumed an estimated 20.6 million barrels of petroleum products per day in March 2005, of which 13 million barrels were imported (EIA 2005); an estimated cost of over $3 billion a week. Regardless of the perverse effect that better fuel economy may induce more traveled vehicle miles and consequently increase costs of the associated issues such as congestion and safety, improved fuel efficiency yields economic benefits and may mitigate the dependency of U.S. on energy imports. It is estimated that when both cars and light trucks increase their gas mileage by 3.8 mpg, an overall fuel consumption saving of 10 percent would be expected, which is estimated as a monetary saving of $3.6 billion per year (Congressional Budget Office, 2003). The California Energy Commission estimates a net effect of reducing light-vehicle fuel consumption by 4 percent by 2020, saving California drivers $1.3 billion in direct non-environmental costs (which would scale to approximately $11 billion nationwide) in present value (Lovins et al. 2005).

There is no overall fuel saving estimation for increased usage rate of fuel-efficient vehicles because it varies considerably with selection of the vehicle models. For example, assuming the estimated annual 15,000 miles travel per vehicle, the fuel economy improvements for the four wheel drive GM K15 Pickup vary from 3 to 21 percent, while the manual transmission equipped Civic hybrid provides a fuel economy improvement of approximately 40 to 70 percent. Similarly, fuel economy improvements for diesels range from about 25 percent to nearly 55 percent and these vehicles also offer relatively high savings in fuel usage (Heavenrich, R. M., 2005).

E. User Values and Behavior Implications

The difference between a car that gets 20 MPG and one that gets 30 MPG amounts to $550 per year in today’s price of gas (FuelEconomy.gov, 2006f). Improved gas mileage comes from both fuel-efficient vehicle choices and driving behaviors. Many fuel-efficient vehicles double the gas mileage of traditional models. Good driving behaviors can also considerably save fuel. These behaviors include smooth driving, avoiding excessive idling, reasonably planning and combining trips, and regularly maintaining vehicles.

F. Current Policy Framework

In the Energy Policy and Conservation Act of 1975 (EPCA), Congress created the Corporate Average Fuel Economy (or CAFE) program. This program consistently sets and updates fuel economy standards to be met by vehicle manufactures and dealers in the U.S. domestic market. Currently, these standards are 27.5 miles per gallon (mpg) for cars and 20.7 mpg for light trucks (which should increase to 22.2 mpg by 2007). The CAFE program is only one of many policies that could reduce petroleum consumption (Congressional Budget Office 2003).

Besides CAFE, a variety of other approaches have been put forward that would have the effect of promoting greater fuel economy. These alternatives include gasoline taxes, insurance reform, and federal tax incentive. Listed in Table 3 are the available incentives and laws for fuel-efficient vehicles by state (U.S. Department of Energy 2006b).

1. Gasoline Taxes: The federal government began levying a tax on gasoline in 1932. Since then, the tax has increased gradually over the years, from an initial rate of 1 cent per gallon to today's 18.4 cents per gallon. Including state and local taxes on gasoline, which average 22.6 cents per gallon, the average tax in the United States is about 41 cents per gallon (Congressional Budget Office, 2003). For economic efficiency grounds alone, raising the gasoline tax would be an effective approach to reducing gasoline consumption rather than tightening CAFE standards, because it exploits all potential behavioral responses for reducing fuel use (Congressional Budget Office 2003).

2. Insurance Reform: Recently, an insurance approach known as pay-as-you-drive (PAYD) insurance has been made public. The advent of global positioning systems (GPS) and on-board telemeter devices have made it possible to enforce the insurance by monitoring vehicle use. Its limitation is that it provides no incentives to improve fuel economy, as it penalizes miles driven rather than fuel use (Congressional Budget Office 2003). Another insurance approach is Pay-at-the-Pump car insurance (PATP). This approach suggests that the basic third-party property-damage and bodily-injury insurance can be bought at the fuel pump via the existing state fuel-tax system and repaid to each state's insurance issuers in proportion to their current-year market share. This is simply a smarter way to pay about one-third of an insurance bill, and reduces everyone's bills because there are no longer any uninsured motorists (Lovins et al. 2005).

3. Federal Tax Incentive: The federal government has put forth federal income tax incentives for fuel-efficient vehicle purchases such as HEVs. According to the tax regulation, qualifying hybrids placed into service after December 31, 2005 may be eligible for a federal income tax credit up to $3,400, or a tax deduction of up to $2,000. Many states and local governments also provide tax incentives to encourage the purchase of hybrids (FuelEconomy.com, 2006g).

4. Feebate: The feebate program provides a rebate for, or levies a fee on each new vehicle depending on its efficiency. Buyers of new light vehicles that exceed a certain annually defined fuel economy benchmark would receive a rebate to be subtracted from the purchase price. Therefore, buyers of new vehicles with fuel economies lower than the pivot point for vehicles of that size would pay a corresponding surcharge on

their purchase price (Lovins et al. 2005; Langer 2005). California and Ontario have been operating similar programs and several other states, including Vermont and Massachusetts, have been considering the program for a long time.

Table 3
Fuel-Efficient Vehicle Related Incentives and Laws by State

State	Incentive/ Regulation	Description
Arkansas	Hybrid Electric Vehicle (HEV) Rebate	The HEV Rebate Program, administered by the Arkansas Energy Office, provides an incentive to state agencies to purchase new HEVs.
California	Alternative Fuel and Hybrid Electric Vehicle Incentives	Farmers Insurance provides an insurance discount for hybrid electric vehicle and alternative fuel vehicle owners. Owners can cave 5% on all major insurance coverage.
Colorado	Alternative Fuel Vehicle (AFV) and Hybrid Electric Vehicle (HEV) Tax Credit	An income tax credit is available from the Colorado Department of Revenue for the incremental cost of purchasing an AFV, or for the conversion of a vehicle to operate using an alternative fuel. HEVs also qualify for this incentive.
Connecticut	Alternative Fuel Vehicle (AFV) and Hybrid Electric Vehicle (HEV) Tax Exemption	Between October 1, 2004 and October 1, 2008, new HEVs with a U.S. Environmental Protection Agency fuel economy rating of at least 40 mpg are also exempt from sales tax.
District of Columbia	Hybrid Electric Vehicle (HEV) and Alternative Fuel Vehicle (AFV) Tax Exemption	It allows for the exemption of vehicle excise taxes for owners of HEVs and clean fuel vehicles. Additionally, vehicle registration fees for HEVs and clean fuel vehicles are reduced to $36.00 per year.
Maine	State Fleet Fuel Economy Mandate	The Departments of Administrative and Financial Services, Transportation, Public Safety, and other agencies shall continue to improve the overall fuel economy of the state fleet.
	Fuel Efficient Vehicle Acquisition Requirements	The State Purchasing Agent may not purchase or lease any car or light duty truck for use by the State or any department or agency of the state unless, beginning January 1, 2000, the car has a manufacturer's estimated highway mileage rating of at least 45 miles per gallon and the light-duty truck has a manufacturer's estimated highway mileage rating of at least 35 miles per gallon.
Maryland	Hybrid Electric Vehicle (HEV) Exemption from Vehicle Testing Requirements	A qualified HEV is exempt from certain mandatory motor vehicle emissions test and inspection requirements if the vehicle obtains a rating from the U.S. Environmental Protection Agency of at least 50 miles per gallon during city fuel economy tests.
Mississippi	Fuel Efficient and Alternative Fuel Vehicle Use	The Bureau of Fleet Management will encourage the use of fuel efficient or hybrid vehicles appropriate for the state agency’s intended purpose and, when feasible, the use of alternative fuels, including but not limited to, ethanol or bio-diesel.
North Carolina	Alternative Fuel Use and Fuel Efficient Vehicle Requirements	By January 1, 2006, state-owned vehicle fleets with more than 10 motor vehicles designed for highway use must develop and implement plans to improve the use of alternative fuels and efficient vehicles. The plans must enable the state-owned fleets to achieve a 20% reduction or displacement of the current petroleum products consumed by January 1, 2010.

Table 3
Fuel-Efficient Vehicle Related Incentives and Laws by State (continued)

State	Incentive/ Regulation	Description
Oregon	AFV, HEV and Refueling Infrastructure Tax Credit	A Business Energy Tax Credit is available to business owners who invest in AFVs or HEVs for business use. The tax credit is 35% of the incremental cost of the system or equipment and is taken over five years.
	Alternative Fuel Vehicle (AFV) and Hybrid Electric Vehicle (HEV) Tax Credit	In the case of a new HEV, residents may apply for a total tax credit of up to $1,500.
	Electric and Hybrid Electric Vehicle (HEV) Registration Fees	The registration period for electric and hybrid electric vehicles is a biennial period, except for new vehicles for which new registration plates will be issued.
Pennsylvania	Alternative Fuel Vehicle (AFV), Hybrid Electric Vehicle (HEV) and Refueling Infrastructure Funding	The Alternative Fuels Incentive Act established the Alternative Fuels Incentive Grant (AFIG) which provides financial assistance and information on alternative fuels, AFVs, HEVs, anti-idling technologies that use alternatives to diesel fuel for heavy duty trucks, and advanced vehicle technology research, development, and demonstration.
	Hybrid Electric Vehicle (HEV) Pilot Program	Under the pilot program, the state will add 30 HEVs to the state fleet by 2006, 50 HEVs for model year 2008, and 75 HEVs by model year 2010. By model year 2011, at least 25% of all new passenger vehicles purchased for the Commonwealth fleet will be HEVs.
Rhode Island	Alternative Fuel Vehicle (AFV) and Hybrid Electric Vehicle (HEV) Acquisition Requirements	The state is required to take actions including the following: 1) At least 75% of state motor vehicle acquisitions must be AFVs, and the remaining 25% must be HEVs to the greatest extent possible; 2) All new light-duty trucks in the state fleet must achieve a minimum of 19 miles per gallon (mpg) city and achieve a minimum certification of a low emission vehicle, and all new passenger vehicles in the state fleet must achieve a minimum of 23 mpg city.
Vermont	Fuel Efficient Vehicle Acquisition Requirements	All state government agencies, offices, and departments are directed to purchase the most fuel efficient vehicles available in each vehicle class according to specifications set by the Working Group. This directive expires on July 1, 2020.

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ISSUE/TOPIC: What fuel savings are achievable by increasing the number of fuel-efficient vehicles in Kansas?

A. Topic/Issue Description

It is estimated that when both cars and light trucks increase their gas mileage by 3.8 mpg, an overall fuel consumption saving of 10 percent would be expected, which is estimated as a monetary saving of $3.6 billion per year (Congressional Budget Office, 2003). The California Energy Commission estimates a net effect of reducing light-vehicle fuel consumption by 4 percent by 2020, saving California drivers $1.3 billion in direct non-environmental costs (which would scale to ~$11 billion nationwide) in present value (Lovins et al. 2005).

Kansas has more than 2.4 million motor vehicles registered. These vehicles account for more than 29 billion vehicle-miles traveled and 1.7 billion gallons of fuel (gasoline and diesel) consumed every year (KDOT 2006). If the vehicle-miles traveled for Kansas vehicles remain unchanged, an increase of one mile per gallon (mpg) in the average gas mileage would save about 100 million gallons of fuel. As for nationwide, vehicles with advanced fuel efficiency technologies such as hybrids only comprise a trivial proportion in Kansas. Accounts for the insignificant share of fuel-efficient vehicles certainly include their short selling history in the US auto market, but relatively higher prices and lack of public awareness also contribute. By definition, fuel-efficient vehicles are the vehicles with improved miles per gallon (MPG) values. Therefore, since fuel-efficient vehicles such as hybrids travel many miles per gallon gas more than vehicles using only petroleum based fuels, a higher share in the auto market would yield valuable fuel savings (assuming the vehicle-miles traveled remain unchanged).

B. Existing Policies/Programs

1. Corporate Average Fuel Economy (CAFE) program, a program aimed at reducing energy consumption by increasing the fuel economy of cars and light trucks. Regulated by National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA).

2. Gasoline Taxes: both the federal and Kansas State governments levied taxes on gasoline beginning in 1932. The taxes directly penalized for the use of fuel, thereby economically encouraging travelers to save fuel and consider purchasing more fuel-efficient vehicles.

3. Federal Tax Credits: a tax incentive for hybrid electric vehicle purchases regulated by the federal government. According to this regulation, qualifying hybrids placed into service after December 31, 2005 may be eligible for a federal income tax credit up to $3,400 or a tax deduction up to $2,000.

C. Policy/Program Option

1. Gasoline Tax Increase

   The United States taxes gasoline and diesel fuel at some of the lowest rates in the world, much lower than Europe and Japan. The current fuel taxes are insufficient to prompt the purchases of efficient vehicles. Much higher taxes are the most obvious and economically doctrinaire way to signal the true social costs of buying and burning oil, and the public good of using less of it (Lovins et al. 2005).

   Pros:
   It is the most obvious and efficient way to encourage fuel economy.

   It can reduce VMTs.

   High gasoline taxes do not have to be regressive if immediately recycled into corresponding cuts in other taxes.

   Cons:
   It is politically difficult to implement.

2. Improved CAFE Standard

   Informed by detailed analyses and hearings, the standards were carefully set at levels that could be met cost-effectively (or nearly so) with straightforward available technologies. In the decade after Congress enacted Corporate Average Fuel Economy (CAFE) standards in 1975, U.S. oil use dropped 7 percent and oil imports dropped 23 percent, while GDP grew 37 percent.

   Pros:
   It can efficiently reduce the nationwide oil consumption by transportation.

   It encourages automakers to produce more fuel-efficient vehicles.

   Cons:
   Imposing mandates can be less efficient than market mechanisms.

   Automakers complain that CAFE standards can push customers toward smaller cars that do not meet their needs, might be less safe, and are far less profitable to make.

   It may lead to further increases in the share of higher fuel-efficient Japanese vehicles in the U.S. market.

3. Feebate

   The feebate program provides a rebate for, or levies a fee on each new vehicle depending on its efficiency. Buyers of new light vehicles that exceed a certain annually defined fuel economy benchmark, called the "pivot point," would receive a rebate to be subtracted from the purchase price. Therefore, buyers of new vehicles with fuel economies lower than the pivot point for vehicles of that size would pay a corresponding surcharge on their purchase price (Lovins et al. 2005; Langer 2005). California and Ontario have been operating similar programs and several other states, including Vermont and Massachusetts, have been considering the program for a long time.

Pros:
Feebates reward and propel continuous fuel economy improvement.

Feebates directly signal the value of efficiency to the buyer at the time and place of choosing the vehicle.

Feebates are completely transparent and predictable to manufacturers and customers, which makes them more efficient than standards.

Cons:
Questions remain about who pays and who benefits.

There is essentially no real-world experience to reveal the impacts of a feebate program.

If the funding source of the balance (when rebate amounts are more than fees) is available.

It may lead to more out-of-state vehicle purchases.

Fees lead to extra burden for people such as delivery workers, who must use less fuel-efficient vehicles.

Other negative impacts caused by mandatory fees charged on less fuel-efficient vehicle purchases.

4. Smart Government Fleet Procurement

The 2002 federal vehicle fleet, both civilian and nontactical military, contained more than 470,000 light vehicles and 21,000 heavy trucks. Including state and municipal fleets, the number would be nearly four million vehicles, among which, over half are light vehicles. Lovins et al. (2005) suggested that federal and state agencies should be required to purchase American-made vehicles from the 10 percent most efficient in their class, subject to operational requirements. This extends the policy in the State of Massachusetts which requires purchase of only the most efficient and best-lifecycle-value vehicles, all with ultra-low emissions and no less than 20 mpg city rating (EPA adjusted).

Pros:
Similar programs can be extended to medium and heavy vehicles.

This program will yield considerable long-term fuel savings.

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Lovins, A. B., Datta, E. K., Bustnes, O., Koomey, J. G., and Glasgow, N. J. (2005). *Wining the Oil Endgame*. Rocky Mountain Institute.

ISSUE/TOPIC: What incentives can be offered consumers to encourage them to purchase fuel-efficient vehicles?

A. Topic/Issue Description

Fuel-efficient vehicles comprise a very small percentage of total vehicles nationwide. For example, in 2005, only 0.1 percent of cars sold in the U.S. were hybrid electric vehicles (Plunkett Research, Ltd. 2006). Impedances for the popularity of fuel-efficient vehicles include their higher prices and the relatively passive public responding to governmental promotion of fuel-efficient vehicle purchases. The federal government and some state Departments of Transportation (DOTs) have put forward incentives such as income tax credits to encourage fuel-efficient vehicle purchases. However, there are no such incentives in the state of Kansas.

B. Existing Policies/Programs

1. Gasoline Taxes: Federal and state taxes on gasoline penalize the excessive use of gasoline and economically force travelers to save fuel.

2. Federal Tax Credits: a tax incentive for hybrid electric vehicle purchases regulated by the federal government. According to this regulation, qualifying hybrids may be eligible for a federal income tax credit up to $3,400 or a tax deduction up to $2,000 (FuelEconomy.com, 2006).

1. Policy/Program Options

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The United States taxes gasoline and diesel fuel at some of the lowest rates in the world, much lower than Europe and Japan. The current fuel taxes are insufficient to prompt the purchases of efficient vehicles. Much higher taxes are the most obvious and economically doctrinaire way to signal the true social costs of buying and burning oil, and the public good of using less of it (Lovins et al. 2005).

Pros:
It is the most obvious and efficient way to encourage fuel economy.

It can reduce VMTs.

High gasoline taxes do not have to be regressive if immediately recycled into corresponding cuts in other taxes.

Cons:
It is politically difficult to implement.

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   Informed by detailed analyses and hearings, the standards were carefully set at levels that could be met cost-effectively (or nearly so) with straightforward available technologies. In the decade after Congress enacted Corporate Average Fuel Economy (CAFE) standards in 1975, U.S. oil use dropped 7 percent and oil imports dropped 23 percent, while GDP grew 37 percent.

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   It encourages automakers to produce more fuel-efficient vehicles.

   Cons:
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   Pros:
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   Feebates directly signal the value of efficiency to the buyer at the time and place of choosing the vehicle.

   Feebates are completely transparent and predictable to manufacturers and customers, which makes them more efficient than standards.

   Cons:
   Questions remain about who pays and who benefits.

   There is essentially no real-world experience to reveal the impacts of a feebate program.

   If the funding source of the balance (when rebate amounts are more than fees) is available.

Fees lead to extra burden for people such as delivery workers, who must use less fuel-efficient vehicles.

Other negative impacts caused by mandatory fees charged on less fuel-efficient vehicle purchases.

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The 2002 federal vehicle fleet, both civilian and non-tactical military, contained more than 470,000 light vehicles and 21,000 heavy trucks. Including state and municipal fleets, the number would be nearly four million vehicles, among which, over half are light vehicles. Lovins et al. (2005) suggested that federal and state agencies should be required to purchase American-made vehicles from the 10 percent most efficient in their class, subject to operational requirements. This extends the policy of the State of Massachusetts which requires purchase of only the most efficient and best-lifecycle-value vehicles, all with ultra-low emissions and no less than 20 mpg city rating (EPA adjusted).

Pros:
Similar programs can be extended to medium and heavy vehicles.

This program will yield considerable long-term fuel savings.

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Lovins, A. B., Datta, E. K., Bustnes, O., Koomey, J. G., and Glasgow, N. J. (2005). *Wining the Oil Endgame*. Rocky Mountain Institute.

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OVERVIEW: CONSUMER CHOICE (SPEED LIMITS/HORSE POWER)

There are three general elements of traffic safety: the roadway, the vehicle and the driver. Engineers design roadways; auto manufacturers install safety devices in the vehicle, and legislatures enact laws. However, traffic safety depends on the driver, who chooses how to interact with the roadway, how to use the safety equipment, and compliance with the laws. Driving above a certain speed is one factor affecting efficiency of the vehicle. Simply posting speed limit signs will not ensure compliance. It is an ongoing process to develop technology trends to make drivers comply with posted speed limits. A second element of consumer choice to be considered in this section is fuel conservation when the vehicle is not in motion; i.e fuel consumption associated with truck idling.

A. Technology Trends

Speed limit compliance

1. Stationary Patrol Vehicles: Average traffic speeds tend to be closer to the posted limit in the immediate vicinity of a patrol vehicle. A Federal Highway Administration synopsis on speeding-related research noted that average speed increased to the pre-enforcement level within three days after a single episode of stationary enforcement, whereas exposure to a stationary patrol vehicle over a five-day period had the greatest effect in suppressing speeds after enforcement ended. (Information obtained from governors highway safety association, "Survey of the states speeding", 2005)

2. Laser/Radar Technology: Law enforcement has been using radar (Radio Detection and Ranging) since the late 1940s. Subsequently, many jurisdictions established governing principles and procedures for the use of radar and many courts take judicial notice of the reliability of the underlying science on which radar is based. Radar detectors and jammers, however, have compromised the usefulness of radar in some jurisdictions (1).

   New technology such as laser speed measurement, provide an alternative that is more difficult for recalcitrant speeders to detect. Moreover, laser speed measurement is able to target individual vehicles more accurately on multi-lane roads and employs laser and pulse timing technology to effect speed measurement.

3. Automated Enforcement: This system combines radar or laser measuring technology and video or photographic identification to automatically detect and record speed limit violations. Radar or infrared laser instruments detect a speeding vehicle and triggers a pre-positioned camera to photograph the vehicle's license plate and driver. The time of the violation and recorded vehicle speed are superimposed on the photograph. If the license plate number and driver can be clearly identified in the photograph, a speeding citation is issued and mailed to the registered owner. This technology can be operated as an attended or unattended system, 24-hours a day, regardless of weather conditions. Long-range performance permits it to be mounted in overpasses and covert tunnel installations (2). This technology also offers the ability to select individual lanes from multi-lane roads and eliminates obstruction of passing vehicles from non-targeted lanes.

As of March 2005, states such as Arizona, California, Colorado, North Carolina, Ohio, Oregon and Washington D.C are using this technology (3).

4. Radar Actuated Speed Display Board: Radar actuated speed display boards are the large display boards mounted on the rear of the operating unit and provides an indication of the passing vehicle's speed. The digits are usually 9-10 inches in height and are displayed in florescent orange for night-time visibility. At the operator's option (and in accordance with a jurisdictions policy), the speed display can be set to display the speeds of all passing vehicles, or only those of violators (4). Radar actuated speed display boards are of different types like:

   - Vehicle mounted
   - Roadside mounted
   - Speed display trailer

   Research conducted in Kansas to check the effectiveness of a radar actuated speed display board showed statistically significant decreases in mean speed, 85^{th} percentile speed, and percent speeding, both at the display location and as far as half a mile downstream (5). The mean speed reduction between before (without the display) and after (with the display) was about 3 mph at the display and about 1 mph half a mile downstream. Data also were collected for several hours while a Kansas Highway Patrol (KHP) vehicle was positioned at the same location. Changes in speed characteristics relative to baseline conditions were similar to those observed with the speed display at the display/vehicle location. A half-mile downstream, though, speeds were well above baseline speeds when the KHP was present.

5. Aerial Enforcement: In the Aerial Enforcement program, markings are carried out on highways at regular intervals and by Tactical Flight Officer in a surveillance aircraft, who calculates speed of the vehicle on ground with the help of a stop watch. If the vehicle is indeed speeding, the Tactical Flight Officer identifies the offender to the Traffic Enforcement Unit officers on the ground, indicating the speed at which the vehicle was traveling. Research has demonstrated that aerial speed enforcement programs have a generally positive effect in reducing highway speed.

6. Active Real-Time GPS Car Tracking Systems: GPS car tracking system transmits the location positions and other additional information, like speed and direction of vehicle, direct to the user. There are a lot of different systems available, depending on the country, provider, etc. Generally, GPS location data of the unit can be transmitted via mobile/cell phone systems, radio communication and satellite systems (Information obtained from http://www.environmental-studies.de/GPS/GPS-tracking-systems/GPS-car-tracking-systems/gps-car-tracking-systems.html. Accessed on March 30, 2006.)

Technology to reduce consumption associated with Truck Idling

Truckers idle their engines while they rest for a variety of reasons, including heating or cooling, preventing start-up problems, or to operate electrical equipment. Reducing the idling time of heavy-duty trucks reduces petroleum consumption, fuel costs, engine wear and maintenance costs, emissions, and noise.

The alternatives to idling fall into two categories: onboard and off-board (external) technologies. The onboard solutions consist of direct-fired heaters, auxiliary power units (APUs), automatic engine shutdown/startup systems, and battery-powered systems. The external technologies consist of two types of electrification systems. At a truck stop, the driver would run an outdoor extension cord from the electricity source to the truck to maintain cabin comfort and power any appliances. This option requires modifying the truck's engine to facilitate plugging into the electrical connection points. The second external technology is known as a truck stop electrification (TSE) system or electrified parking space. The TSE system provides electrification to trucks to operate air conditioning, television and other electric equipments without any modification to the truck. There are currently fewer than 50 TSE stations in eleven states—Alabama, Arkansas, California, Georgia, Maryland, New Jersey, New York, North Carolina, South Carolina, Tennessee, and Texas (6).

B. Current Infrastructure / Management Framework

According to the Current Infrastructure and Management Framework, roadways in Kansas have speed limit and authority handling, as shown in Table 1, for each of the different types of roadways.

Table 1
Kansas Posted Speed Limits

Highway Classification	Posted Speed Limit (mph)	Authority Handling
Interstate	70	Federal Highway Administration (FHWA)
State highways	65	FHWA, KDOT
Rural roads	55	FHWA, KDOT and City
City street	30	City

Public education and awareness are one of the contributing factors to encourage speed compliance. Research shows that compliance with, and support for, traffic laws can be increased through aggressive, targeted enforcement combined with a vigorous public information and education program. Kansas Corporation Commission's (KCC) energy program distributes pamphlets on "Auto Energy Saving Tips" as a means to educate people.

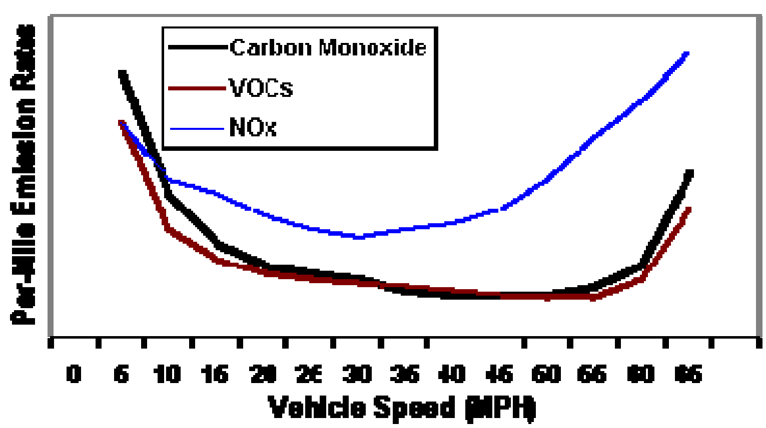
C. Environmental Implications

Green house gases like Carbon Monoxide (CO), Volatile Organic Compounds (VOCs) and Nitrogen Oxides (NOx) are harmful to the environment and play a major role in the depletion of the Ozone layer. It is important to minimize the emission of these gases into the environment. Factors affecting emission of green house gases from the vehicles are as follows:

- Characteristics of vehicles
- Atmospheric conditions
- Driving characteristics.

Driving characteristic is one of the factors affecting emission of the pollutants from vehicles. As shown in Figure 1, a study was conducted to find relationship between speed of vehicle and emission of various green house gases. The study showed that emission of pollutants is higher for vehicles traveling below 20 mph and above 60 mph. Hence, the speed of a vehicle has a significant role in the emission of pollutants to the environment (7).

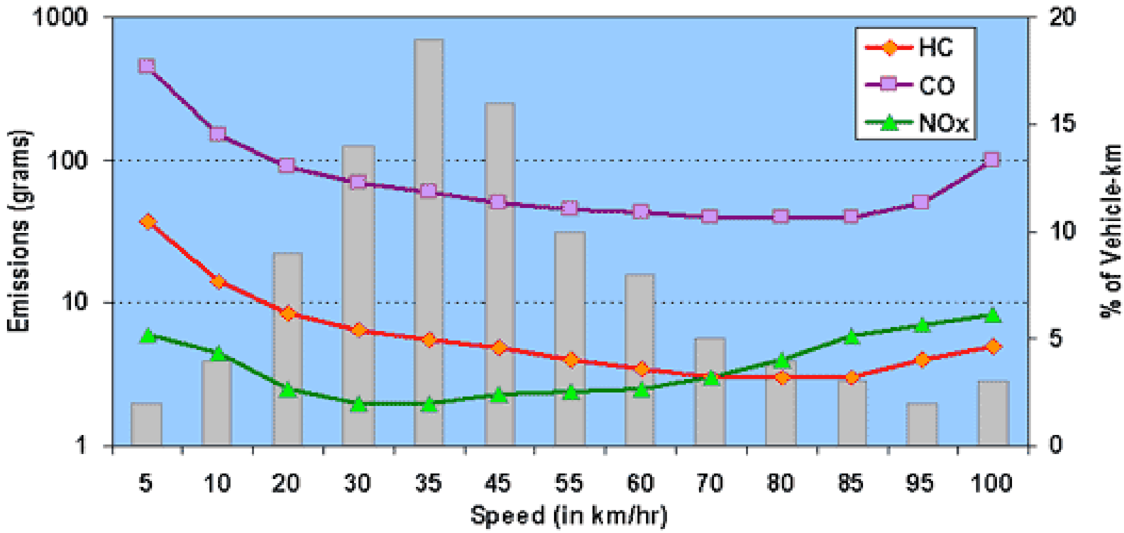
Figure 1
Speed Versus Emission of Green House Gases



Source: - http://www.vtpi.org/tdm/tdm12.htm

Figure 1 (Cont'd.)

The graph below shows the emission of different green house gases corresponding to different speed of vehicle for urbanized area.

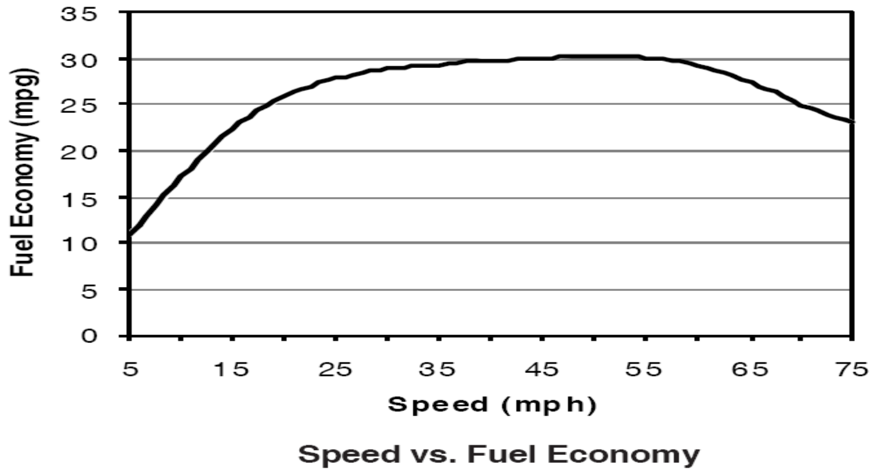


Source: Adapted from W.P. Anderson et al (1995) Simulating Automobile Emissions in an Integrated Urban Model, Paper presented at the Conference of the American Association of Geographers, Chicago, Illinois.

D. Economic Implications

Each vehicle reaches its optimal fuel economy at a different speed; however, fuel economy usually decreases as the vehicle travels above 60 mph. It is estimated that for each 5 miles per hour driven over 60 mph, a reduction of 7-23 percent can be expected in fuel consumption. According to official energy statistics website http://eia.doe.gov/, average daily consumption of gasoline in Kansas is approximately 3.3 million gallons per day. According to graph shown in Figure 2, fuel economy decreases when traveling below 25mph and above 60mph.

Figure 2
Speed Versus Fuel Economy.

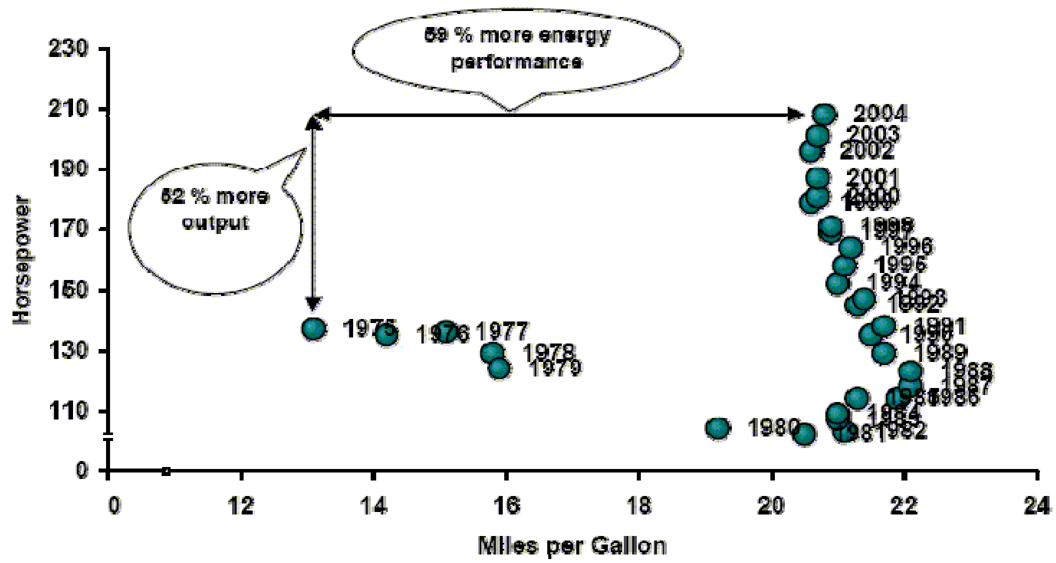


Source: http://www.fueleconomy.gov/feg/driveHabits.shtml

E. User Values and Behavior Implications

When buying a car, some consumers look for high horsepower, fuel efficiency, durability, cost and make of the car. However, the trend in the U.S. has been to buy cars with higher horsepower. Technological advances have helped to provide more horsepower without substantial decline in fuel efficiency. There are limits to maintain the fuel economy, figure 3 provides an example of the horsepower and on-road fuel economy of light-duty vehicle from 1975-2004. From 1975 to 2004 light-duty vehicle provides 52 percent more output and 59% increase in energy performance.

Figure 3
Sales-weighted Horsepower & On-road fuel economy for new light-duty vehicles 1975-2004 model years.



Source: Environmental Protection Agency, Fuel Economy Trends 2004 accessed from http://www.eia.doe.gov/emeu/rtecs/nhts_survey/2001/

Behavior implications

1. Aggressive Driving: Speeding, rapid acceleration and braking can lower gas mileage by 33 percent at highway speeds and by 5 percent around town. KDOT conducts spot speed studies on various sections of roadways in Kansas to check the speed limit compliance. In 2005, KDOT conducted spot speed studies on various roadway sections in Kansas, which revealed that 85th percentile speed on which people travel is generally 10 mph higher than the posted speed limit (9).

2. Idling: Each year, U.S. trucks consume more than 800 million gallons of diesel fuel—without even moving. Truckers idle their engines for a variety of reasons while they rest. These reasons include heating or cooling, preventing start-up problems, or to operate electrical equipment. Reducing the idling time of heavy-duty trucks reduces petroleum consumption, fuel costs, engine wear and maintenance costs, diesel emissions, and noise.

   Argonne National Lab estimated that based on the approximately 460,000 long-haul trucks currently operating in the United States, idle reduction technologies could reduce diesel fuel use by 838 million gallons per year. That wasted diesel fuel translates to $1.4 billion that could be saved by drivers using idle reduction technologies. By reducing the amount of time that trucks idle, estimated at about 6 hours per day, drivers can significantly reduce engine wear and the associated maintenance costs. Routine maintenance can be performed less often and trucks can travel farther before needing an engine overhaul.

In addition, Argonne National Lab estimated that idle reduction technologies used by the approximately 460,000 heavy-duty trucks operating on diesel fuel can reduce emissions of NO_x by 140,000 tons, CO by 2,400 tons, and CO_2 by 140,000 tons per year (10).

The Truck Stop Electrification Station Locator (TSE) was developed through an inter-agency agreement by the U.S. Department of Energy's (DOE's) and National Renewable Energy Laboratory (NREL), with funding from the U.S. Department of Transportation's (DOT's) Federal Highway Administration (FHWA). Truck stop electrification allows truckers to plug in their long-haul tractor-trailers so they can operate the heater, air-conditioner and run electrical appliances such as refrigerators or televisions when they are resting during their federally required rest periods. The mapping tool is available on the Clean Cities Web site at (http://www.eere.energy.gov/cleancities/idle/station_locator.html). There are currently fewer than 50 TSE stations in eleven states—Alabama, Arkansas, California, Georgia, Maryland, New Jersey, New York, North Carolina, South Carolina, Tennessee, and Texas.

F. Current Policy Framework

Speed limit compliance

According to Kansas's speed statute K.S.A 8-1558, it is a violation of Kansas's law to speed as little as one mile per hour over the posted speed limit. However, Kansas state statute states that speed violations of ten or less miles per hour over the speed limit in 55 to 70 mile per hour zones will not count as moving violations for the purpose of driving records (11).

A number of states have imposed additional sanctions for speeding in construction zone and/or school zones. Kansas's law imposes a double fine for speeding in a construction zone; all but three states have speeding sanctions for work zone speeding. Kansas is one of eighteen states that do not impose additional sanctions for speeding on a school zone. Appendix I provide a list of state sanctions for speeding in a work zone and school zone (12).

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10. Data obtained from US Department of Energy website http://www.eere.energy.gov/cleancities/idle/idle_benefits.html

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12. Summary Table of Special Sanctions for Exceeding the Speed Limit in either a Construction or School Zone accessed from http://www.nhtsa.dot.gov/people/injury/enforce/speedlaws501/summary_schoolzone.html access date June 14, 2006.

APPENDIX I

STATE	SANCTIONS FOR SPEEDING IN A CONSTRUCTION ZONE	SANCTIONS FOR SPEEDING IN A SCHOOL ZONE
AK		**Six (6) points** are assessed on a person's record for exceeding the speed limit in school zone.
AR	An additional fine, which is equal to all of the other fines, is imposed for exceeding the posted speed limit in a highway work zone when construction personnel are present. I.e., the fine is **double** the amount that would otherwise be imposed.	1st offense: Jail-**1 to 10 days**/fine-**$25 to $100** 2nd offense (within 1 year): Jail-**5 to 25 days**/fine-**$50 to $250** and license suspension for **6 months** Subsequent offense (within 1 year): Jail-**25 days to 6 months**/fine-**$250 to $1,000** 3rd offense (within 1 year): License suspension for **1 year**
CO	If a speeding offense occurs in a construction zone, the designed fines and surcharges are **double** the usual amount.	If a speeding offense occurs in a school zone, the designed fines and surcharges are **double** the usual amount.
CT	If a speeding offense occurs in a construction zone, the designed fine is **double** the usual amount.	
FL	For exceeding the speed limit in a construction zone (except for speeds £5 MPH over the posed speed limit where only a **warning** is issued), the designed fine is **double** the amount in the fine schedule. Note: If a person decides to adjudicate the speeding offense in a construction zone, the fine is not more than **$1,000**.	For exceeding the speed limit in a school zone, the designed fine in the schedule is **$50** if the speed limit was exceed by £5 MPH. Otherwise the fine is **double** the amount in the fine schedule. Note: If a person decides to adjudicate the speeding offense in a school zone, the fine is not more than **$1,000**.
GA	Jail-not more than **12 months**/fine-**$100 to $2,000**	

IL	There is a fine of **$150 (mandatory) to $1,000**. There is an additional fine of **$50** which is used for school safety.	There is a fine of **$150 (mandatory) to $1,000**. There is an additional fine of **$50** which is used for school safety.
IN	The court may order a person to pay a fee of **$25** for exceeding a worksite speed limit.	A fine of not more than **$1,000**.
IA	The fine is **double** the amount in the fine schedule.	
KS	The fine is **double** the usual amount.	
KY	If a speeding offense occurs in a construction zone, the designed fine is **double** the usual amount.	
ME		The fine is **double** the amount in the fine schedule.
MD		A fine of not more than **$1,000**
MI	A fine that is **double** that prescribed by law.	Imprisonment for not more than **90 days** and a fine that is **double** that prescribed by law (i.e., not >$200).
MN	A surcharge is assessed which **equals the fine**. However, the surcharge cannot be **<$25**.	A surcharge is assessed which **equals the fine**. However, the surcharge cannot be **<$25**.
MS	For exceeding the posted speed limit in a "highway work zone," there is a fine of not more than **$250**.	
MO	For speeding in a construction zone, a person is assessed an additional fine of **$35**.	

MT	If a speeding offense occurs in a Awork zone,@ the designed fine is **double** the usual amount.	
NE	If a speeding offense occurs in a construction zone, the designed fine is **double** the usual amount.	If a speeding offense occurs in a school crossing zone, the designed fine is **double** the usual amount.
NV	There is an **additional** sanction which is **equal** to the original sanctions imposed for exceeding such limit. Imprisonment sanctions for the original and additional sanctions must run consecutively. However, the combined sanctions cannot exceed 6 months of imprisonment, $1,000 or 120 hours of community service.	
NJ	The fine is **double** the usual amount.	
NY	Exceeding the speed limit £10 MPH: Fine-**$60 to $100** Exceeding the speed limit >10 MPH but <30 MPH: Jail-Not more than **30 days**/fine-**$120 to $100** Exceeding the speed limit >30 MPH: Jail-Not more than **30 days**/fine-**240 to $400** For a 2nd offense (within 18 months) for any of the above offenses, the fine is increase by **$100**. For a subsequent offense (within 18 months) for any of the above offenses, the fine is increase by **$250**.	Exceeding the speed limit by £10 MPH: Fine-**$60 to $200** Exceeding the speed limit by >10 MPH but £30 MPH: Jail-Not more than **15 days**/fine-**$120 to $400** Exceeding the speed limit by >30 MPH: Jail-Not more than **30 days**/fine-**$240 to $800** For a 2nd offense (within 18 months) for any of the above offenses, the fine is increase by **$100**. For a subsequent offense (within 18 months) for any of the above offenses, the fine is increase by **$250**.
NC	There is a fine of **$250** (mandatory).	There is a mandatory **$25** fine and **3 points** are assessed against a person's driving record.
ND	Fee schedule for exceeding the speed limit by 1 to 10 MPH-**$40** Fee schedule for exceeding the speed limit by >10 MPH-**$40** plus $1 for each MPH over 10 MPH	

OH	If a speeding offense occurs in a construction zone, the designed fine is **double** the usual amount.	
OR	The fine is **80%** of the maximum fine established for the violation.	The fine is **80%** of the maximum fine established for the violation.
PA	If a speeding offense occurs in a construction zone, the designed fine is **double** the usual amount.	Exceeding the speed limit in a school zone-**$35** plus $2 for every MPH in excess of 5 MPH
SC	A jail term of not more than **30 days** and/or a fine of **$75 to $200.**	
SD	If a speeding offense occurs in a construction zone, the designed fine is **double** the usual amount.	
TN	For speeding in a construction zone, a person is subject to a fine of from **$250 (mandatory) to $500**. The following points have been assigned for speeding in a construction zone: Speeding violations where the vehicle's speed was not noted on the citations-**3 points**; exceeding the speed limit 1 through 5 MPH-**2 points**; exceeding the speed limit 6 through 15 MPH-**6 points**; exceeding the speed limit 16 through 35 MPH-**7 points**; and, exceeding the speed limit by 36 or more MPH-**8 points.** The following points have been assigned for speeding in a construction zone by a commercial vehicle: Speeding violations where the vehicle's speed was not noted on the citations-**4 points**; exceeding the speed limit 1 through 5 MPH-**2 points**; and, exceeding the speed limit 6 through 14 MPH-**5 points.**	

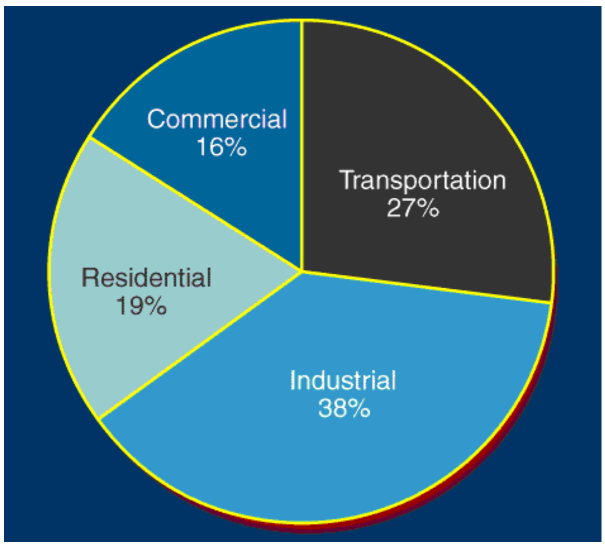
TX	If a speeding offense occurs in a construction zone, the minimum and maximum fines are **doubled**.	
UT	A person, who is convicted of speeding in a construction zone when workers are present, is subject to a fine which is **double** the amount of the fines in the Uniform Recommend Fine Schedule.	
VA	The fine for exceeding the speed limit in a construction zone is not more than **$250**.	The fine for exceeding the speed limit in a school crossing zone is not more than **$250**.
WA	There is a mandatory fine for exceeding the speed limit in a roadway construction zone which is **double** the normal amount.	There is a mandatory fine for exceeding the speed limit in a school or playground crosswalk which is **double** the normal amount.
WV	A fine of not more than **$200** Exceeding the construction zone speed limit by ³15 MPH, a jail term of not more than **20 day**.	A fine of **$100 to $500** Exceeding the school zone speed limit by ³15 MPH when one or more children are in the zone, a jail term of not more than **6 months**.
WI	If a speeding offense occurs in a construction zone, the maximum and minimum fines are **double**.	If a speeding offense occurs in a designated school zone, the maximum and minimum fines are **double**.
WY	When operating motor vehicles with a gross vehicle weight >26,000 lbs., persons, who exceed a construction zone speed limit by 6 MPH, are subject to a fine of **$100**. This fine appears to be mandatory.	

ISSUE/TOPIC: How does driver indifference of speed limits impact energy use?

A. Topic/Issue Description

According to the statistics of energy consumption in the U.S., Kansas ranks 31st among all the states for energy consumption in transportation sector, with the total of 287.8 Trillion Btu of energy consumption in the year 1999. Transportation and Industrial sectors are the two largest consumers of energy in Kansas. The pie chart below shows the break up of energy consumption in Kansas.

Figure 1
Kansas energy consumption by sector, 1999



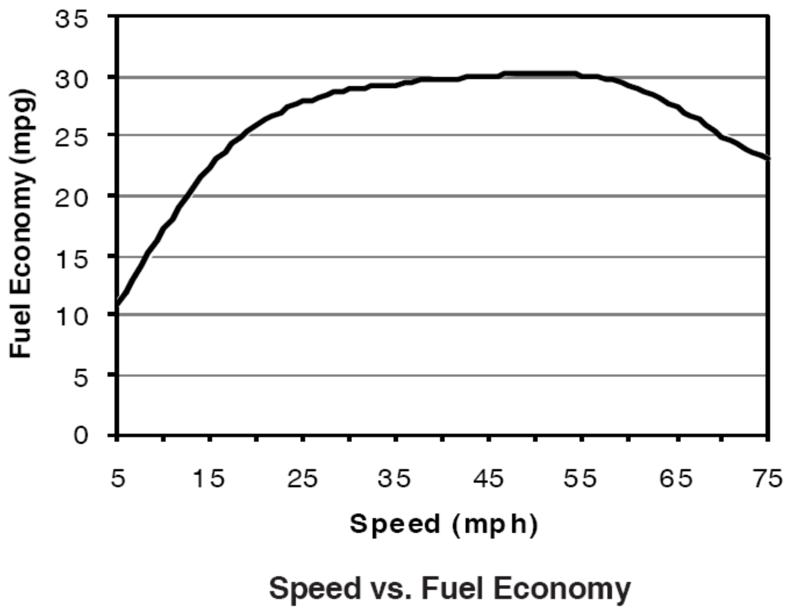
http://www.kansasenergy.org/

Hence energy consumption in the transportation sector will have a great impact on total consumption of energy in Kansas. Various activities related to transportation sector that consumes energy are as follows:

- Vehicle operation.
- Vehicle manufacture and maintenance.
- Infrastructure construction and maintenance.
- Energy generation.

Speeding is one of the factors influencing consumption of energy, which falls under the category of vehicle operation as mentioned above. Each vehicle reaches its optimal fuel economy at a different speed limit; however, fuel economy usually decreases as the vehicle travels above 60 mph. It is estimated that for each 5 miles per hour driven over 60 mph can reduce fuel economy by 7-23% (2). As shown in Figure 2, idling and speeding over 60 mph reduces fuel economy.

Figure 2
Speed Vs Fuel Economy.



Source: [US Department of Energy website http://www.fueleconomy.gov/feg/driveHabits.shtml](http://www.fueleconomy.gov/feg/driveHabits.shtml)

Simply posting a speed limit sign will not ensure compliance. Rather, effective speed management requires a multifaceted approach: the setting of rational speed limits; a public education campaign that fosters public support; and enforcement and sanctions. Although many drivers will voluntarily comply with rational speed limits, a minority of drivers will obey the law only when they perceive a credible threat of detection and punishment.

KDOT conducts spot speed studies on various sections of roadways in Kansas to check speed limit compliance. Spot speed studies conducted by KDOT in 2005 on various roadway sections in Kansas revealed that 85th percentile speed on which people travel is generally 10 mph higher than the posted speed limit.

B. Existing Policies/Programs

1. Speed Limits: Speed limits should promote safe travel, and should be perceived by the public as safe and reasonable. If the public does not understand the consequences of speeding to themselves and others, they are less likely to adjust speeds for traffic and weather conditions, or to comply with posted speed limits. KDOT has established speed limits on the state highway system that encourages voluntary compliance. Based on speed studies and roadway environment, the posted speed limit is set so that 85% of drivers are traveling at or below the posted speed.

2. Education, Public Information and Enforcement: State and local enforcement should focus on the types of drivers and situations where speeding has a significant impact on

public safety. Speed enforcement must be complemented by focused public information and education campaigns. Research shows that compliance with, and support for, traffic laws can be increased through aggressive, targeted enforcement combined with a vigorous public information and education program. This approach has been successful in addressing impaired driving, occupant protection, red-light running, and commercial motor vehicle safety issues. Public information and education also contribute to public support for speed management by increasing the awareness of the consequences of speeding (3). Kansas Corporation Commission's (KCC) energy program distributes pamphlets on "Auto Energy Saving Tips" as a means to educate people.

3. Advance Technologies: Advance Technologies used currently, such as automated speed enforcement, speed display trailers, radar/laser, etc., have proven to be an effective means to encourage speed compliance. The state of Kansas uses radar/laser, speed trailers in some locations, to encourage speed compliance.

C. Policy/Program Option:

1. Automated Speed Enforcement: Automated speed enforcement (ASE) is another emerging law enforcement tool. Basically, an ASE program combines a computer, radar unit, and a camera. The radar clocks the speed, the computer triggers the camera, and the camera snaps a picture of the vehicle and/or driver, and the citation is mailed to the vehicle owner. Currently, only Arizona, Colorado, Oregon, and Washington DC have an ongoing ASE program.

   Pros:
   Automated Speed Enforcement technique can record time and speed of violating vehicle and can be recorded on photograph of the license plate of the vehicle. If the license plate number and driver can be clearly identified in the photograph, a speeding citation is issued and mailed to the registered owner. This technique can effectively catch and mail speeding citations to the violator.

   This technology can be operated as an attended or unattended system, 24-hours a day, regardless of weather conditions.

   Long-range performance permits it to be mounted in overpasses and covert tunnel installations.

   It also offers the ability to select individual lanes from multi-lane roads and eliminates obstruction of passing vehicles from non-targeted lanes.

   Cons:
   ASE suffers many of the same criticisms directed at photo red light enforcement. The controversy surrounds not the reliability of ASE, but rather the more thorny issues of privacy and responsibility. Some ASE programs hold the owner vicariously liable; thus, reducing the charge to a civil fine. Other jurisdictions hold the driver responsible; thus, invoking identification problems and raising Fifth Amendment issues. Although

sanctioning the owner presents fewer legal hurdles, it is questionable as to whether driver behavior is affected by fining a non-driving owner.

Aside from the legal issues, public opinion has not always looked favorably upon ASE (or photo red lights). Fairness issues regarding tolerances, lack of opportunity to present mitigating circumstances, the appearance of revenue generating, the depersonalization, and even the cold efficiency of ASE have worked against the ASE programs.

Finally, although ASE may be highly efficient, the lack of contact between law enforcement and the violator negates any opportunity to discover additional crimes. Moreover, the subsequent use of the photo as an investigatory tool, or as evidence of an unrelated crime is highly controversial. Thus, an ASE program's application to a comprehensive law enforcement scheme may be limited. Therefore, automated enforcement, particularly photo radar, can provide an effective complement to traditional enforcement methods, particularly where police patrol vehicles cannot be deployed effectively or safely, and where agencies do not have the necessary resources to sustain a successful traffic safety program. However, successful introduction of automated enforcement may require legal authority and support from the public (3).

2. Strict Laws and Regulations: One of the factors that influence driver's behavior is the perception of risk. Perception of risk can be referred to as the tendency to obey certain laws based on whether the driver believes he or she will be cited. When speeding laws are strict, then the perception of risk increases and the driver will tend to obey the law. Some states, like Iowa, and New Mexico have law of license suspension for drivers not obeying the speeding law. According to Iowa Legislation law 321.210(2)(d) II, for licensing action based on a serious violation (i.e. exceeding the speed limit by ≥25 MPH), state regulations provide for graduated license suspension periods depending upon the speed of the vehicle; e.g. a person convicted of speeding ≥25 mph but <26 mph over the speed limit is subject to a 60 day suspension. Whereas, a person convicted of speeding ≥49 mph over the speed limit is subject to a 1 year license suspension (4).

   According to California legislation law (VC §28150), no vehicle shall be equipped with any device that is designed for, or is capable of, jamming, scrambling, neutralizing, disabling, or otherwise interfering with radar, laser, or any other electronic device used by a law enforcement agency to measure the speed of moving objects (5). Many drivers use radar detectors in cars for speeding on the freeway as they can get a prior warning of cops in the surrounding area. Use of Radar detectors is legal in Kansas except for commercial vehicles with gross vehicle weight ratings of 10,000 pounds or more. Various speeding laws of different states are shown in appendix II.

   Pros:
   Strict law enforcement will increase the driver's perception of risk and it will compel them to obey speeding law.
3. Speed Display Trailers: The Speed Display Trailer (SDT) is a small device that usually consists of a changeable speed display, a radar speed detector, and a regulatory speed limit or advisory speed sign. The speeds of approaching vehicles detected by the radar are displayed in real-time. A static sign that reads "Your Speed" is also attached to the

display so passing drivers receive immediate feedback as to how fast they are driving and how their speed relates to the posted speed limit. The digits are usually 9-10 inches in height and are displayed in florescent orange for night-time visibility. At the operator's option (and in accordance with a jurisdictions policy), the speed display can be set to display the speeds of all passing vehicles, or only those of violators. Radar actuated speed display boards are of different types like:

- Vehicle mounted
- Roadside mounted
- Speed display trailer

A research was conducted on a segment of Kansas Route 10 (K10), west of Lawrence, Kansas, immediately north of the US40 interchange. The segment is a rural 2-lane highway with an AADT of 8,830 vpd and a posted speed of 65 mph. The results of the data analysis show that the display caused both a reduction in mean speed and an increase in speed uniformity. The reduction in mean speeds was 3.7 mph, and the percentage of vehicles complying with the posted speed increased by 30%. Overall, the display appears to be effective at reducing speeds, and increasing speed uniformity and posted speed compliance, and its effectiveness does not quickly dissipate, as is commonly perceived to be the case (6).

In April 1997, the San Diego County Sheriff's Department found a Kustom Signal's radar trailer to be extremely effective. Before placement of the trailer, 77% of the drivers exceeded the school zone's 20 mph limit. After placement, only 20% of drivers exceeded the limit. Speed Measurement Laboratories, Inc. (SML) found that Applied Concepts, Inc. (i.e., Stalker) radar trailers, placed in El Paso and Del Rio, TX, school zones produced sustained, long-term speed reductions and improved speed limit compliance. Before trailer placement in Del Rio, 81% of drivers exceeded the limit. After placement, only 18% were above the limit. El Paso data were almost identical with a significant speed reduction of 8.5 mph, 85th percentile with the trailer in place.

Texas A & M University's Texas Transportation Institute (Report #00-1475) found large numeral LED radar displays to be "statistically significant" in reducing speeds. The report attributes the effectiveness to visibility of the displayed speed numerals.

Dr. Geza Pesti, Department of Civil Engineering, University of Nebraska, conducted a long-term study on large digit, LED numeral speed displays. He found the "percentage of passenger and nonpassenger cars complying with the speed limit increased to 91 and 90 percent respectively" with the use of high visibility speed displays. He also found "it was equally effective day and night, with even greater effectiveness at night because of its greater night time visibility." (7)

Pros:
The speed display trailer is an effective speed reduction measure in work zones. Mean speeds are reduced by 2 to 7 mph.

Speed limit compliance is increased by 10 to 40 percentage points.

Drivers have shown positive attitudes toward the speed monitoring display.

Set-up and removal of the speed display trailer is easily accomplished.

The speed display trailer is a cost-effective speed control measure.

Cons:
Effectiveness of speed display trailer may decrease over time.

Although an effective speed control countermeasure, speed reductions attained with the SDT are usually less than what is desired (8).

ISSUE/TOPIC: What is the estimated loss of efficiency associated with truck idling and what options exist to reduce the loss?

A. Topic/Issue Description: Truckers idle their engines while they rest for a variety of reasons, including heating or cooling, preventing start-up problems, or to operate electrical equipment. Reducing the idling time of heavy-duty trucks reduces petroleum consumption, fuel costs, engine wear and maintenance costs, emissions, and noise.

Argonne National Lab estimates that, based on the approximately 460,000 long-haul trucks currently operating in the United States, idle reduction technologies could reduce diesel fuel use by 838 million gallons per year. That wasted diesel fuel translates to $1.4 billion that could be saved by drivers using idle reduction technologies. By reducing the amount of time that trucks idle, estimated at about 6 hours per day, drivers can significantly reduce engine wear and the associated maintenance costs. Routine maintenance can be performed less often and trucks can travel farther before needing an engine overhaul.

In addition, Argonne National Lab estimates that idle reduction technologies used by the approximately 460,000 heavy-duty trucks operating on diesel fuel can reduce emissions of NOx by 140,000 tons, CO by 2,400 tons, and CO2 by 140,000 tons per year (9).

B. Existing Policies/Programs: Currently there are no policies and programs implemented in Kansas to reduce energy consumption related to truck idling.

C. Policy/Program Option:

1. Idle restriction: Currently seventeen states have implemented idle restriction program. The details of idle restriction requirements by state are as given in Table 1.

Table 1
Truck Idling Requirements by State

State	Idle restriction requirements
Arizona	Heavy-duty diesel vehicles operated in Maricopa County with a gross vehicle weight rating of more than 14,000 pounds must limit idling to five minutes. Exemptions apply for emergency vehicles, certain traffic or weather conditions, certain driver accommodations, and idling necessary for refrigeration equipment.
California	The California Air Resources Board has adopted a new engine and in-use truck requirement and emission performance requirement for technologies used as alternatives to the truck's main engine idling. The new engine requirements require 2008 and newer model year heavy duty diesel engines to be equipped with a non-programmable engine shutdown system that automatically shuts down the engine after five minutes of idling or optionally meets a 30 gram per hour oxides of nitrogen (NOx) idling emission standard. The in-use truck requirements require operators of sleeper berth equipped trucks to

	manually shut down their engine when idling more than five minutes at any location within California beginning in 2008. The penalty for violating this measure is $100 per violation. The City of Sacramento has passed an ordinance prohibiting the idling of all heavy-duty on-road vehicles and all heavy-duty off-road equipment longer than five minutes at a given location.
Colorado	Idling of any vehicle for more than 10 minutes in any one-hour period is prohibited. Exemptions apply for the following: ambient outside air temperature of less than 20 degrees Fahrenheit for the previous 24 hours; current ambient outside air temperature of less than 10 degrees Fahrenheit; emergency vehicles; vehicles engaged in traffic operations; vehicles which are being serviced; vehicles that must idle to operate auxiliary equipment; vehicles en route to a destination that are stopped by traffic congestion.
Connecticut	School bus operators are prohibited from idling the engine of any school bus for more than three consecutive minutes when the school bus is not in motion except under the following conditions: 1) when the school bus is forced to remain motionless because of traffic conditions or mechanical difficulties over which the operator has no control, 2) when it is necessary to operate heating, cooling, safety or auxiliary equipment installed on the school bus, 3) when the outdoor temperature is below 20 degrees Fahrenheit, 4) when it is necessary to maintain a safe temperature for students with special needs, 5) when the school bus is being repaired, or 6) when the operator is in the process of receiving or discharging passengers on a public highway or public road.
Dist. of Colombia	A diesel or gasoline powered motor vehicle may not be allowed to operate for more than three consecutive minutes when the vehicle is not in motion, with the following exceptions: 1) to operate private passenger vehicles; 2) to operate air conditioning equipment on a bus for 15 minutes when 12 or more people are on board; or 3) to operate heating equipment for five minutes when the ambient temperature is 32 degrees Fahrenheit or below.
Maryland	A motor vehicle engine may not be allowed to operate for more than five consecutive minutes when the vehicle is not in motion, with the following exceptions: 1) traffic conditions or mechanical difficulties; 2) operation of heating, cooling or auxiliary equipment installed on the vehicle; 3) bring vehicle to manufacturer's recommended operating temperature; or 4) when it is necessary to accomplish the intended use of the vehicle. Violators may be subject to a fine up to $500.
Massachusetts	Unnecessary operation of the engine of a motor vehicle, while vehicle is stopped, in excess of five minutes is not permitted. This section shall not apply to (a) vehicles being serviced, provided that operation of the engine is essential to the repair, (b) vehicles engaged in the

	delivery or acceptance of goods, wares, or merchandise for which engine assisted power is necessary and substitute alternate power cannot be made available, or (c) vehicles engaged in an operation for which the engine power is necessary for an associate power need other than movement and substitute alternate power cannot be made available provided that such operation does not cause or contribute to a condition of air pollution.
Missouri	In order to restrict the emission of visible air contaminants within the City of St. Louis, motor vehicles, except for emergency vehicles, are not permitted to idle for more than 10 consecutive minutes.
Nevada	A person shall not idle the engine of a diesel truck or a bus for more than 15 consecutive minutes. The provisions of this subsection do not apply to diesel trucks or buses: for which the State Environmental Commission has issued a variance from this requirement; which are emergency vehicles; used for removal of snow; used to repair or maintain other vehicles; which are stopped due to traffic congestion; which are undergoing repair or maintenance; producing emissions that are contained and treated according to State Environmental Commission methods; which must idle to perform a specific task.
New Hampshire	New Hampshire regulations help to minimize the impact from engine idling and reduce exposure to diesel exhaust emissions by establishing a limit on the amount of time that engines are permitted to idle. The limit is based on outside temperature, as follows: Above 32 degrees Fahrenheit, 5 minute limit; between -10 degrees and 32 degrees Fahrenheit, 15 minute limit; below -10 degrees Fahrenheit, no limit.
New Jersey	A diesel powered motor vehicle may not be allowed to operate for more than three consecutive minutes when the vehicle is not in motion, with the following exceptions: 1) a motor vehicle at the place of business where the vehicle is permanently assigned may idle for 30 consecutive minutes, and 2) a motor vehicle may idle for 15 consecutive minutes when the vehicle's engine has been stopped for at least three hours. These provisions do not apply to the following: 1) a light-duty diesel vehicle; 2) a diesel bus while loading or unloading; 3) a vehicle stopped in a line of traffic; 4) a vehicle being inspected by a State or Federal motor vehicle inspector; 5) an emergency vehicle in an emergency situation; 6) a vehicle being repaired or serviced; or 7) a vehicle needing auxiliary power for equipment or for climate control. Violators will be issued fines ranging from $100 to $200 for the first offense, and up to $3,000 for repeated offenses.
New York	Heavy-duty vehicles (vehicles with a Gross Vehicle Weight Rating exceeding 8,500 pounds) are prohibited from idling for more than five consecutive minutes when the vehicle is not in motion. Exceptions may apply, including the following: idling due to traffic conditions; to maintain temperatures (under regulation) for passenger comfort; idling to provide auxiliary power or for maintenance

	purposes; hybrid electric vehicles idling to recharge batteries; idling of emergency service vehicles.
North Carolina	North Carolina local policy must prohibit unnecessary school bus idling on school grounds and prohibit the warming up of buses for longer than 5 minutes.
Pennsylvania	The Allegheny County Board of Health limits idling of heavy duty diesel vehicles. If idling more than five minutes, violators may be fined up to $500 for repeat offenses.
Texas	No driver using a vehicle's sleeper berth may idle the vehicle in a school zone or within 1,000 feet of a public school during its hours of operation. A penalty up to a $500 fine applies.
Utah	Owner or operator is not allowed to have the vehicle idle for more than 15 minutes. Vehicles may be exempted from these requirements under the following conditions: a) to supply power to a refrigeration unit to cool trailer contents, b) to provide heat or air conditioning to a sleeper unit of the vehicle, or c) emergency vehicles. However, exempted vehicles may not idle for more than 15 minutes if located within 500 feet of any residence.
Virginia	Prohibits bus engine idling for more than 10 minutes when the bus is parked, left unattended, or stopped for reasons other than traffic or maintenance.

Source: - US department of Energy website
http://www.eere.energy.gov/afdc/laws/incen_laws.html accessed on June 14, 2006.

2. Idle reduction tax incentives: Currently Washington state has on going Idle reduction tax incentives program. Tax incentives are available for the infrastructure and services that support the use of auxiliary power for heavy-duty vehicles weighing more than 14,000 pounds through on-board or stand-alone electrification systems. These incentives offer a business and occupation tax deduction and sales and tax exemption for machinery and equipment integral to providing auxiliary power at truck stops. Sales and use tax exemptions are also available for parts and labor necessary to enable heavy-duty diesel trucks to accept power for onboard electrification systems. (Information available from US department of energy website http://www.eere.energy.gov/afdc/progs/in_matrx.cgi accessed on June 14, 2006.

3. Truck Stop Electrification: The alternatives to idling fall into two categories: onboard and off-board (external) technologies. The onboard solutions consist of direct-fired heaters, auxiliary power units (APUs), automatic engine shutdown/startup systems, and battery-powered systems. Although each of these technologies offers a viable alternative to idling, cost and weight are among the factors that drivers and trucking companies need to consider when selecting a solution.
   Direct-fired heaters are small, lightweight devices usually installed in the tool or luggage compartment. They provide heat only. APU's are small, 3.7- to 7.5-kilowatt (5- to 10-horsepower) diesel-powered generators installed on the truck to provide air conditioning, heat, and electrical power to run appliances. An automatic engine

shutdown/startup system controls the engine (start and stop) based on a set time period or on ambient temperature, and other parameters (such as battery charge). Battery-powered systems provide air conditioning and heat, using a battery pack to supply the power. The battery pack is usually installed under the bunk bed in the sleeper compartment and can provide 8 to 10 hours of power depending on the capacity and voltage of the batteries. One new battery technology system, which will heat and cool the cab for more than 10 hours, has built-in components that will replace the need for several factory components, such as the under bunk heating, ventilation, and air-conditioning (HVAC) system, the standard battery box, and the starting batteries, thereby eliminating some of the weight issues related to the use of battery-powered systems.

The external technologies consist of two types of electrification systems. The first, shore power, takes its name from the process used to supply electricity to mobile users at marinas and recreational vehicle parks. At a truck stop, the driver would run an outdoor extension cord from the electricity source to the truck to maintain cabin comfort and power any appliances. This option requires modifying the truck's engine to facilitate plugging into the electrical connection points.

The other external technology is known as a truck stop electrification (TSE) system or electrified parking space. After pulling into a space, the driver rolls down the window and inserts a plastic template that is connected by a hose to an overhead truss equipped with an HVAC system and electrical power. The TSE system requires no modification to the truck.

The comparison between onboard and off board technologies, considering cost aspects and various pros and cons are as shown in Table 2.

The TSE was developed through an inter-agency agreement by the U.S. Department of Energy's (DOE's) National Renewable Energy Laboratory (NREL) with funding from the U.S. Department of Transportation's (DOT's) Federal Highway Administration (FHWA). The mapping tool is available on the Clean Cities Web site (http://www.eere.energy.gov/cleancities/idle/station_locator.html). There are currently fewer than 50 TSE stations in eleven states—Alabama, Arkansas, California, Georgia, Maryland, New Jersey, New York, North Carolina, South Carolina, Tennessee, and Texas.

The Petro Stopping Center in Bucksville, Alabama, can accommodate 81 long-haul trucks at any given time - and none of them needs to idle. Each truck can use the IdleAire Advanced Travel Center Electrification (ATE) shore power system to provide electric power, heating, air conditioning, television, and other amenities normally restricted to a home or motel room. There is also a telephone connection.

Table 2
Summary of Pros and Cons of Idle-Reduction Technologies

Technology		Cost	Pros	Cons
Onboard	Engine Control Module	$0	No extra cost, available from engine manufacturer	Does not address cab comfort
	Automatic Shutdown/Turn-On System	<$1,000	Low cost, available from engine manufacturer	Low driver acceptance
	Direct-Fired Heaters	$900–$1,200	Low cost, lightweight, available from engine manufacturer	Heat only
	Auxiliary Power Units/Generator Sets	$5,000–$7,000	Provides all needs	Expensive, heavy, noisy, maintenance, requires after-market retrofit
	Battery Powered Heating/AC	$7,000–$8,000	Provides all needs, zero air emissions	Heavy
External (Offboard)	Electrified Parking Spaces – RV Model	$6,000 per space	Lower cost	Requires modifications to truck (electric heat/AC, inverter/charger)
	Electrified Parking Spaces – All Inclusive	$18,000 per space	No truck modifications needed	Very expensive

Source: - Turchetta, Diane “Financing Idle reduction projects”, Turner Fairbank Highway Research center, March April 2005, Vol 68. No.5. Accessed from http://www.tfhrc.gov/pubrds/05mar/02.htm

Each service delivery module has a color touch screen computer that allows the driver to pay for the service with a credit card to access electrical shore power outlets, filtered heating and cooling, the Internet, television and phone service, and movies on demand. Online and phone-based help is also available. The module is attached to a long hose that is connected to an HVAC unit mounted on metal trusses erected above the parking spaces. The driver buys a window adapter (about $10) and inserts it in the passenger window. The module snap-locks into the adapter, and takes just seconds to install. The standard service package costs $1.25/hour for drivers who belong to a fleet that has an agreement with IdleAire; $1.50/hour otherwise.

Long-haul truck drivers are required by law to rest for 10 hours after 11 hours of driving, so they are accustomed to idling their engines to have power for heating or air conditioning, and to run small appliances. The idling uses 1-1.1 gallons of diesel fuel per hour, and drivers often say they do not rest well with the engine noise, vibrations, and diesel fumes. Considering price of diesel as $ 2.8/gallon, for 8-hour haul of truck total consumption of gas will be around 8 gallons costing $22, which would otherwise be $12 if TSE were used. Hence saving per truck considering 8-hour haul period is $10 per truck. These quiet-running modules save truck owners the cost of fuel and the additional engine wear. Plus, the drivers say they rest much better. IdleAire shares revenue from the system with the travel centers, which creates new revenue streams from the parking lots. The installations are staffed by IdleAire employees 24/7, so if a unit has a problem or needs maintenance, it is taken care of quickly.

<u>Funding for Truck Stop Electrification Projects:</u> USDOT, EPA, and DOE all offer Federal sources of funding for idle-reduction projects. The Congestion Mitigation and Air Quality Improvement (CMAQ) program has been the largest source of support. To date, CMAQ has funded numerous electrification projects (in operation or pending in the application process) around the country at a cost of approximately $15 to $17 million. The CMAQ program was established to fund projects and programs that reduce transportation-related congestion and emissions in non-attainment and maintenance areas. Since the beginning of the program, CMAQ has funded approximately 15,000 projects, at a total cost of $13 billion. The administration proposed reauthorizing the program in the new bill for transportation funding, the Safe, Accountable, Flexible, and Efficient Transportation Equity Act (SAFETEA), at $8.9 billion over the 6-year life of the bill.

One of USDOT's innovative financing programs, the State Infrastructure Bank (SIB), also has provided funding for idling-reduction projects. An SIB is a state-directed program that enables states to borrow funds for eligible Federal-aid projects. The state receives repayment over time, which payments can be directed toward other transportation projects. New York State, for example, successfully secured funding from its SIB to provide some of the capital needed to finance two truck stop electrification projects along the New York State Thruway.

Section 129 loans (named for Section 129 of Title 23 of the United States Code) are a similar USDOT innovative financing program, which also can be used to fund idle-reduction projects. Through Section 129, states can use federal-aid funding to make loans to private or public entities. The loans must be repaid within a 30-year period, but smaller activities like idling-reduction projects could have a shorter repayment period, which means that states will be reimbursed quickly (with interest) so they can fund more projects.

At the state level, programs such as California's Carl Moyer Memorial Air Quality Standards Attainment Program and the Texas Emissions Reduction Plan also provide financial assistance. State agencies, such as the New York State Energy Research and Development Authority - a pioneer in the field of idle reduction - and the Sacramento Municipal Utility District, also have funded numerous projects. The funding has supported projects for both onboard and external technologies. A leading manufacturer of idling-reduction equipment currently has a pending loan application on file with USDOT's Transportation Infrastructure Finance and Innovation Act program. If approved, USDOT would lend the company approximately $300 million to deploy TSE infrastructure at truck stops around the country.

Another alternative for funding might be a public-private partnership. Because several of the CMAQ-funded projects were financed through public-private partnerships, idle-reduction projects may also consider this type of stakeholder collaboration as a potential option for funding as well (10).

Pros:
Truck Stop Electrification Location will help truckers operate electrical equipment, and heating and cooling systems without keeping the engine on and, thus, reducing petroleum consumption, fuel cost, engine wear, and emission of green house gases.

Cons:
TSE is a very expensive technology compared to other on board technologies, as shown earlier in the comparison chart in Table 2.

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APPENDIX II

State	Speed Limit	Law	Comments
California	70	VC §§22348(b), 22352	Prohibits certain kinds of speed traps
Florida	70	316.192, 316.183, 316.187	318.18(3)(b) requires warnings for speeding 5 or less over the limit outside a school zone
Georgia	70	40-6-390, 40-6-181	6 points for +35, 0 for driving too fast for conditions (40-5-57), no fine for speeding five MPH or less over the limit: 40-6-1, Georgia Code
Hawaii	60	291-2, 291C-101, 291C-102	+15 punished as speeding but is worth 3-6 points, the same as reckless driving
Iowa	70	321.277, 321.285	License suspension possible for +25
Kentucky	65	189.290, 189.390	Point system (regulations allow 90 day suspension for 26 or more over the limit)
Minnesota	70	169.14, 169.13	Six month license revocation for speeding over 100 miles per hour
New Mexico	75	66-8-113, 66-7-301	+26 in a residential zone or while also exceeding 75 MPH is 8 points, for which a license may be suspended. no points for speeding in rural areas (more than two miles from corporate limits), except for heavy trucks
New York	65	Traffic law §1180, 1212, 1643	The law permits a 15 day jail sentence for 11 MPH over the speed limit, State police traffic stops by marked cars only
North Dakota	75	39-08-03, 39-09-02	+36 in a 70 or 75 MPH zone or +46 elsewhere is 12 points, enough for a 7 day license suspension
Pennsylvania	65	75 §3362, 75 §3736	Mandatory license suspension for +11 in a work zone
Virginia	65	46.2-862, 46.2-870	In recent years some judges have started sending people to jail for driving 90+ on an Interstate
Wisconsin	65	346.57, 346.62	15 day license suspension for speeding +25 over a 55/65 MPH speed limit

Accessed from http://www.mit.edu/~jfc/laws.html

OVERVIEW: HIGHWAY AND ROADWAY DESIGN

A. Technology Trends

Highway and roadway design is important to assist the driver in transportation efficiency. In 2003, congestion accounted for 3.7 billion hours of travel delay and 2.3 billion gallons of wasted fuel (Capka, 2006). Congestion is created by many factors, including peak hour travel demand, crashes, work zones, vehicle breakdowns, adverse weather, and inadequate design such as poor roadway geometric design, and signal timing. The congestion leads to a loss of capacity within the current infrastructure, which makes the system less productive and wastes energy.

Intelligent Transportation Systems (ITS) (www.itsa.org) is a generic term denoting the use of technology to create solutions which move vehicles more efficiently, and to convey information to the traveling public. ITS technologies include traffic management systems, advanced signal control, electronic toll collection, automated collision notification, and traveler information systems. When integrated into the transportation system infrastructure, and in vehicles themselves, these technologies help monitor and manage traffic flow, reduce congestion, provide alternate routes to travelers, and enhance productivity, as well as contributing to saving lives, time and money.

As an example of an ITS operational strategy, transit signal priority facilitates the movement of in-service transit vehicles, either buses or streetcars, through traffic signal controlled intersections.

Table 1
Transit Signal Priority Conservation

	Express Bus	Cross-Street Bus
Reduced Travel Time	4.0%	9.1%
Reduced Person Delays	6.5%	14.2%
Reduced Vehicle Stops	1.5%	2.9%

Source: (http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ID/F49CA44A29F3CB9385256CD20064AB60?OpenDocument&Query=State, April 2006)

Incident Management Systems (IMS), one component of ITS, provide traffic operators with the tools to allow quick and efficient response to accidents, hazardous spills, and other emergencies. The communications systems of an IMS link data collection points, transportation operations centers, and decision support software into an integrated network that can be operated efficiently and "intelligently." An automated crash notification system can transmit crash information such as collision force and angle of impact to assist responders in determining what type of help to send and where to transport the injured. San Antonio, Texas has incorporated a freeway and incident management program that saves an estimated 2,600 gallons of fuel per major accident (http://www.itsbenefits.its.dot.gov/its/benecost.nsf/_images/Reports/$File/deskref.pdf, April 2006).

Traffic engineering software is another set of technologies that allow transportation planners and traffic engineers to generate models of existing conditions and future demands of traffic for study and analysis. Programs can focus on varying aspects, including traffic signal timing, site impact, freeway studies, parking, and pedestrian impact. Simulation models can aid in proper layout of future designs, allowing for the maximum efficiency of the design. Advanced Traffic Management Systems (ATMS) employ detectors, cameras, and communication systems to monitor traffic, optimize signal timings on major arterials, and improve the flow of traffic, thereby reducing energy consumption.

511 traveler information services is the universal 3-digit telephone number assigned by the Federal Communications Commission (FCC) for travel and traffic information purposes. By the end of 2006, it is estimated that 50 percent of the nation's population will have access to 511 systems. 511 gives the driver the opportunity to select the best route based on routes and weather. This will allow the driver to pick the most efficient route to reduce energy used in detours and idle time. In Kansas, it is possible to access automated, near real-time, route-specific road conditions, construction detours, and travel weather (both current and forecasted) information for Interstate, U.S., or state highways in Kansas and the Kansas Turnpike. Travelers can also request information for Nebraska State Highways (the only neighboring state with 511). As other states adjoining Kansas deploy 511, access to their information will also be provided. Kansas 511 also broadcasts active AMBER, General Transportation or Homeland Security Alerts (http://www.ksdot.org/bureaus/offTransInfo/511Info/factsheet.asp, April 2006).

Technology also can be applied to new construction and maintenance to reduce energy impacts. Features such as additional lanes, redesigned interchanges, and grade separations can help reduce congestion and delays. It is also important during these projects to reduce the amount of time construction crews are working by building better, safer, and longer lasting roads that will reduce the amount of repair and roadwork in the future. This will help to reduce the amount of time, money, and resources invested into roads, as well as reduce travel delays that are typically encountered when driving in a construction zone. Features to control access management to reduce crashes and consequent delays causing congestion and wasted energy are described in Table 2.

Table 2
Access Management Techniques to Reduce Crashes

Replace Two-Way Left Turn Lanes with a non-traversable median	• 15%-57% reduction in crashes on 4-lane roads • 25%-50% reduction in crashes on 6-lane roads
Type of left-turn improvement a) painted b) separator or raised divider	 • 32% reduction in total crashes • 67% reduction in total crashes
Add right-turn bay	• 20% reduction in total crashes •Limit right-turn interference with platoon flow, increased capacity
Visual cue at driveways, driveway illumination	• 42% reduction in crashes
Add a left-turn bay	• 25% to 50% reduction in crashes on 4-lane roads • up to 75% reduction in total crashes at unsignalized access • 25% increase in capacity
Prohibition of on-street parking	• 30% increase in traffic flow • 20%-40% reduction in crashes

Source: (http://www.accessmanagement.gov/manual.html, April, 2006)

Table 3
Overview of Intelligent Traffic Systems

Arterial Management Systems	Safety	Automated enforcement of traffic signals has reduced red-light violations 20-75%.
	Mobility	Field studies in several cities have shown that adaptive signal control systems can reduce peak period travel time 5-11%.
	Productivity	Transit signal priority on a Toronto Transit Line allowed same level-of-service with less rolling stock.
	Energy & Environment	Model estimates showed advanced traffic signal control systems can reduce fuel consumption 2-13%.
	Customer Satisfaction	In Michigan, 72% of surveyed drivers felt "better off" after signal control improvements.
Freeway Management Systems	Safety	Studies of traffic management centers using ramp meters show freeway management systems reduce accidents 15-50%.
	Mobility	Advanced Traffic Management Systems (ATMS) in the Astrodome area reduced street congestion delay by 46%.
	Productivity	Variable speed limits with lane controls on the German Autobahn reduced injury accidents 20-29%, saving approximately $4 million/year.
	Efficiency	After ramp meters were experimentally turned off in the Twin Cities of Minnesota, freeway volume declined 9% and peak period throughput decreased 14%.
	Energy & Environment	In Denver, Colorado, dynamic message signs (DMSs) that displayed real-time vehicle emission levels motivated most motorists surveyed to consider repairs.
	Customer Satisfaction	After the Twin Cities ramp meter shutdown test, support for a complete shutdown fell from 21% to 14%.
Transit Management Systems	Mobility	Computer Aided Dispatch (CAD) and Automatic Vehicle Location (AVL) technologies improved on-time bus performance 9-23%.
	Productivity	In San Jose, California, a para-transit scheduling and routing system increased shared rides 45% and reduced operating costs $500K the first year.
	Efficiency	In Portland, Oregon, models of transit data showed AVL/CAD may allow same level-of-service to more travelers using the same rolling stock.
	Customer Satisfaction	In Denver, installation of a AVL/CAD system contributed to improved schedule adherence. Customer complaints decreased 26% per 100K boarding.
Incident Management Systems	Safety	In Pennsylvania, Traffic and Incident Management Systems (TIMS) decreased secondary incidents on highways 40% between 1993 and 1997.
	Mobility	The I-95 Traffic and Incident Management System (TIMS) in Pennsylvania cut highway incident closure time 55%.
	Productivity	In Minnesota, a $600K/yr Highway Helper Program reduced the average duration of stall incidents by 8 minutes, saving $1.4 million/year in delay costs.
	Energy & Environment	Based on calculations of incident delay reduction, models of the Maryland CHART system showed a fuel savings of 4.1 million gallons/year in 2000.
	Customer Satisfaction	The Virginia DOT has received hundreds of "thank you" letters from customers satisfied with service patrols

Traveler Information	Safety	IDAS models of ARTIMIS in Cincinnati and Northern Kentucky estimated traveler information reduced fatalities 3.2%.
	Mobility	In the DC metro area, a simulation model estimated that commuters who used traveler information improve their on-time reliability 5-16%.
	Productivity	In the DC area, models showed pre-trip departure notification can reduce early/late arrivals and save 40% of users $60 or more each year in lost time.
	Efficiency	A simulated traffic network in Seattle showed that supplementing freeway ATIS with arterial ATIS may not significantly improve throughput.*
	Energy & Environment	Models of vehicle emissions in Boston showed users of Smart Traveler generated 1.5% less NOx, and 25% less VOCs.
	Customer Satisfaction	In Philadelphia, 66% of surveyed commuters changed their departure time, and 86% changed their route after receiving traveler information.
Electronic Payment System	Safety	In Florida, driver uncertainty about toll plaza configuration and traffic speeds contributed to a 48% increase in accidents at E-PASS toll stations.*
	Mobility	The New Jersey Turnpike Authority (NJTA) E-Zpass system has reduced vehicle delay by 85%.
	Productivity	In New Jersey, automated fare collection increased revenues 12%, and saved an estimated $2.7 million from the reduced cost of handling fare media.
	Efficiency	Tappan Zee Bridge, New York, NY: Manual lane 400-450 vehicles/hour (vph), ETC lane 1000 vph.
	Energy & Environment	NJTA models indicate E-Zpass saves: 1.2 mil gallons of fuel/year, 0.35 tons of VOC/day, and 0.056 tons NOx/day.
	Customer Satisfaction	20% of surveyed travelers on two bridges in Lee County, Florida, adjusted their departure times as a result of value pricing at electronic tolls.
Crash Prevention & Safety	Safety	In Colorado, a downhill speed warning system on interstate I-70 decreased truck accidents 13% and reduced runaway ramp usage 24% in 2 years.
	Mobility	Models of increased traffic flow at a San Antonio rail crossing showed dynamic message signs with delay information can reduce system delay 6.7%.
	Energy & Environment	An automated horn warning system in Ames, Iowa, reduced elevated noise impact areas 97% adjacent to a highway rail intersection.
	Customer Satisfaction	70% of truck drivers and 85% of car drivers surveyed in California felt curve speed warning systems were useful.

Source: (http://www.itsbenefits.its.dot.gov/, April, 2006)

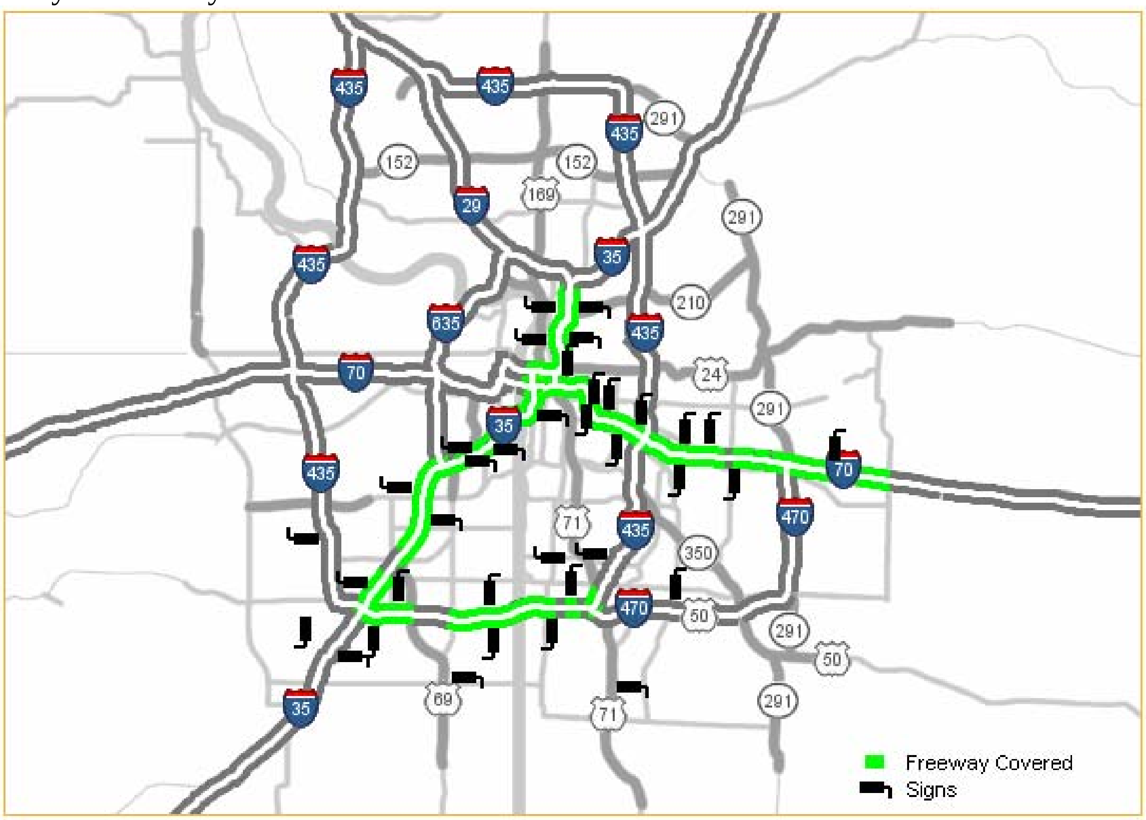
B. Current Infrastructure / Management Framework

Eighteen states and Puerto Rico have enacted statutes that enable the use of various public-private partnerships (PPP) for the development of transportation infrastructure (http://www.fhwa.dot.gov/ppp/legislation.htm, April, 2006). A PPP is a contractual agreement formed between a public agency and private sector entity that allows for greater private sector participation in the delivery of transportation projects. Expanding the private sector role allows public agencies to tap private sector technical, management and financial resources in new ways to achieve certain public agency objectives such as greater cost and schedule certainty, supplementing in-house staff, innovative technology applications, specialized expertise or access to private capital. Public agencies have been turning to PPP for reasons such as accelerating the implementation of high priority projects by packaging and procuring services in new ways, allowing the private sector to provide specialized management capacity for large and complex programs, implementing new technology developed by private entities, or allowing for the reduction in the size of the public agency and the substitution of private sector resources and personnel. Kansas is not one of the eighteen states enact statutes for PPP. The Midwest states that have enacted statutes are Missouri and Minnesota.

Traffic Management Systems in Kansas:

Kansas City uses a bi-state traffic management system known as Scout. Scout manages traffic on a continuous 75 miles of freeway in the greater Kansas City metropolitan area. It uses cameras to monitor the highways from its operations center in Lee's Summit, relies on sensors to gage traffic flow, uses large electronic message boards to send urgent traffic notices to drivers along the freeways, and activates a Highway Advisory Radio system that motorists in Missouri can tune into for urgent traffic information. Scout is a joint effort of the Kansas and Missouri departments of transportation. To date, Scout's 75 miles of continuous coverage is the largest initial deployment of a traffic management system ever in the United States (http://www.kcscout.net/kcatis/faqs.htm, April, 2006).

Figure 1
Highway Covered by SCOUT



Source: (http://www.kcscout.com/kcatis/index.asp, April, 2006)

Automatic Toll Collection in Kansas:
In order to drive across the Kansas Turnpike more efficiently, drivers have the option of using K-TAG, which is a small, transferable tag attached to the inside of the vehicle's windshield. Entering or exiting the turnpike, the driver travels through the K-TAG lane without stopping to pick up a ticket or to pay. An electronic reader charges the drivers account and the gate opens. In the year 2005, 38 percent of all vehicles traveling on the Kansas Turnpike were using K-TAG. Currently, there are no plans to implement additional K-TAG incentives beyond the existing 10 percent discount for prepaid customers. K-TAG currently does not have any method of predicting fuel savings based on reduction of acceleration and delay.

Table 4
2005 Kansas Turnpike Traffic

Vehicle Type	Average Per Day	Yearly	Estimated K-Tag Use
Passenger Cars	76,416	27,891,984	10,598,954
Commercial Vehicles	11,804	4,308,501	1,637,230
Other	1,073	391,358	148,716
Total	89,293	32,591,843	12,384,900

Source: Kansas Turnpike Authority

Other states have implemented similar automatic systems to pay tolls along their highways. New York uses the E-Z PASS, which they promote by offering commercial vehicles 5 percent discounts as well as volume discounts. Illinois has implemented the I-PASS, which they promote by offering discounted congestion pricing for using the pass during the night time and off-peak daytime hours (http://www.uppermidwestfreight.org/files/The_Role_of_Tolls_in_Moving_Freight_11_905.pdf#search='automatic%20toll%20booth%20incentives', May, 2006.)

Other states with automatic systems include Oklahoma, Texas, Florida with the E-Pass, and the New Jersey Turnpike E-Z Pass where passenger car delay was reduced by 1.8 million hours per year, and truck delay was reduced by 291,000 hours per year (http://www.calccit.org/itsdecision/serv_and_tech/Electronic_toll_collection/electronic_toll_collection_rep_print.html#where, May, 2006.)

C. Environmental Implications

The National Environmental Policy Act of 1969 (NEPA), Public Law 91-190 requires, to the fullest extent possible, that the policies, regulations, and laws of the Federal Government be interpreted and administered in accordance with its environmental protection goals. NEPA also requires Federal agencies to use an interdisciplinary approach in planning and decision making for any action that adversely impacts the environment.

NEPA requires and FHWA is committed to the examination and avoidance of potential impacts to the social and natural environment when considering approval of proposed transportation projects. In addition to evaluating potential environmental effects, we must also consider the transportation needs of the public in reaching a decision that is in the best overall public interest. The FHWA NEPA project development process is an approach to balanced transportation decision making that takes into account the potential impacts on the human and natural environment and the public's need for safe and efficient transportation (http://environment.fhwa.dot.gov/projdev/index.asp, April, 2006.)

D. Economic Implications

The highway and roadway design has a direct influence on the driver as well as road conditions through layout, network coordination, and new traffic management systems. Proper design can lead to a reduction in travel time and delay, which will consequently lead to reduced fuel usage and decreased spending. As efficiency increases in roadway design, energy use will continue to decline, contributing to lower costs for the user.

The Kansas City Scout project cost $43 million. Of that amount, the Federal Highway Administration (FHWA) contributed 80-90 percent of the project cost and KDOT and MoDOT shared the remaining cost. At $43 million for a 75-mile project, Scout's deployment costs average $573 thousand per mile. That compares to a $3-$6 million cost per mile for a new roadway (http://www.kcscout.net/kcatis/faqs.htm, April, 2006.)

Table 4
Traffic Signal Retiming Results

	Syracuse, NY	Abilene, TX	California (state wide)
Reduction in Travel Time	17%	13%	7%
Reduction in Delay	15%	37%	15%
Reduction in Fuel Usage	10%	6%	9%
Total Stops	13%	-	-
Reduction in Emissions	11%	-	-
Increase in Vehicle Speed	12%	-	-

Source: (http://www.ops.fhwa.dot.gov/arterial_mgmt/video.htm, March, 2006.)

Table 5
Costs of Traffic Signal Improvements

Equipment or Software Updating	$2,000-$3,000 per signal
Timing Plan Improvements	$300-$400 per signal
Signal Coordination and Interconnection	$5,000-$13,000 per signal
Signal Removal	$3,000-$4,000 per signal
Signal Modification/ New Signal Installation	$150,000-250,000 per intersection

Source: (www.calccit.org/itsdecision/serv_and_tech/Traffic_signal_control/traffsigrep_print.htm#costs, May, 2006.)

Retiming of traffic signals can have positive impacts for the driver. The driver will typically experience a reduction in travel time, delay, and fuel usage, which will help reduce the amount of energy used and contribute to an economic savings for the driver.

E. User Values and Behavior Implications

Driver behavior can influence the performance of their car. Aggressive driving can cause up to 33 percent reduction in fuel efficiency on the highway and 5 percent in the city, as well as posing a risk to other drivers on the road. Removing extra weight can help increase performance. Miles per gallon can decrease by up to 2 percent for every 100 pounds of weight added. When driving over 60 miles per hour, every extra 5 miles per hour will decrease the fuel efficiency of your vehicle. Proper car maintenance will also assist in improved mileage, which includes clean air filters, regular oil changes, and proper tire pressure (http://www.fueleconomy.gov/feg/drive.shtml, April, 2006.).

Table 6
The Energy Consumption Effects of Access Management Techniques

Add continuous Two-Way Left Turn Lane (TWLTL)	• 35% reduction in total crashes • 30% decrease in delay • 30% increase in capacity
Add non-traversable median	• >= 55% reduction in total crashes • >= 30% decrease in delay • >= 30% increase in capacity
Increase driveway speed from 5 mph to 10 mph	• 50% reduction in delay per maneuver; less exposure time to following vehicles
Long signal spacing with limited access	• 42% reduction in total vehicle-hours of travel • 59% reduction in delay • 57,500 gallons fuel saved per mile per year

Source: (http://www.accessmanagement.gov/manual.html, April, 2006.)

Utilized by the Federal Highway Administration, the Interactive Highway Safety Design Model (IHSDM) defines geometric design consistency. It is important in all highway designs that driver expectancy is not violated to improve roadway safety. Guidance decisions such as speed and path are often the problem that drivers encounter.

F. Current Policy Framework

In August of 2005, President Bush signed Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Public Law 109-59 into effect with guaranteed funding for highways, highway safety, and public transportation totaling $244.1 billion. This represents the largest surface transportation investment in our Nation's history. SAFETEA-LU incorporates changes aimed at improving and streamlining the environmental process for transportation projects. These changes, however, come with some additional steps and requirements on transportation agencies. The provisions include a new environmental review process for highways, transit, and multimodal projects, with increased authority for transportation agencies, but also increased responsibilities (e.g., a new category of "participating agencies" and notice and comment related to defining project purpose and need, and determining the alternatives). A 180-day statute of limitations is added for litigation, but it is pegged to publication of environmental actions in the Federal Register, which will require additional notices. There are several delegations of authority to States, including delegation of Categorical Exclusions for all states, as well as a 5-state delegation of the USDOT environmental review authority under NEPA and other environmental laws. The air quality conformity process is improved with changes in the frequency of conformity determinations and conformity horizons. The act also gives states new resources to set up information management programs that will monitor the real-time traffic and travel conditions and relay that information back to the driver to increase expectancy and to plan around congestion. Travelers will be aided in picking the fastest route with the safest conditions, allowing emergency vehicles to respond more quickly and efficiently to crash sites, and assist transportation agencies response to changing traffic conditions as well as reduce wasted fuel (http://www.fhwa.dot.gov/safetealu/summary.htm, April, 2006).

The Federal Highway Administration supports the use of access management to improve traffic distribution, reduce vehicle conflicts, and reduce crashes, by providing better control of driveway access points
(http://ops.fhwa.dot.gov/access_mgmt/docs/benefits_am_trifold.htm, April, 2006).
It is impossible for a major arterial or highway to maintain free flow speeds with numerous access points that add slow moving vehicles. A research synthesis found that roadway speeds were reduced an average of 2.5 miles per hour for every 10 access points per mile, up to a maximum of 10 miles per hour reduction at 40 access points per mile (Gluck, 1999). "By managing roadway access, government agencies can extend the life of roads and highways, increase public safety, reduce traffic congestion, and improve the appearance and quality of the built environment. Not only does access management preserve the transportation functions of roadways, it also helps preserve long-term property values and the economic viability of abutting development. From an environmental perspective, improved traffic flow translates into greater fuel efficiency and reduced vehicular emissions. Consolidating access roads is also less damaging to rural landscapes or environmentally sensitive areas that have numerous individual private drives." ("Access Management Manual" - TRB, 2003.)

On January 1, 1970, the National Environmental Policy Act of 1969 (NEPA) was signed into Law. NEPA established a national environmental policy intentionally focused on Federal activities and the desire for a sustainable environment balanced with other essential needs of present and future generations of Americans. NEPA established a supplemental mandate for Federal agencies to consider the potential environmental consequences of their proposals, document the analysis, and make this information available to the public for comment prior to implementation. The environmental protection policy established in NEPA, Section 101, is supported by a set of "action forcing" provisions in Section 102 that form the basic framework for Federal decision making and the NEPA process. While NEPA established the basic framework for integrating environmental considerations into Federal decision making, it did not provide the details of the process for which it would be accomplished. Federal implementation of NEPA was the charge of the Council on Environmental Quality (CEQ), which interpreted the law and addressed NEPA's action, forcing provisions in the form of regulations and guidance.

FHWA adopted the policy of managing the NEPA project development and decision making process as an "umbrella," under which all applicable environmental laws, executive orders, and regulations are considered and addressed prior to the final project decision and document approval. Conclusion of the NEPA process results in a decision that addresses multiple concerns and requirements. The FHWA NEPA process allows transportation officials to make project decisions that balance engineering and transportation needs with social, economic, and natural environmental factors. During the process, a wide range of partners including the public, businesses, interest groups, and agencies at all levels of government provide input into project and environmental decisions (http://environment.fhwa.dot.gov/projdev/index.asp, April, 2006.)

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ISSUE/TOPIC: What highway and roadway design features can increase transportation system efficiency?

A. Issue/Topic Description

Certain features can be implemented into highways and roadways to maximize the efficiency of the design. The purpose of the highways and roadways should be to transport travelers between locations as efficiently and safely as possible with minimal costs of improvement on the existing transportation system. The reason for a need to focus on the transportation system efficiency is that this sector has shown little increase in efficiency as activity and energy use have continued to grow. Since the 1990's, freight transportation energy-efficiency levels have actually declined.

B. Existing Policies / Programs

The Overview of this section discusses where Super 2 Highways are being implemented in the state of Kansas. A Super 2 is a two-lane road with lowered access-to-structure placement ratios. Adjacent property access has been removed to give Super 2 full control of the access. Both freeways and expressways can be constructed or converted to a Super 2. Super 2 freeways have all intersecting roads closed off or grade separated.

Kansas City uses a bi-state traffic management system known as Scout. Scout manages traffic on a continuous 75 miles of freeway in the greater Kansas City metropolitan area. It uses cameras to monitor the highways from its operations center in Lee's Summit, relies on sensors to gage traffic flow, uses large electronic message boards to send urgent traffic notices to drivers along the freeways, and activates a Highway Advisory Radio system that motorists in Missouri can tune to for urgent traffic information. Scout is a joint effort of the Kansas and Missouri departments of transportation. To date, Scout's 75 miles of continuous coverage is the largest initial deployment of a traffic management system ever in the United States.

Kansas has implemented policies to control the maximum legal dimensions and weights allowed on the highways. This will help to reduce the impact of freight on the current highway infrastructure.

Table 1
Legal Loads

LEGAL MAXIUM DIMENSIONS	
Width	8 1/2 ft.
Height	14 ft.
Length (Single Motor Vehicle)	45 ft.
Length (Truck-Trailer Combinations)	65 ft.
Length (Tractor-Trailer Combinations)	No Limit
Length (Single Semi Trailer)	59 1/2 ft.
Length of each Trailer when pulled in Tandem*	28 1/2 ft.

* A truck-tractor semi-trailer-trailer combination shall be used when pulling trailers in tandem.

LEGAL WEIGHTS	
Single Axle	20,000 pounds
Tandem Axle	34,000 pounds
(Tandem axles with centers less than 40 inches apart are counted as one axle)	
Maximum Gross Weight Limit – Interstates	80,000 pounds
Maximum Gross Weight Limit – Other highways	85,500 pounds
The weight on any group of axles is limited by the Federal Bridge table	

STATE OF KANSAS SIZE AND WEIGHT OF TRUCKS AND TRAILERS ON INTERSTATE AND OTHER HIGHWAYS							
Distance in feet between the extremes of any group of 2 or more consecutive axles				Maximum load in pounds carried on any group of 2 or more consecutive axles			
Dist	2 axles	3 axles	4 axles	5 axles	6 axles	7 axles	8 axles
50			75,500	79,000	84,000		
51			76,000	80,000	84,500		
52			76,500	80,500	85,000		
53			77,500	81,000	85,500		
54			78,000	81,500			
55			78,500	82,500			
56			79,500	83,000			
57			80,000	83,500			
58				84,000			
59				85,000			
60				85,500			

Two consecutive sets of tandem axles may carry a gross load of 34,000 pounds each if the overall distance between the first and last axles is 34 feet or more.

The maximum gross weight allowed on interstate highways is 80,000 pounds.

Source: (http://www.kcc.state.ks.us/trans/ktc_handbook.pdf, May, 2006)

C. Policy / Program Proposals

1. Traffic Signal Timing

(a) Description

Traffic signal timing is meant to provide continuous movement of vehicles and adding to a reduction in the delay along arterial roadways or throughout a network of major streets.

By utilizing current technology to plan and implement traffic signal timing networks, you can reduce delays and overall travel time as well as improve fuel efficiency of vehicles by minimizing stops and starts. Traffic signal retiming is one of the most cost effective ways to help traffic move and is one of the most basic strategies to help mitigate congestion. The Federal Highway Administration has estimated that poor signal traffic timing accounts for 5-10 percent of all traffic delay, which is equal to about 295.8 million vehicle-hours of delay on major roadways. Traffic signal timing will require coordination among the signal controls, compatible equipment, and adequate and appropriate signalized intersection spacing.

Table 2
Examples of Traffic Signal Timing Projects

Houston, TX	In 2004 and 2005, 543 traffic signals optimized in 137 corridors. http://www.publicworks.cityofhouston.gov/traffic/optimization.htm
Freemont, CA	15 street segments improved with signal timing and coordination. http://www.ci.fremont.ca.us/Community/Traffic/SignalTimingandCoord.htm
King County, WA	$400,000 invested in 7 jurisdictions along 9 regional traffic corridors to improve 20 miles of roadway. http://www.metrokc.gov/exec/news/2001/041701.htm
Portland, OR	Over 5 years, improve timing on 17 major metropolitan area arterials. http://www.climatetrust.org/offset_traffic.php
Denver, CO	The Denver Regional Council of Governments (DRCOG) currently has 16 projects of both capital and timing improvements. http://www.drcog.org/index.cfm?page=TrafficSignals
Arlington, VA	Comprehensive retiming of 175 signals to improve traffic flow. http://www.commuterpage.com/walk/news/text.cfm?id=31
Kansas City, MO	Improved an arterial corridor near US 71 approximately 1 mile long with 9 signals creating an estimated daily savings of $8,653. http://www.marc.org/transportation/ogl/Bannister_timing_report.pdf
Nashville, TN	221 signals in 7 major corridors have been improved with plans to improve 14 more supplemental corridors. http://www.nashville.gov/pw/traffic_signal_study.htm
Seattle, WA	Retime and synchronize 150 traffic signals in 17 corridors; has already retimed many of its 975 signals in the past 5 years. http://www.cityofseattle.net/transportation/signaloptimization.htm

(b) Implications of Program Implementation

Pros:
The costs for retiming traffic signals generally range from around $500 to $3,000 per intersection. Optimizing traffic signals can produce benefit cost ratios as high as 40 to 1, thereby making it a very cost effective method to increase efficiency.

Coordination can provide for continuous or nearly continuous movement of traffic at a definite speed along a given route and increase the traffic-handling capacity of the intersection.

It can help reduce the frequency of certain types of accidents, especially right angle.

Traffic Signal retiming can take into account pedestrian traffic and can aid them in safe crossing at busy intersections.

Cons:
Traffic signal retiming will not fix all problems. Traffic signals might still encourage the use of less adequate routes in an effort to avoid traffic signals.

Accident frequency can be significantly increased at unwarranted signals or at locations where installation was not based on sound engineering analysis.

2. Retrofitting Existing Deficient Roadways

(a) Description

More roads exist than the amount of new roads being built. It is, therefore, important to preserve the current infrastructure that does exist. By using the most up-to-date technology, we can implement designs that will not only help maintain the life expectancy of the roadway, but also aid in safety of the driver. Calculated user costs are dependent on the identified lane configuration of a road. The lane configuration is defined as a combination of road type (divided or undivided) and total number of lanes (includes all travel lanes in both directions). Divided pavements are those in which the traffic traveling in opposite directions is divided by a barrier or median. The current approach allows the agency to select from six different lane configuration choices:

- 2-lanes, undivided pavement.
- 4-lanes, undivided pavement.
- 4-lanes, divided pavement.
- 6-lanes, divided pavement.
- 8-lanes, divided pavement.
- 10-lanes, divided pavement.

(b) Implications of Program Implementation

Pros:
The highway and roadway infrastructures have been a large public investment. There are new roads being built, but even fewer highways, so it is beneficial to preserve and enhance the current facilities.

The identification of priority networks will allow for the most efficient and effective use of available resources. Directing funds to the functionally most significant part of the transportation system will create the largest impact.

Cons:
Highway and roadway retrofitting is time consuming and expensive. It is important to properly identify the facilities for construction work to prevent improper use of state funds.

3. Truck Only Open Lanes

(a) Description

This would involve the development of new lanes along major shipping routes to reduce highway congestion as traffic continues to increase. Shipping companies are looking for ways to maximize cargo in their shipments, including ideas such as triple trailers. Separation of large trucks from light passenger vehicles would help increase safety while reducing congestion.

(b) Implications of Program Implementation

Pros:
Improved shipping capabilities of companies increase productivity and efficiency of driving times.

Reduced congestion will lead to reduction in delay and energy consumed. Additionally, there will be less heavy impact on the highway system, which will contribute to a longer life cycle of the highway and lead to less repairs and use of materials.

Cons:
Poole and Samuel estimate that, in general, constructing a truck-only facility alongside an existing rural interstate would cost approximately $2.5 million per lane-mile (about $10 million per route-mile for two lanes in each direction), plus land acquisition costs, if applicable. The cost would vary considerably, depending on right-of-way availability, topography, the need for overpass reconstruction for heavier gross vehicle weights, number of entrance and exit ramps needed, and a host of other factors. Costs in densely developed urban areas could be much higher. http://www.tfhrc.gov/pubrds/05sep/02.htm.
More land may have to be acquired for expansion of the highway system. The expansion might be in parts that are environmentally or culturally sensitive.

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OVERVIEW: RAILROADS

Railroads play an important role in the nation's freight transportation. In the past decades, although railroad track mileage continuously decreased, the railroad productivity and efficiency actually increased. Up to 2004, the U.S. railroad system had 556 railroads which transported 42 percent of the nationwide inter-city freight, while accounted for only 7 percent of the total freight transportation energy consumption and a trivial percentage of air pollutant emission. In addition, passenger railroads have been mitigating the highway congestion and air pollution in many highly populated metropolitan areas. Undoubtedly, railroads have been one of the most productive and environment-friendly transportation modes in the United States.

A. Technology Trends

The rail ton-miles have increased consistently due to heavier cars, longer trains, and faster throughput (FHWA, 2005). Despite the high efficiency utilization of the current rail system, U.S. freight railroads are facing significant capacity constraints on parts of their networks (AAR 2006a). Railroad safety has continuously been the top-priority issue for government agencies and rail industry. However, considerable efforts of railroad technology development are devoted on such areas as productivity/capacity improvement, intelligent railroad systems, and high-speed railroads.

1. Productivity/Capacity Improvement: The railroad freight traffic demand will increase 55 percent by 2020. Although railroads achieved sharp productivity gains in the previous years, they will have to make every effort to achieve further evolutionary gains in aspects such as track and signaling, information technology systems, more powerful and reliable locomotives, and larger freight cars (AAR 2006b).

2. Intelligent Railroad Systems: Intelligent Railroad Systems incorporate the new digital communication technologies into train control, braking systems, grade crossings, defect detection, route planning and scheduling systems. This development will improve safety, security, and efficiency of freight, intercity passenger, and commuter railroads (FHWA 2005).

3. High-Speed Railroads: The U.S. high-speed railroad development efforts are focused primarily on passenger railroads. This development may mitigate the problems caused by the long-term growth in America's population, income, travel demand, and congestion in intercity transportation by air and auto transportations, and thus offer various benefits such as energy savings, emission reductions, and maximized use of existing facilities (FRA 2002).

B. Current Infrastructure / Management Framework

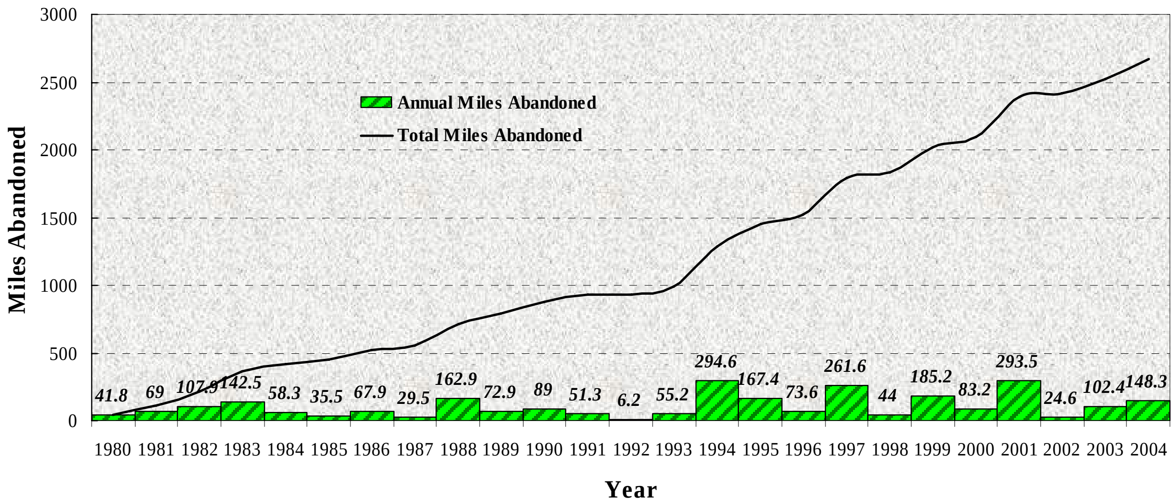
The demands on the American railroad system have been growing continuously, and changing technologies have been providing the opportunity to improve system effectiveness and efficiency. In 2000, the entire United States railroad system encompassed 660 railroads, 220,000 miles of track, 20,000 freight locomotives, 8,800 passenger locomotives/coaches, 1,300,000 freight cars, and 265,000 employees (FHWA 2005). Until 2004, U.S. freight railroad system had 556 railroads, 170,071 miles of track, 593,842 freight cars, and accounted for 42 percent (1,720,000,000 ton-miles) of intercity freight; 90 percent of them are privately owned and operated (AAR 2006c). For the same year, the U.S. had 22,256 miles of passenger railroads under operation which supported 1,211 passenger cars and 276 locomotives (AAR 2006d). These passenger railroads locate in highly populated areas and are heavily subsidized. The National Railroad Passenger Corporation (Amtrak) operates most of them including the intercity passenger rail services in 46 States and the District of Columbia.

Kansas ranks in the top ten in railroad mileage in the U.S., despite the loss of track miles due to abandonment each year. The state's line-haul railroad mileage as of December 2004 totaled 4,776 miles. This total excludes double trackage, spur and business tracks, sidings and yards, and privately owned "not-for-hire" railroads. Railroad miles owned and operated by Class I carriers totaled 2,790 miles, while Class III carriers (short line operators and non-operators) own and operate 1,986 rail miles in Kansas. Kansas's short lines, or Class III carriers, operate 42 percent of the rail lines in the state (KDOT 2005). Listed in Table 1 are the Kansas railroad carriers and their miles owned. Recently, a proposed new Logistics Park and Inter-modal Hub Center in Gardner, Kansas have been under evaluation. The hub would provide a service area where truck trailers and containers are transferred between trucks and trains and is proposed to meet the growing demand for intermodal service in the Kansas City region (BNSF Railway 2006). Figure 2 shows the railroads in Kansas including the abandoned stations.

On the other hand, the length of the mainline railroad track network has been continuously declining in the past few years. In Kansas alone, approximately 4,700 miles of railroad have been abandoned from 1920 to the present. In the 1980's, more than 800 miles were abandoned and between 1991 and 2004, approximately 1,775 miles were abandoned (KDOT 2005). The light density lines (rail lines carrying less than one million gross ton-miles per mile) in Kansas are generally considered at risk for potential abandonment at some time in the future. The branch lines of major carriers usually are light density lines. Including the miles operated by short lines, Kansas has roughly 2,000 miles of light density rail lines– approximately 50 percent of the total railroad mileage in the state (KDOT 2005). Figure 1 shows the abandoned railroad track miles from 1980 to 2004.

The U.S. Department of Transportation's (DOT's) Federal Railroad Administration (FRA) has established its leading role for the rail industry, including both railroad management and technology research and development. Most of the state DOTs also have offices or programs assisting their statewide railroads. In addition, other research-oriented associations such as Association of American Railroads (AAR) have actively participated in railroad-related issues to include law making and technology development.

Figure 1
Kansas Railroad Track Miles Abandoned between 1980 and 2004



C. Environmental Implications

Railroads are one of the most environmentally-friendly transportation modes in which to transport people and goods in the U.S. They have contributed to the entire American transportation system to increase fuel efficiency, reduce emissions, and relieve traffic congestion.

1. Fuel Efficiency: Freight railroads are one of the most energy efficient transportation approaches. They move 42 percent of the total U.S. freight but consumed only 7 percent of the total freight transportation energy (FHWA 2006a; AAR 2006e). Study showed that the railroads' energy intensity (measured in Btu per ton-mile) was 345, compared with 471 for waterborne commerce and 3476 for trucks (see Table 2). If just 10 percent of the freight that currently moves by truck were diverted to rail instead, fuel savings would approach one billion gallons per year (AAR 2006e).

2. Emission: The emission of ground transportation is accused as one of the main sources of air pollution. In contrast, railroads emit much less air pollutants than other ground transportation modes. While transport 42 percent of the U.S. intercity freight ton-miles, they account for only 9 percent of total transportation related nitrogen oxides (NOx) emissions and 4 percent of transportation-related particulate emissions. Furthermore, railroad fuel efficiency and emission has been consistently improving: in 2004 alone, U.S. freight railroads consumed three billion fewer gallons of fuel and emitted 34 million fewer tons of carbon dioxide than they would have if their fuel efficiency had remained constant since 1980 – (AAR 2006e).

Table 1
Kansas Rail Miles Owned and Operated

Class I Carriers	Main Line Owned	Lines Leased To Class III	Miles Operated	Trackage Rights
BNSF Railway	1,237		1,237	443
Kansas City Southern	18		18	
Norfolk Southern				3
Union Pacific System	1,830	(295)	1,535	862
Class I Total	3,085	(295)	2,790	1,308
Class III Carriers	**Main Line Owned**	**Lines Leased From Class I**	**Miles Operated**	**Trackage Rights**
Abilene & Smoky Valley Railroad	18		18	
Blue Rapids Railroad	10		10	
Boothill and Western Railway	10		10	1
Cimarron Valley Railway	182		182	4
Blackwell Northern Gateway Railroad	18		18	
Garden City Western Railway	45		45	
Hutchinson & Northern	3		3	
Kansas City Terminal	25		25	
Kansas & Oklahoma Railroad	642		642	36
UP System*		111	111	
Kyle	16		16	
Port Authority**	255		255	
UP System*		176	176	13
Midland Railway	11		11	2
Missouri & Northern Arkansas*		8	8	
Nebraska Kansas Colorado Railway	122		122	17
New Century Air Center Railroad	5		5	
South Kansas & Oklahoma	305		305	72
V & S Railway	21		21	2
Wichita Terminal Association	3		3	
Class III Total	1,691	295	1,986	146
Grand Total	4,776		4,776	1,454

NOTE: Only common carrier mileage is shown. Not included are privately-owned, not-for-hire miles, business tracks, parallel tracks, etc.
* Branch lines leased from the Union Pacific. ** Lease/purchase agreement with the Mid State Port Authority.

(Source: *Kansas Rail Plan 2004-2005*, Kansas Department of Transportation, 2005)

Table 2
Freight Transportation Energy Intensity

Transportation Mode	Energy Intensity (Btu/ton-mile)	Relative Energy Intensity
Railroad	345	1.00
Waterborne Commerce	471	1.37
Truck	3,476	10.08

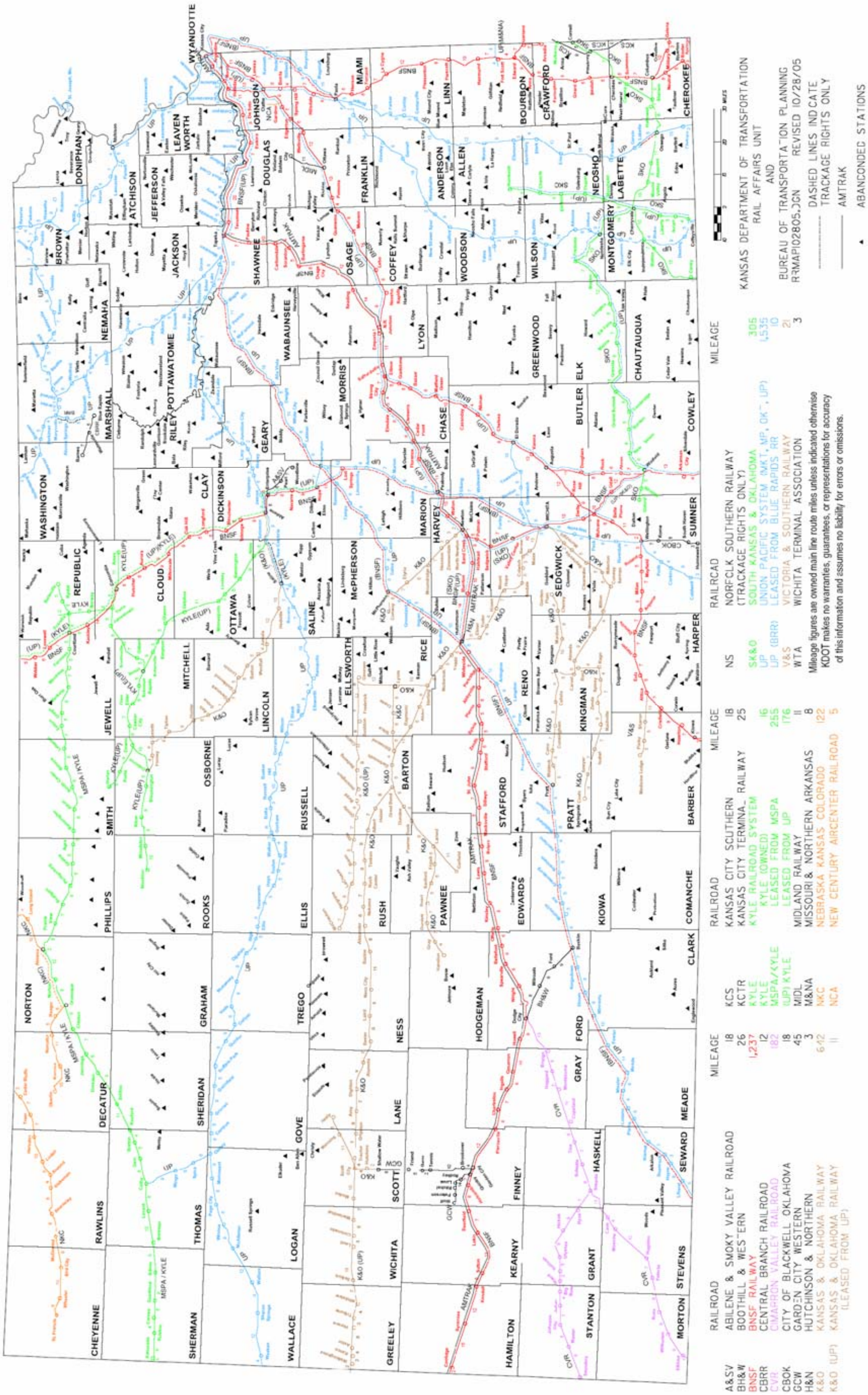


Figure 2: Kansas Rail Map 2005

3. Traffic Congestion: Two thirds of the U.S. urban areas have been suffering from "undesirable" congestions. Without railroads, the situation would be much worse since a considerable portion of traffic has been replaced by both freight and passenger railroads. A single freight rail car can hold up to six times as much tonnage as a truck (Crossharborstudy.com 2006). An intermodal train carrying 100 cars takes up to 280 trucks (equivalent to more than 1100 cars) off our highways and trains carrying other types of freight take up to 500 trucks off our highways (AAR 2006e).

D. Economic Implications

The railroads in the U.S. have been producing significant economical benefits. In addition to their benefits associated to the efficient energy consumption, considerably lower emission, and traffic congestion mitigation, the railroads have significant impacts on many areas constituting the U.S. economy. Freight railroads have been a major source of productivity and a major global competitive advantage for the United States (AAR 2006f).

While moving 42 percent of the U.S. intercity ton-miles, freight railroads only generate 10 percent of intercity freight revenue. If all freight rail traffic were shifted to trucks, current rail shippers would have to pay an additional $69 billion per year. The U.S. freight railroads have been particularly beneficial in transporting commodities such as agricultural products, chemicals, coal, food products, forest products, inter-modal transportations, and motor vehicles. They also provide competitive wages and benefits to 176,899 employees and 570,000 retired workers (AAR 2006f; FRA 2006).

E. User Values and Behavior Implications

An overwhelming majority of the customers of the U.S. railroad system are from industries that require massive transportations. In 2004, the major rail-carried commodities (in terms of ton-miles) included coal (40 percent), inter-modal traffic (trailers and containers on flat cars) (16 percent), farm products (predominantly grain and soybeans, 9 percent), and chemical products (9 percent) (FRA 2006).

1. Coal Transportation: Coal determines the U.S. electricity generation because it is the most cost-effective fuel choice, and railroads are a critical reason for that. Statistics showed that 65 percent of U.S. coal shipments were delivered by rail in 2003 (the most recent year available). With the intensifying competition in the U.S. electricity generation marketplace, coal shippers consider the engagement in true partnerships with railroads to be vital. Railroads have already shown their willingness to provide consistently high value coal transportation service through continuously improvements of technology and service (AAR 2006g).

2. Inter-modal Transportation: Rail inter-modal transportation combines the door-to-door convenience of trucks with the long-haul economy of railroads. In addition, more highway congestions and trucks' inefficient fuel consumption have been leading shippers to rail inter-modal. In 2005, railroads transported 11.7 million trailers and containers, which more than tripled that of 1980. The increasing user demand requires significant

expansion of rail intermodal, which can occur through the use of innovative public/private partnerships and targeted tax incentives integrated in national transport policy (AAR 2006h).

3. Grain Transportation: U.S. freight railroads are a critical part of the U.S. grain logistical chain and one of U.S. agriculture's primary weapons in the highly-competitive global grain marketplace. Grain shippers benefit from strong competition among various ground transportation modes and barge transportation. Although the share of grain transportation for trucking has increased consistently due to factors such as increasing local processing of grain and the number of private trucks owned by farmers, railroads are still responsible for about one third of the grain transportation. The future rail transportation for grain could be improved through more competitive rates, more efficient logistic processing, and policy incentives (AAR 2006i).

4. Chemical Transportation: Although transportation of chemicals constituted 9 percent of the total freight railroad transportation, the importance of railroads for chemical industry ranks behind trucking and water transportation. However, with the influences of increasing energy price and tightening environmental and safety regulations, the importance of railroads in chemical transportation has a big potential to increase in the future (AAR 2006j).

Railroads also play an important role in passenger transportation. Although the current passenger railroads are not comparable with highway transportation and air transportation, some railroad routes provide an attractive, practical alternative in corridors connecting major urban areas up to 400 miles apart. The existence of these passenger railroads mitigates problems such as highway congestion and air pollution. Potential implementation of the next generation of high-speed rail transportation may promote the current passenger railroads to a main competitor of air transportation. The Congress has noticed the national interest in the implementation of high-speed rail and authorized relating technology developments (FRA 2002).

F. Current Policy Framework

Accompanying the growth of the U.S. railroad industry, there have been many federal and state policies and regulations enacted. Historically, one of the most remarkable policies in the railroad industry is the Staggers Rail Act of 1980 passed by the Interstate Commerce Commission. The act removed many regulatory restraints on the railroad industry and provided the industry increased flexibilities to adjust their rates and tailor services to meet shipper needs and their own revenue requirements (FHWA 2006b). The flexibilities have led to reduced rates for shippers (after adjusting for inflation) and enhanced railroad maintenance and capital expenditures on track and rolling stock. Railroad productivity has increased substantially as more freight is moving over a smaller network with a smaller workforce (FRA 2006).

The existing regulations or policies cover all railroad related subjects such as safety, operation, financial assistance, passenger railroads, and high-speed railroads. According to Bitzan (2000), the recent interest in railroad regulatory issues has generated at least three policy proposals for changing railroad regulations that have been tied to reauthorization of the funding for the Surface Transportation Board. The types of changes in regulations suggested by these proposals vary widely, but the main components of regulatory change suggested have included: (1) restrictions on merger activity, (2) changes in maximum reasonable rate determinations to introduce more equity among shippers, and/or (3) introduction of intramodal competition through open access to rail lines or through reciprocal switching agreements.

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ISSUE/TOPIC: What percentage of the state's transportation energy consumption is attributed to rail?

A. Issue/Topic Description

Kansas ranks in the top ten in the United States in railroad mileage, despite the loss of track miles due to abandonment each year. The state's line-haul railroad mileage as of December 2004 totaled 4,776 miles. Railroad miles owned and operated by Class I carriers totaled 2,790 miles, while Class III carriers (short line operators and non-operators) own and operate 1,986 rail miles in Kansas (KDOT 2005). There are no statistics showing the energy consumption by Kansas railroads. However, it is roughly estimated that Kansas railroads are responsible for about 9.5 percent of the total statewide transportation energy consumption[1]. This percentage is slightly higher than the 7 percent (AAR 2006) estimated nationwide.

B. Existing Policies/Programs

1. Congestion Mitigation and Air Quality Improvement Program (CMAQ), a federal program developed to reduce transportation-related emissions by providing options to the state departments of transportation and local governments to fund different emission reduction strategies. The program supports the use of railroads including metropolitan transit railroads (KDOT 2004).

C. Policy/Program Option

1. Freight Railroad Preservation Program
   The program provides grants to local units of government, industries, and railroads for the purpose of preserving essential rail lines and rehabilitating them following purchase. Wisconsin has been operating this program since the 1990's. This program will assist local governments and the railroad industry to preserve the railroads at risk of abandonment.
   Pros:
   The program helps preserving railroads that have low profitability yet are important for local transportation.
   Cons:
   Funding availability.

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[1] The percentage is estimated according to the available data as:

$$\frac{KRT}{TRT} \times \frac{TREC}{KTEC} = \frac{5995}{134298} \times \frac{1558 \times 10^{9} \times 345}{251.6 \times 10^{12}} = 9.5\%$$

Where:

- KRT: Kansas total rail track length which was 5995 miles in 2003(BTS 2006a);
- TRT: US total rail track length which was 134298 miles in 2003 (BTS 2006a);
- TREC: US total railroad energy consumption which is the production of railroad energy intensity (345 Btu/ton-mile, AAR 2006) and US total railroad ton-miles (1558 billion in 2002, BTS 2006b);
- KTEC: Kansas total energy consumption which was 251.6 trillion Btu in 2001(BTS 2006c)

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ISSUE/TOPIC: What efficiencies, if any, could be achieved by greater use of rail?

A. Issue/Topic Description

Railroads are the most energy efficient transportation approach. Statewide, they moved 42 percent of the total U.S. freight but consumed only 7 percent of the total freight transportation energy and generate only 10 percent of intercity freight revenue (FHA 2006; AAR 2006; FRA 2006). If just 10 percent of the freight that currently moves by truck were diverted to rail instead, nationwide fuel savings would approach one billion gallons per year (AAR 2006). However, in Kansas, the grain transportation has been continuously shifting from railroads to trucking and many miles of non-profitable rail tracks have been abandoned. Factors for the abandonment include the lack of attractive incentives, the increasing local processing of grain, and the increasing number of private trucks owned by farmers.

B. Existing Policies/Programs

1. Federal Local Rail Freight Assistance to States (LRFA) is a program which authorizes Kansas Department of Transportation to loan Federal Railroad Administration funds to short-line railroads. This program is intended to support rail service, which contributes to the state's economy, enhances market competitiveness, attracts new industry and encourages expansion of current business.

2. State Rail Service Improvement Funds (SRSIF) is a program established to provide short-line railroads operating in Kansas with low-interest, 10-year revolving loans to be used primarily for track rehabilitation. The program will allow ongoing opportunities for railroads to improve their system and service, and benefit the economy of the state.

3. Railroad Rehabilitation and Improvement Financing (RRIF) is a federal credit program for the purpose of acquisition, improvement and rehabilitation of intermodal, rail equipment or facilities, including track, components of track, bridges, yards, buildings and shops. Additional purposes of this program include refinancing existing debt and the development of new inter-modal or railroad facilities.

C. Policy/Program Option

1. Freight Railroad Preservation Program: The program provides grants to local units of government, industries, and railroads for the purpose of preserving essential rail lines and rehabilitating them following purchase. Wisconsin has been operating this program since the 1990's. This program will assist local governments and the railroad industry to preserve the railroads at risk of abandonment.

   Pros:
   The program helps preserving railroads that have low profitability yet are important for local transportation.
   Cons:
   Funding availability.

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ISSUE/TOPIC: Opportunities for short-line rail transportation in Kansas to capture additional energy efficiencies?

A. Issue/Topic Description

Short-line railroads play an important role in Kansas. Kansas ranks second in the nation in the amount of farm products it ships out of state by rail (Moran, 2003). Kansas's short lines, or Class III carriers, own and operate 1,986 rail miles or 42 percent of the rail lines in the state (KDOT 2005). Short-lines keep the farmers and small businesses in Kansas connected to the national rail network. However, short-lines in Kansas have been continuously abandoned. Between 1991 and 2004, approximately 1,775 miles were abandoned in Kansas. Moreover, Kansas has roughly 2,000 miles of light density rail lines–approximately 50 percent of the total railroad mileage in the state are considered at risk for potential abandonment, of which a significant percentage are short-lines (KDOT 2005). The loss of short-line rail service in Kansas could add over $20 million to the annual cost of transporting and handling the state's wheat harvest (Moran, 2003). Important reasons for the loss of short-lines include the new industry standard of heavier 286,000 pound railcars and the tough competition from Class I railroads (Johnson et al. 2004). Short-lines have advantages such as more flexible customer services over the Class I railroads and less fuel consumption and pollutant emission over trucks. The short-line industry may be supported by improved government regulation and infrastructure funding to capture additional energy efficiencies.

B. Existing Policies/Programs

1. Short-line railroad loan/grant program, a program initiated to support short-line railroad rehabilitation and improvement. Through the program, KDOT provides $3 million per year to short-line railroads in Kansas to upgrade their tracks to provide more efficient rail service within the state (Rosacker 2006).

2. Federal Local Rail Freight Assistance to States (LRFA), a program which authorizes Kansas Department of Transportation to loan Federal Railroad Administration funds to short-line railroads. This program is intended to support rail service, which contributes to the state's economy, enhances market competitiveness, attracts new industry and encourages expansion of current business (KDOT 2004).

3. State Rail Service Improvement Funds (SRSIF), a program established to provide short-line railroads operating in Kansas with low-interest, 10-year revolving loans to be used primarily for track rehabilitation. The program will allow ongoing opportunities for railroads to improve their system and service, and benefit the economy of the state (KDOT 2004).

4. Railroad Rehabilitation and Improvement Financing (RRIF), a federal credit program for the purpose of acquisition, improvement and rehabilitation of intermodal, rail equipment or facilities, including track, components of track, bridges, yards, buildings and shops. Additional purposes of this program include refinancing existing debt and the development of new inter-modal or railroad facilities (KDOT 2004).

5. Congestion Mitigation and Air Quality Improvement Program (CMAQ), a federal program developed to reduce transportation-related emissions by providing options to the state departments of transportation and local governments to fund different emission reduction strategies. The program supports the use of railroads including metropolitan transit railroads (KDOT 2004).

C. Policy/Program Option

1. Freight Railroad Preservation Program: The program provides grants to local units of government, industries, and railroads for the purpose of preserving essential rail lines and rehabilitating them following purchase. Wisconsin has been operating this program since the 1990's. This program will assist local governments and the railroad industry to preserve the railroads at risk of abandonment.

   Pros:
   The program helps preserve railroads that have low profitability yet are important for local transportation.

   Cons:
   Funding availability.

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ISSUE/TOPIC: Where would increased short-line rail use have positive economic benefit?

A. Topic/Issue Description

Short-line railroads play an important role for the grain shippers in Kansas. These railroads provide flexible delivery services and connect the local farmers and small businesses to the mainline network in the nation. However, the continuous short-line rail abandonment has had negative impacts to local communities including 1) farmers having lower grain prices and higher shipping costs – i.e., lower revenue and increased production costs; 2) rail shippers having higher transportation costs and lower profits; 3) shippers having reduced market options; 4) loss of businesses directly and indirectly tied to rail shippers; and 5) decreased economic development opportunities for rural communities (KDOT 2005). Generally, increased short-line rail use would have positive economic benefits in the areas including agriculture, manufacturing, and international exports (KDOT 2005). Listed in Table 1 and 2 are the rail shipments originating and terminating in Kansas and their percentage changes. The improvement of short-line railroads are impeded by many factors including track maintenance and upgrading to meet the new heavier car standard and the competitive intermodal services provided by mainline carriers (KDOT 2005; Babcock et al. 2003; Johnson et al. 2004).

Table 1
Top Rail Shipments Originating in Kansas – 1999 and 2003 (KDOT 2005)

Commodity	Tons Originated (thousands)				
	Tons 1999	Percent of Total	Tons 2003	Percent of Total	Percent Change 1999-2003
Farm Products	15,927	60%	9,849	50%	-38%
Food Products	3,731	14%	2,784	14%	-25%
Chemicals	2,090	8%	2,140	11%	2%
Mixed & Misc. Freight	1,208	5%	1,510	8%	25%
Petroleum	952	4%	-	-	-
Glass & Stone Products	-	-	953	5%	-
All Other	2,458	9%	2,489	13%	1%
Total	26,368	100%	19,726	100%	-25%

Table 2
Top Rail Shipments Terminating in Kansas – 1999 and 2003 (KDOT 2005)

Commodity	Tons Terminating (thousands)				
	Tons 1999	Percent of Total	Tons 2003	Percent of Total	Percent Change 1999-2003
Coal	5,806	34%	14,916	57%	157%
Farm Products	2,002	12%	1,726	7%	-14%
Chemicals	1,841	11%	1,706	7%	-7%
Mixed Freight	1,188	7%	1,605	6%	35%
Glass & Stone Products	1,311	8%	1,268	5%	-3%
All Other Commodities	4,838	28%	4,765	18%	2%
Total	16,987	100%	25,987	100%	53%

B. Existing Policies/Programs

1. Short-line railroad loan/grant program, a program initiated to support short-line railroad rehabilitation and improvement. Through the program, KDOT provides $3 million per year to short-line railroads in Kansas to upgrade their tracks, providing more efficient rail service within the state (Rosacker 2006).

2. Federal Local Rail Freight Assistance to States (LRFA), a program which authorizes Kansas Department of Transportation to loan Federal Railroad Administration funds to short-line railroads. This program is intended to support rail service which contributes to the state's economy, enhances market competitiveness, attracts new industry and encourages expansion of current business (KDOT 2004).

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   Pros:
   The program helps preserving railroads that have low profitability yet are important for local transportation.

   Cons:
   Funding availability.

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OVERVIEW: OFF-ROAD VEHICLES

A. Technology Trends

An off-road vehicle is defined as a land-based transportation vehicle/equipment that does not use the highway system or other paved roadways. Examples of off-road vehicles include concrete pavers, rollers, excavators, crushing/processing equipment, and forklifts. Categories of interest in this study of off-road, transportation-related fuel use include agriculture, construction, commercial, industrial, and personal/recreational. Use of fuel for off-road purposes is not well documented, nor is the number of off-road vehicles. Types of fuel used for off-road vehicles include gasoline, diesel, compressed natural gas (CNG), liquid propane gas (LPG), and other alternative fuels.

The Federal Highway Administration (FHWA) collects information on fuel usage. Because the information on off-road vehicles is not well documented, FHWA has to estimate the fuel usage for off-road vehicles based on the state-provided data and computer models. These models were originally developed by Oak Ridge National Laboratory (ORNL) in 1986 and were modified in 1994 (Davis and Truett 2005). Table 1 shows the estimated transportation-related off-road fuel consumption in the United States in 1997, 2001, and 2005, based on the data provided by Davis and Truett. Nationwide, the off-road fuel consumption was increased from 17,106 to 20,296 millions of gallons (by 19%) between 1997 and 2005 and more than half of the fuel consumed by the off-road vehicles was diesel. Figure 1 shows the total off-road fuel consumption from 1997 to 2005.

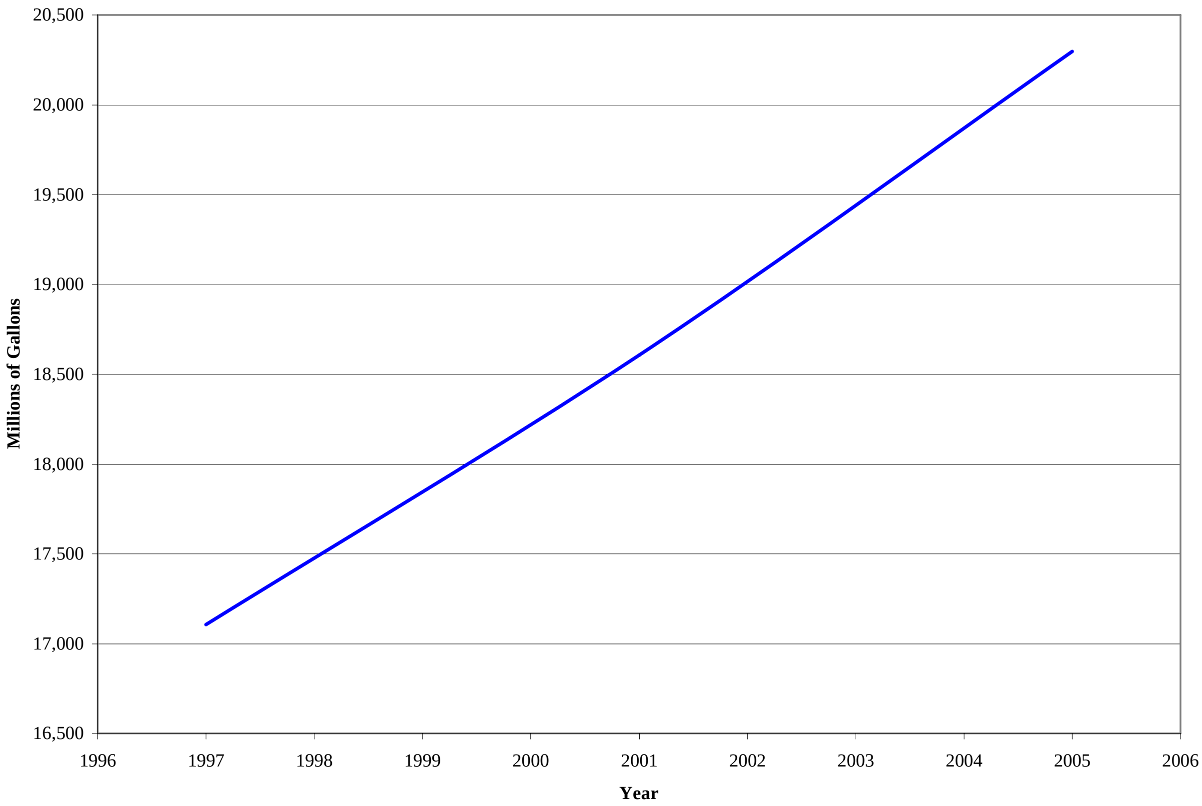
Table 1
Estimated Transportation-Related Off-Road Fuel Consumption (millions of gallons)

Sector	**1997**				**2001**				**2005**			
	Gas	Diesel	Other	Total	Gas	Diesel	Other	Total	Gas	Diesel	Other	Total
Agriculture	319	2,994	5	3,318	338	3,352	4	3,694	357	3,753	4	4,114
Industrial & Commercial	1,761	1,579	1,854	5,193	1,733	1,794	2,108	5,636	1,705	2,039	2,398	6,143
Construction	289	4,766	18	5,073	274	5,347	19	5,639	259	5,998	21	6,278
Personal & Recreational	3,425	37	7	3,469	3,524	42	7	3,573	3,626	47	7	3,680
Other	2	48	2	52	2	61	2	65	2	76	3	81
Total	5,797	9,424	1,885	**17,106**	5,870	10,596	2,141	**18,607**	5,949	11,914	2,433	**20,296**

Note: The category "Other" includes CNG, LPG, and other alternative fuels.

Research on reducing off-road fuel consumption has been conducted for many years. Best practices and new technologies include (1) construction operation improvement; (2) lighter equipment; (3) GPS technology; (4) improved engine efficiency; (5) equipment management system; (6) simulating fuel-efficient; and (7) electrical-powered equipment.

Figure 1
Total Off-Road Fuel Consumption in Millions of Gallons from 1997 to 2005.



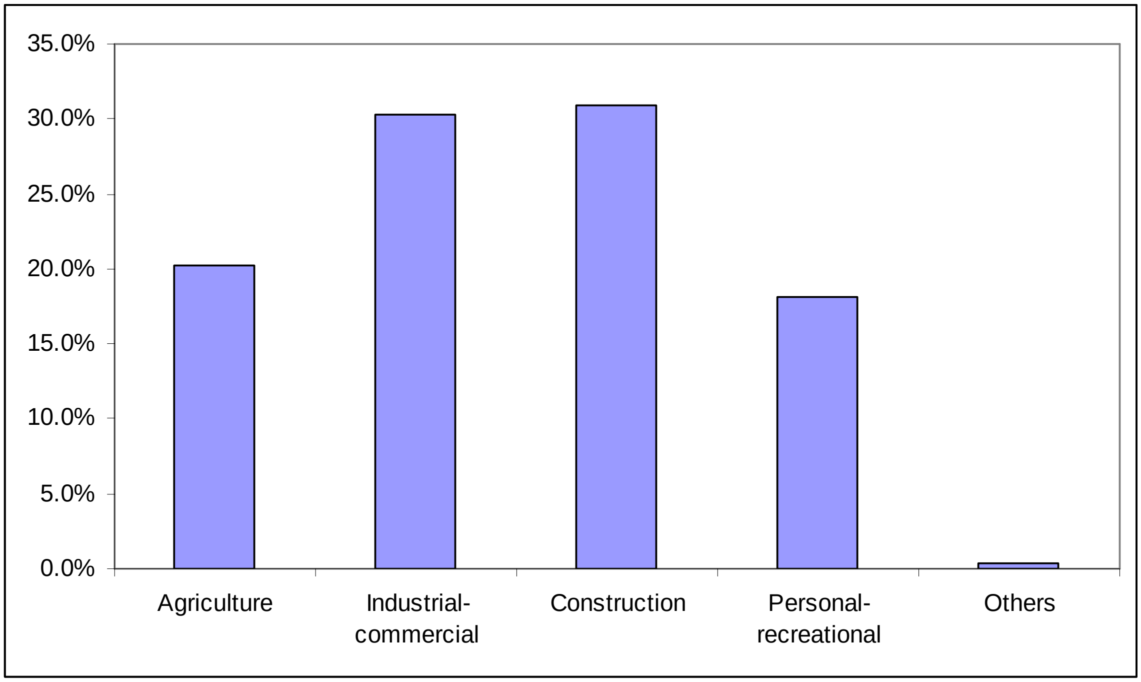
1. Construction Operation Improvement

In 2005, off-road construction equipment consumed 6,278 millions of gallons of fuel (31% of total), which was the largest share by sector, see Figure 2. Good construction operation practices can optimize the fuel consumption. These practices include (Cianchette 1976):

- Drive at slow speeds until engines warm up,
- Make sure tires are properly inflated and that crawler tracks are properly adjusted,
- Place equipment on a strict, periodic tune-up schedule,
- Do a better job of matching equipment to the job,
- Improve earth-moving techniques (short-haul distances and smooth haul roads),
- Shut off engine rather than idle equipment,
- Use maximum daylight hours for construction activity, and
- Conduct periodic "fuel audits" to determine further conservation measures.

Benson from Construction Industry Manufacturers Association forecasted that emphasis in future development of construction equipment design would be on productivity. One way to increase the productivity would be the development of automatic control systems that enable machines to attain 95% of maximum potential performance, regardless of operator's skill level, (Benson 1981). Automatic control systems on dozers, hauling units, scrapers, loaders, and graders could improve machine efficiency by 10 to 20%.

Figure 2
Percentage of Transportation-Related Off-Road Fuel Consumptions by Sector in 2005



2. Lighter Equipment

Productivity of construction equipment can be increased by reducing the weight of working tools such as a loader or backhoe. Efficient design with high-strength micro-alloyed steels offers the designers an opportunity to reach this goal. To apply this technique, forming or welding in the manufacturing process was considered and incorporated into the design process to insure an increase in productivity through efficient component design.

There are several reasons that micro-alloyed steel, instead of low-carbon steel, is suggested as a means of producing lighter working tools for off-road equipment. Use of equipment made of micro-alloyed steel can result in increased pay load, increased response, and lower inertia loads (Tucker and Dunn 1976). As a result, fuel consumption for the operations is decreased.

3. GPS Technology

Global Positioning System (GPS) is a technology that utilizes satellite data from space to provide highly accurate location, navigation, tracking, mapping, and timing information. The U.S. Department of Defense (DoD) developed the system, called Navstar, in 1978 and made the satellites freely available to the U.S. public in 1983. Navstar currently consists of 28 to 33 satellites worldwide circling the earth in controlled orbits 24 hours a day, while continuously broadcasting their position to various locations. Each satellite broadcasts two signals, a precise signal and a standard signal. The precise signal is only available to the U.S. military and its allies for security purposes, while the standard signal is for civilian access. The standard signal allows GPS receivers to calculate fixed positions.

The emergence and application of GPS to earthmoving operations has yielded phenomenal productivity benefits. Productivity is increased because GPS eliminates the need for constant surveying and mapping updates on the job site and project progress can be assessed and monitored throughout the construction process. A contractor is able to finish the job with less manpower. Caterpillar's AccuGrade GPS grade control package is available directly from the factory on its track-type tractors. The company estimated that equipment with the GPS package was providing customers with an estimated 30 to 50% productivity gains (LuuAbles 2006). With the increase of productivity, fuel consumption per cubic yard of earth moving is reduced.

4. Improved Engine Efficiency

Fuel is wasted because the vehicle is not operating at maximum efficiency. This waste is caused by the inability of discrete speed transmissions to select the optimum ratio for the operating conditions (Trachman 1979). The energy that required moving a vehicle or a piece of equipment consists of three components: (1) the energy to accelerate the mass of the vehicle, (2) the aerodynamic drag of the vehicle, and (3) the rolling resistance of the tires. The algebraic sum of these three components is the energy available on wheel or wheel energy. All of the wheel energy, as well as the energy losses attributable to the transmission, must be supplied by the engine and/or the flywheel. The flywheel is a device for storing and delivering energy. It allows the wheel energy to be stored, and then used when required. To make the system work, there is a need to use a continuously variable-ratio transmission (CVT). Vadetec Corporation used the vehicle performance simulations to test the CVT for off-road vehicles. The test results indicated that CVT permits improvement in the fuel economy of a diesel engine by 30 to 50% (Trachman 1979).

Other technologies are also being developed to improve the engine efficiency for the heavy-duty trucks including: (1) reduced internal friction, (2) increased peak cylinder pressure, (3) improved fuel injection and more efficient combustion, and (4) reduced waste heat and improved thermal management (Saricks et al. 2003). These trucks could be used for construction operations such as earthmoving.

5. Equipment Management System

An equipment management system (EMS) is a database management system that is developed to manage large investment in construction equipment. A well-designed and developed equipment management system can significantly supplement the contractor's equipment policy and result in more effective and efficient utilization of equipment and higher profitability. As a result, the system can help to reduce the fuel consumption directly or indirectly. The equipment policy includes equipment cost, replacement analysis, equipment finance, equipment records, equipment standardization, inventory management, maintenance management, and safety (Tavakoli et al. 1990).

6. Using Electrical-Powered Equipment

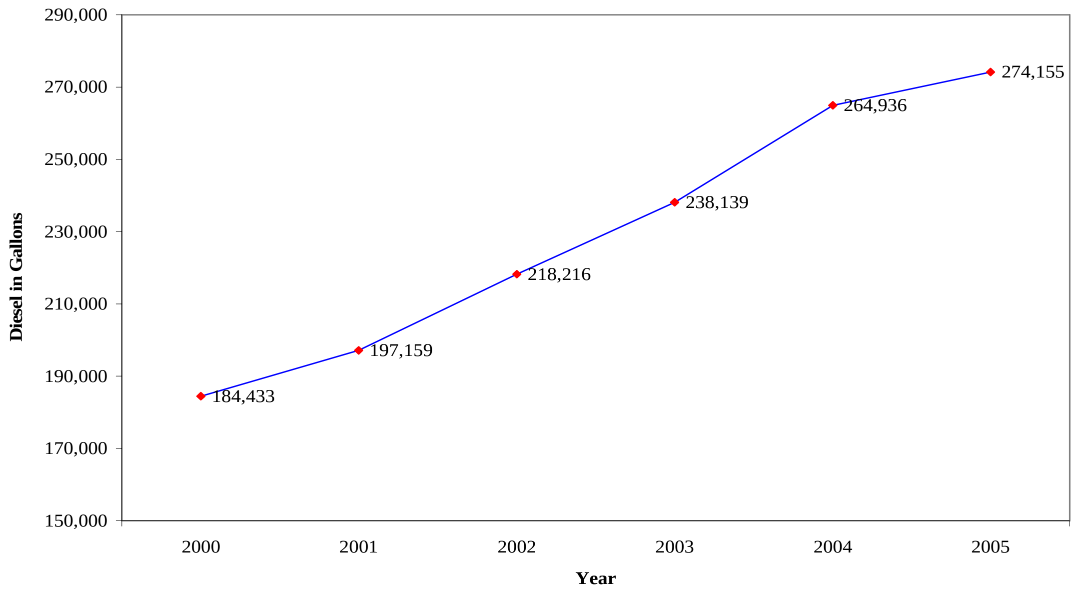
   By integrating mechanical and electronic technologies, SKF Group has successfully developed an all-electric "E-Truck" forklift (Ruiz 2006). To build the all-electric forklift, engineers stripped a forklift truck down to the frame. Existing systems were removed and the vehicle was rebuilt using an electromechanical steering system, actuators, mast height control, and direct-drive traction motors. Rolling out the all-electric forklift demonstrated how existing technologies can reduce fuel consumption, improve ergonomics for greater operator safety and comfort, and deliver new efficiencies and economies. Currently, many innovations incorporated into the all-electric forklift have been implemented for other off-road applications such as the tandem rollers. Detailed information on all-electric forklift can be found in the following web site: http://www.oemoffhighway.com/

B. Current Infrastructure/Management Framework

Kansas Department of Transportation (KDOT) Equipment Division has an EMS to manage off-road construction equipment for the agency. The EMS records equipment class, capacity, mark, model, model year, life to date (LTD) miles, LTD hours, and LTD fuel. LTD fuel (diesel in gallons) is recorded for every piece of off-road equipment. LTD miles and LTD hours are recorded for some pieces of equipment, but not all equipment. From 2000 to 2005, 1,377,038 gallons of diesel were consumed for the off-road equipment, with an average of 229,506 gallons per year. Figure 3 shows diesel consumption of KDOT off-road equipment from 2000 to 2005.

Besides KDOT, large construction companies may own their fleet of equipment to conduct business in Kansas. Fuel consumed for company owned equipment is not clear at this time. These companies should have some type of equipment management systems in order to be competitive in the business market. Companies usually bill the owners based on dollars per hour including the fuel cost.

Figure 3
Diesel Consumption of KDOT Off-Road Equipment from 2000 to 2005



C. Environmental Implications

The major environmental problem for off-road vehicles is the diesel engine emission. The Environmental Protection Agency (EPA) classifies emissions into three categories: (1) mobile, (2) stationary, and (3) area sources (EPA 2005). EPA further subdivides mobile sources into on-road and non-road categories. Non-road emissions result from the use of fuel in a diverse collection of vehicles and equipment, including off-road vehicles, locomotive equipment, and aircraft. The non-road vehicles and equipment were a significant source of volatile organic compounds (VOC), nitrogen oxides (NOx), and particulate matter (PM) emissions (EPA 1991). It was estimated that in some areas of the country, non-road emissions contributed to as much as a third of the total mobile source NOx and VOC inventory and over two-thirds of the mobile source PM inventory.

The EPA has developed a non-road emissions model, called NONROAD, to assist states and local regulatory agencies in the creation of accurate emission inventories. The NONROAD model can estimate current year emissions for the specified geographic area, as well as project future year emission and backcast past year emissions for calendar years 1970 through 2050. Technical documentation of the model may be found at the EPA's Office of Transportation and Air Quality web site: http://www.epa.gov/otaq/nonrdmdl.htm

D. Economic Implications

Figure 4 shows oil price (dollars per barrel) from 1986 to 2006. The data was provided by the Dow Jones & Company and downloaded from the following web site:
http://research.stlouisfed.org/fred2/series/oilprice/98

Since 2002, the oil price has continuously increased and current price is over $60 per barrel. The high oil price has a significant impact on the business communities. Companies have to find ways to increase the fuel efficiency because there is a limit on how much customers can absorb the price increase. Many companies are looking for ways to reduce fuel consumptions by adopting best practices and new technologies.

Figure 4
Oil Price from 1986 to 2006

E. User Values and Behavior Implications

Many off-road vehicles are used for heavy/highway construction. State Departments of Transportation (DOTs), as owners of roadways and bridges, play significant roles in off-road fuel consumption and vehicle emissions. Texas DOT (TxDOT) has added a special provision in Standard Contract Specifications for contractors. The provision encourages the contractors to use alternative fuel vehicles and equipment. TxDOT is also pursuing the accelerated replacement of off-road equipment with EPA-certified Tier 2 and Tire 3 off-road equipment. More information is available at the following web site:
http://www.cleantexasair.org/agencypractices/bestpractices.html

With the continuous increase of fuel prices and the tight EPA regulations on emissions, contractors have put more pressure on construction equipment manufacturers to make diesel engines more efficient and economical. Construction equipment hybrids, fuel cells, and battery electric power will be available in the market soon (Hampton and Armistead 2006). Some commercial truck prototypes with hybrid engines are being tested in the field. Hybrid engines featured on heavy construction equipment may be previewed at the end of 2006.

F. Current Policy Framework

KDOT does not have any fuel saving policies in place except for its operators being told not to leave their equipment idling for extended periods of time. Construction companies should have more restrictive policies for off-road equipment fuel usage in order to compete in the market. However, the detailed policies are unknown at this time.

ISSUE/TOPIC: What is the potential to capture energy efficiencies in the way people and materials are moved in the workplace?

A. Issue/Topic Description

Most off-road equipment uses diesel fuel. The development of new technologies such as alternative energy resources and electrical-powered equipment will reduce the diesel fuel consumption and improve energy efficiency in the workplace. Labeckas and Slavinskas (2005) conducted a research project that used rapeseed oil to directly inject in the off-road diesel engine. Although the practical usage of rapeseed oil for diesel engine has a long way to go, the promise of potential saving on diesel fuel can be achieved if adequate research funding in this area is continually available.

SKF Group has successfully developed all-electric "E-Truck" forklift by integrating mechanical and electronic technologies. The successful development of the all-electric forklift demonstrated how existing technologies can reduce fuel consumption, improve ergonomics for greater operator safety and comfort, and deliver new efficiencies and economies. Currently, many innovations incorporated into the all-electric forklift have been implemented for other off-road applications such as the tandem rollers.

B. Existing Policies/Programs

1. Government Subsidies and Tax Credits on Biodiesel. Consumers bought 75 million gallons of biodiesel in 2005, an increase of 300% over the previous year (McGourty 2006). Until recently, the cost of biodiesel was almost $1 more per gallon than the regular diesel, but thanks to government subsidies and tax credits, the price of biodiesel is about the same as the regular diesel in today's market.

2. Equipment Management Systems. Government agencies such as state DOTs and large construction companies that own a fleet of off-road equipment have established some kind of equipment management systems to manage their assets. Although equipment management systems are different from place to place, use of these systems has helped agencies and companies to properly maintain the off-road equipment, reduce the breakdown during construction, and improve productivity. As a result, fuel consumption has been reduced.

C. Policy/Program Proposals

1. Use of Electric Off-Road Equipment

   (a) Description

   Some of the electric off-road equipment, such as a forklift, is available in the market. There is a need to encourage more companies and organizations to use such kinds of equipment. With the demand increased, the price would be more affordable.

Pros:
Reduce the fuel consumption.

Decrease diesel engine emission (environmental friendly).

Advance new technology.

Cons:
Less powerful than the diesel-power equipment.

ISSUE/TOPIC: Technology and infrastructure barriers that restrict efficiencies in off-road transportation

A. Topic/Issue Description

Many of the new technologies are still under development. Government and industries must continue investing in the research and development (R&D) that can improve efficiencies in off-road transportation. For those technologies available in the market, the barriers that prohibit companies from using them are cost and performance. Adopting new technologies usually requires companies to investment money in advance. Unless companies realize the future return on the investment, they will not invest the money. Performance is another issue. For example, biodiesel users noticed a reduced power output, with longer run times uphill. In addition, equipment powered using biodiesel is more difficult to maintain.

Besides investing in the equipment (hardware), companies must allocate enough resources to train their employees so that their skills are upgraded to keep pace with more sophisticated equipment.

B. Existing Policies/Programs

1. Competitive Bidding for Government Projects: Government agencies such as state DOTs have to award construction contracts to the lowest bidders based on procurement laws. This policy, on one side, protects the general public interest. However, on the other side, it may become a barrier for construction companies to adopt new technologies because they may have to increase bid prices to recover the investment in new technologies. Thus, it may put these companies that use new technologies at a disadvantage.

C. Policy/Program Proposals

1. Fuel Saving Policy

   (a) Description

   The companies establish the fuel saving policy for the use of their off-road equipment. The policy should include the best practices and reward clauses.

   (b) Implications of Program Implementation

   Pros:
   Provide financial incentives to workers to save fuel in their daily operations.

   Demonstrate the company’s commitment on fuel consumption.

   Make company more competitive

Cons:
Require additional resources to monitor the implementation of the policy.

2. Modifying Government Procurement Laws

(a) Description

Construction companies may have to increase their prices on public construction projects in order to invest in new technologies to save fuel consumption. This will put companies at a disadvantage when they bid the public projects. To overcome this, government agencies must give additional credits to companies who invest in new technologies when they evaluate the bidding documents. This means that current government procurement laws need to be modified.

(b) Implications of Program Implementation

Pros:
Encourage companies to adopt new technologies.

Reduce fuel consumption.

Make company more competitive.

Cons:
Difficult to evaluate the bid packages.

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Conclusion

The purpose of this report was to assist the Kansas Energy Council to identify and quantify significant transportation energy use trends in the United States and in Kansas to assist in identifying immediate and long-term priorities for action by the Council. The potential for energy consumption efficiencies were examined in the areas of vehicle miles traveled reduction strategies, utilization of alternative-fueled vehicles or other fuel-efficient improvements on vehicles, improvements in the transportation system itself, changes in user behavior, or use of alternative modes.

This report collected data associated with energy use in the transportation sector in Kansas and trends in the United States and provides a report on trends and strategies for reduction in use in Kansas. The sources of data for each issue have been catalogued and will provide the basis for which future updates and revisions can be made.

The following issues were investigated in this report. A description of the issues, identification of existing programs and policies and discussion of pros and cons of each issue were provided for consideration by the Kansas Energy Council.

1. Mass transportation (including light rail) as a strategy to reduce vehicle miles traveled (VMT).
2. Opportunities for alternative-fueled vehicles to reduce consumption of petroleum-based fuel.
3. With the advent of ultra-low sulfur diesel fuel, what are the opportunities for increased use of diesel-fueled vehicles?
4. What fuel savings are achievable by increasing the number of fuel-efficient vehicles in Kansas?
5. How does driver indifference of speed limits impact energy use?
6. What highway and roadway design features can increase transportation system efficiency? What percentage of the state’s transportation energy consumption is attributed to rail?
7. What is the potential to capture energy efficiencies in the way people and materials are moved in the workplace?