OREGON TRANSPORTATION PLAN UPDATE
The Future Role of Alternative Fuels

Table of Contents

INTRODUCTION.....E-1

POLICY BACKGROUND.....E-2
Federal Statutes.....E-2
State Department of Energy.....E-2

ALTERNATIVE FUELS AND MARKET ACCEPTANCE.....E-2
Fuel Economy.....E-3
Hybrids.....E-3
Ethanol.....E-4
Biodiesel.....E-5
Compressed Natural Gas.....E-6
Methanol.....E-7
Liquefied Natural Gas (LNG).....E-8
Liquefied Petroleum Gas (Propane).....E-8
Hydrogen.....E-9
Hydrogen From Natural Gas.....E-9
Hydrogen From Renewable Resources (Wind, Hydro, PV).....E-10

CONCLUSION.....E-10

RECOMMENDATIONS.....E-11
Oregon Department of Energy Actions.....E-11
Other State Agencies and Partners Actions.....E-11

OREGON TRANSPORTATION PLAN UPDATE
Background Paper

The Future Role of Alternative Fuels

by Justin Klure,
Oregon Department of Energy

Introduction

Alternatives to gasoline and diesel play a role in meeting the state's objectives of cleaner air, reducing demands on foreign petroleum and diversity of transportation fuel. The alternative fuels identified in federal legislation are ethanol, methanol, electricity, compressed natural gas, liquefied natural gas, liquefied petroleum gas, biodiesel, hydrogen and hybrid vehicles using a number of fuels. Many of these transportation fuels burn cleaner, come from renewable sources and originate in North America.

A balanced approach is needed to meet Oregon's air quality and transportation efficiency objectives. Alternative transportation fuels can provide lower emissions, cost savings and insulation from petroleum price variance. Purchasing more efficient lower emission gasoline-powered vehicles provides benefits similar to alternative fuels, most often at a lower first cost. Reduction in the miles traveled in both fleet and private vehicles proves to be the most beneficial action.

The move towards alternative fuels is intended to reduce dependence on foreign oil, diversify transportation fuel supply and improve air quality. The United States has spent about $12 trillion on crude oil imports since the oil embargo in 1973. Foreign oil purchases by the United States in 1998 exceeded $50 billion for all uses. Nearly 70 percent of the oil imported into the United States is consumed in the transportation sector. The transportation sector is responsible for over half of the nation's air pollution.

In Oregon, motorists have registered over 3.1 million motor vehicles for roadway use. Oregonians spend more than $2 billion for transportation fuels each year. Transportation is the state's single largest contributor to poor air quality, more than each of the other energy use sectors--industry, business and commercial, residential or energy production.

Rising fuel costs, increasing air pollution, and the need to develop local economies will drive the renewable fuel (ethanol, biodiesel, hydrogen from renewables) industry and should be a priority for Oregon. However, in the near term, these fuels will not replace a substantial portion of the fossil fuel base. Until price signals accurately reflect the full costs of fossil fuels, significant investment in renewable fuels will likely be small. Alternative fuels are forecasted to emerge in 5-10 years and will play a significant role in the United State's fuel portfolio in 10-20 years.

The renewable fuels ethanol and biodiesel show the most promise and can be made in Oregon. Locally developed fuels provide economic benefits through reduced transport costs, job creation and potentially greater control of supply.

Policy Background

Federal Statutes

The Clean Air Act Amendments of 1990 (CAAA) and the Energy Policy Act of 1992 (EPACT) were enacted to allow the widespread use of alternative fuels in motor vehicles. The alternative fuel provisions of these two laws are the prime movers pushing the states toward using cleaner-burning fuels in motor vehicles. The intent of the CAAA is to reduce air pollution and EPACT to lessen dependence on foreign oil as the source of the nation's transportation fuels. Both Acts mandate that certain public and private sector fleets use alternative fuel vehicles according to a strict schedule.

State Department of Energy

The Oregon Department of Energy encourages Oregonians to reduce their dependence on petroleum. This goal preserves limited natural resources, increases fuel security, reduces economic impacts from the increasing price of refined petroleum products and reduces the harmful effects caused by vehicle fuel use. To meet this goal, the following objectives listed in order of benefit to Oregon's security, economy and environment have been developed:

- Reduce vehicle miles traveled
- Increase the fuel economy of motor vehicles operated in Oregon
- Choose alternatives to petroleum fuels and adopt efficient technologies
- Maintain the petroleum contingency plan to insure a reliable fuel supply

Alternative Fuels and Market Acceptance

Fuel economy and then hybrid vehicles will be first to play major roles in reducing dependence in petroleum. Renewable fuels such as ethanol and biodiesel will emerge in 5-10 years as well. Other alternative fuels that rely on fossil fuels--compressed natural gas, liqufied petroleum gas, liquefied natural gas and methanol are not likely to emerge as viable alternatives in the long term. Hydrogen is also a potential fuel; however, it has not been proven to be cost-effective based on the total energy required to convert hydrogen to a fuel source. The alternative fuels or alternative to fuels (i.e. fuel economy) are listed below in order of their significance in the marketplace over time.

- Fuel economy
- Hybrids

- Biodiesel
- Ethanol
- Compressed natural gas (CNG)
- Methanol
- Liquefied natural gas (LNG)
- Liquefied petroleum gas (propane)
- Hydrogen

Fuel Economy

Fuel economy can simply be described as the miles per gallon a vehicle uses. Fuel economy can be improved by driving more efficient vehicles. As fuel prices continue to rise, automakers will respond by manufacturing more fuel-efficient vehicles through market demand, if not by regulation. Based on the current fuel price structure, research shows consumers will not alter driving behavior (vehicle miles traveled) within the next five years.

- **Factors Which May Influence Use of Alternative Fuels in the Market Place**

  - Gasoline and diesel will likely double in price in 5-10 years
  - Vehicle miles traveled (VMT) will decrease by 10-15 percent in 10-20 years
  - Fleet mile per gallon (MPG) will increase significantly (greater than 15 percent) in 5-10 years

- **Existing Barriers to Creating Greater Fuel Economy**

  - Relatively inexpensive gasoline
  - Unwillingness by manufacturers to produce more fuel efficient vehicles

- **Recommended Actions**

  - Promote fuel efficient vehicles with a target of 25 percent more efficiency in each vehicle class
  - Establish alternative fuel revenue tax
  - Eliminate inefficient vehicles when replaced with preferred vehicles
  - Educate and promote transit and telecommute options
  - Decrease heavy duty truck idle

Hybrids

Hybrid electric vehicles (HEVs) combine the internal combustion engine of a conventional vehicle with the battery and electric motor of an electric vehicle, resulting in twice the fuel economy of conventional vehicles. This combination offers the extended range and rapid refueling that consumers expect from a conventional vehicle, with a significant portion of the energy and environmental benefits of an electric vehicle. The practical benefits of HEVs include improved fuel economy and lower emissions

compared to conventional vehicles. The inherent flexibility of HEVs will allow them to be used in a wide range of applications from personal transportation to commercial hauling.

- **Availability**
  - Toyota Prius, Honda Civic, and Honda Insight are currently available
  - GM and Ford have committed to introducing hybrids in 2004
- **Market Acceptance**
  - Approximately 1600 hybrids were purchased in Oregon through 2003
  - Rates of purchases are increasing, as is number of vehicle options
- **Barriers**
  - High incremental costs
  - Market penetration
- **Recommended Actions**
  - Continue tax credits for hybrid vehicle purchases
  - Determine equitable way to tax fleet environmental impact

Ethanol

Ethanol is an alcohol fuel that is usually mixed with gasoline at 85 percent ethanol and 15 percent unleaded gasoline to form what is called E-85. Ethanol is typically derived from distilling corn; however, it is also a byproduct of starch manufacturing. Currently, E-85 is not commercially available in Oregon. Flexible fuel vehicles (able to use alcohol or gasoline fuels) are now available at the same cost as a dedicated gasoline vehicle.

Ethanol is a non-toxic biofuel distilled primarily from corn. The cool summer nighttime temperatures in Oregon are not ideal for growing the high sugar corn or red hard wheat preferred by ethanol distillers. Those crops are produced mostly in the Midwest and western plain states, distilled there and then shipped as ethanol by rail to Oregon. Those crops could be harvested and then shipped to Oregon for distilling, but there are currently no distillers or refiners located in Oregon. Other Oregon biomass feedstocks such as barley or cellulose wastes (straw or nursery stubble) can be used to make ethanol, but at higher cost. These other forest and agricultural biomass feedstocks for ethanol production are plentiful or can be grown here.

MTBE is a petroleum or natural gas byproduct and is found to be a persistent and carcinogenic pollutant in groundwater. California has ordered MTBE be removed from gasoline by December 31, 2003. California will become the largest ethanol market in the world in order to meet federal air quality requirements through fuel oxygenation.

California will use 760 million to 990 million gallons of ethanol in 2004. The additive makes up between 5 and 6 percent of the state's gasoline supply.

The nation's ethanol production capacity increased from 2.22 billion gallons per year in 2001 to what is expected to be over 3 billion gallons in 2003, an increase of 38 percent. The California market is currently ten times that of the Oregon market. Both markets will continue to grow as ethanol becomes cost competitive with the gasoline it displaces, as oxygenates become a greater proportion of fuel use (up to 10 percent), and as transportation fuel use grows. Despite the less than ideal growing conditions, the market is growing and Oregon has the potential to become an ethanol producer and exporter.

- **Availability**
  - Limited, primarily distilled in the Midwest and shipped by rail to Northwest regions
  - In 2003, ethanol was almost 4 percent of gasoline fuel stock
  - In 2002, up to 60 million gallons of ethanol were used to oxygenate the 1.6 billion gallons of gasoline used by Oregonians
- **Market Acceptance**
  - Ethanol will be only up to 10 percent oxygenate in very near future
  - Oregon has an immediate market for up to 60 million gallons per year
  - The national market for ethanol is growing
- **Market Barriers**
  - California markets for ethanol exceeds supply
  - Oregon cannot grow corn or red hard wheat, the preferred ethanol source
- **Recommended Actions**
  - Require ethanol to be mixed in all fuels at 10 percent year round
  - Ban MTBE as an oxygenate
  - Develop a tax preference/production credit for ethanol
  - Develop local production facilities

Biodiesel

Barley, soy and other crops, along with waste grease from the food service or processing industry, can be distilled into an oil suitable to fuel diesel engine vehicles. These fuels can be used in vehicles with little or no modification to their diesel engines. In addition to being a domestic renewable resource, biodiesel is clean and safe. It provides substantial reductions in carbon dioxide, monoxide and toxic gas emissions. With minor fuel injector adjustments, nitrogen oxide emissions are reduced.

Biodiesel comes in B-20 (20 percent biodiesel, 80 percent petroleum diesel) or B-100 (100 percent biodiesel) forms. Either form of biodiesel meets or exceeds lubricity (fuel based engine lubrication) needs of a diesel engine which can make it a great additive for the new low or ultra-low sulfur petroleum diesel.

- **Sources**
    - Soy, the primary source of the biodiesel in the U.S. (over 90 percent) and the easiest, lowest cost crop to grow
    - Waste grease from food manufacturers
    - Mustard and rape seed
- **Market Acceptance**
    - Suppliers are rapidly developing an Oregon customer base of public and commercial fleets
    - Biodiesel benefits Oregon by diversifying agriculture crops, allowing lower water usage and healthy crop rotation
- **Market Barriers**
    - Less than .01 percent of biodiesel crop sources (rape seed, mustard, canola) are currently being grown in Oregon
    - Bio-diesel costs an additional 10-20 cents per gallon over petroleum diesel and likely will remain at this rate of difference for 5-10 years
- **Recommended Actions**
    - Incrementally influence market demand by requiring Oregon diesel to contain a minimum of 2 percent biodiesel per gallon
    - Promote mustard, rape seed, canola grower co-ops in order to centralize and reduce crushing facility costs

Compressed Natural Gas

Converting a vehicle to use compressed natural gas (CNG) costs about $3,000 and proves to be cost effective over the vehicle's life based on fuel cost savings alone. Some auto manufacturers now support warranty maintenance of system conversions from conventional gas to CNG with certified parts. Currently, the only cost-effective investment in CNG use is for vehicles with convenient access to fast-fill fueling stations. Most CNG fueling sites are located on the Interstate 5 corridor. More fueling sites in Oregon are planned for fleet vehicles.

- **Availability**
    - Limited refueling infrastructure

- **Market Acceptance**

  - Vehicle incremental cost ($2,000) and fueling compressors not likely to go down soon
  - Fuel has better carbon monoxide emissions reductions, but higher in nitrogen oxides

- **Market Barriers**

  - Natural gas cost has increased by 3 times since 2000 and the price is expected to stay high
  - It requires a significant (20-25 percent) miles per gallon improvement in order to compete with petroleum fuel prices
  - Natural gas prices will always track gasoline and diesel cost fluctuations/increases

- **Recommended Actions**

  - Focus CNG conversion efforts on local use heavy-duty vehicles (buses, delivery and short haul). Diesel engines are easily converted at moderate cost and compressor cost amortization benefits exist. Continue tax credits for incremental costs

Methanol

Methanol is an alcohol-based fuel that is expensive to manufacture and currently not available in Oregon. Methanol is most often blended with unleaded gasoline to form M-85. The source material is from digested biomass resources or coal. Methanol has some caustic and toxic characteristics which make it a less desirable transportation fuel.

- **Availability**

  - Limited

- **Market Acceptance**

  - Hobbyist for fuel cells and racing applications
  - No widespread roadway use

- **Market Barriers**

  - Is toxic
  - Burns invisibly
  - Transpires through storage tanks

- **Recommended Actions**
  - None

Liquefied Natural Gas (LNG)

This fuel is cryogenic and stored as a cold liquid that needs insulated storage and distribution systems. LNG vehicles are typically original equipment manufacturer modified for this fuel use. LNG is typically used in heavy-duty vehicles which are not covered under the state mandate in EPACT.

- **Availability**
  - Limited
- **Market Acceptance**
  - Largest area of potential impact is to long haul heavy duty vehicles for conversion costs
  - Cryogenic storage requirements
- **Barriers**
  - Current federal policies do not indicate 5-10 year development
- **Actions**
  - Monitor manufacturers

Liquefied Petroleum Gas (Propane)

Liquefied petroleum gas, commonly known as propane, is currently the most widely used alternative fuel in Oregon. There are more than 250 refueling sites throughout the state. Although this is a petroleum-based fuel, it has some of the clean burning characteristics of other alternative fuels. Conversion of vehicles costs approximately $3,000. It is believed that LPG conversion violates vehicle warranty. The additional conversion cost and price per gallon similar to gasoline do not make propane cost-effective since there is 25 percent less energy content in a gallon of propane compared to unleaded gasoline.

- **Availability**
  - Infrastructure is widespread for fueling
  - Emission benefits are slight

- **Market Acceptance**
  - Common use in school bus fleets and likely to continue
  - Preferred to high particulate/sulfur diesel for that application
- **Barriers**
  - Price is indexed off of gasoline and will always track gasoline
  - Vehicle conversion is about $3,000
- **Actions**
  - Take no action since fuel is not renewable
  - Continue tax incentives for incremental use

Hydrogen

Hydrogen (H2) is the lightest and simplest gas. This makes it a very clean energy source. Storage of this gaseous fuel for transportation use poses challenges that are currently being researched. The two methods of manufacturing hydrogen fuel currently result in costs of $3 to $4 a gallon and use of electricity or natural gas, which typically results in air emissions. Several vehicle manufacturers have developed research vehicles which they expect to be available through fleet leases in 2005 and to retail consumers by 2007.

Pure hydrogen and hydrogen mixed with natural gas (hythane) have been used effectively to power automobiles with internal combustion engines. Hydrogen's real potential rests in its future role as fuel for fuel cell vehicles. Hydrogen and oxygen fed into a proton exchange membrane (PEM) fuel cell "stack" produce enough electricity to power an electric automobile without producing any harmful emissions from the vehicle. Vehicle manufacturers expect these fuel cell vehicles to be proven reliable and on the market as early as 2007.

Hydrogen From Natural Gas

- **Availability**
  - Limited
- **Market Acceptance**
  - Not yet proven
- **Barriers**
  - Well to wheel efficiency not better than gasoline
  - Gas must be reformed (steam and energy input)

- Resulting hydrogen must be compressed (electric input) or put into powder hydride form
- Powder hydrides require 900 pounds of fuel for the same tank miles as 12 gallons of gasoline (600 miles)
- Incremental cost will be too high to justify in near term assuming cost-effective decision only and assuming no price signals for emissions

- **Actions**

  - Observe manufacturer's research, development and demonstration
  - Provide tax credits for early development

Hydrogen From Renewable Resources (Wind, Hydro, Photovoltaic)

- **Availability**

  - Very limited

- **Market Acceptance**

  - Well to wheel efficiency much higher than all other alternative fuels

- **Barriers**

  - Requires substantial fuel economy improvement to compete
  - Proves to be best choice but cost and distribution makes it longest to develop
  - Low cost hydro-electric has not been proven

- **Actions**

  - Continue tax credits
  - Identify how to meter for road use tax
  - Pilot fueling station demonstration using only renewable fuels

Conclusion

The United State's current use of fossil fuels will be disrupted by supply constraints in the future. The timing of these supply constraints is debatable, but Oregon will see market disruptions in supply, price and availability in the next twenty years. To hedge against future oil shortages, it is in Oregon's interest to work with other states to demand more efficient vehicles and to help develop local renewable fuels.

A prudent first step is for the state to influence increased vehicle fuel economy by increasing the fuel economy of its fleets and by working jointly with other states to

regulate vehicle fuel efficiency. A reasonable second step is to help develop local renewable fuels of ethanol and biodiesel. The state should create market incentives for renewable fuels through tax credits, production credits and similar means.

Consumer behavior is based on price signals. The current pricing of fossil fuel does not reflect supply issues or the environmental costs associated with its production and consumption. Incremental steps need to be taken to more accurately reflect the true costs and to help the market shifts. Leadership at the state level has the potential to play a positive role in preparing Oregonians for future disruptions of fuel supply.

Recommendations

Oregon Department of Energy Actions

1. Reduce VMT through education and promotion of transit and telecommute options.
2. Promote fuel-efficient and hybrid vehicles.
3. Promote electrification of truck stops (decrease heavy-duty truck idle time).
4. Continue tax credits to support market penetration of alternative fuel vehicles.
5. Develop alternatives to petroleum fuels.
6. Maintain the petroleum contingency plan to insure a reliable fuel supply.
7. Demonstrate fuel-efficient fleets.
8. Promote and provide incentives for local renewable fuel production facilities.

Other State Agencies and Partners Actions

1. Establish alternative fuel revenue tax.
2. Eliminate inefficient vehicles when replaced with preferred vehicles.
3. Increase 10 percent fuel blend to year round (fuels currently must be mixed with an oxygenate for half the year). Limit blend source to ethanol.
4. Ban MTBE use in Oregon (used as an oxygenate in fuel).
5. Provide incentives for the development of local renewable fuel production facilities.
6. Require all diesel fuel sold in Oregon be a minimum 2 percent biodiesel.
7. Promote mustard, rape seed, canola grower co-ops to centralize and reduce cost of crushing facilities.