Transportation Fuels for the Future

Western Governors' Association
February 2008

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To the Western Governors:

Among the most critical issues facing our nation is our dependence on petroleum for nearly all of our transportation fuel. This dependence and global competition for the resource present enormous risks to our future energy supply, the environment and to our nation's economy.

Reducing these risks cannot be achieved solely with a dramatic increase in our domestic production for many reasons; yet, the outstanding potential for developing and increasing the use of alternative transportation fuels has been relatively unfulfilled. Clearly, petroleum will continue to be the dominant transportation fuel in the near term, requiring us to maintain economically viable production and refining sectors, but we also must increase our efforts to hasten the development of alternative fuels and to deploy far more efficient vehicles and means to move goods and services.

With these considerations in mind, we are pleased to present this "Transportation Fuels for the Future Roadmap," which offers recommendations for decisively moving forward on alternative fuels and vehicle fuel efficiency. This report was developed with the assistance of more than 100 energy experts representing the government, industry, academia, environmental community and general public. Much deliberation has gone into making these recommendations, and we are confident you will find them to be of great value as you adopt future policies.

While the Western region is not unique in how it consumes fuel, we will play a major role in producing the necessary resources for an alternative-fuel future. This creates both opportunities and challenges:

- *The Western states are in position to become a key producer and beneficiary in the emerging alternative-fuels economy. We have abundant renewable energy resources, as well as vast natural gas and coal reserves, which have great potential as domestic sources for transportation fuels.*
- *Our transportation issues are unique. The vast distances that exist between our metropolitan and rural areas – as opposed to more densely populated areas of the country – make it imperative that we have an ample and affordable supply of fuels to maintain our economies.*
- *Similarly, our sustainability issues differ from those of the other parts of the U.S. Water, land use and feedstock supplies are of great concern to all of our states, and careful consideration of these issues is critical as we transition to clean, alternative fuels and more fuel-efficient vehicles.*
- *By working together and leading this transition, the Western states can achieve ambitious goals more rapidly than through individual, uncoordinated efforts.*

The following report highlights cross-cutting and priority recommendations from the alternative fuels teams. We urge you to evaluate all of the teams' reports and implement recommendations from them as appropriate for your individual states.

Some of the alternative fuels detailed in this report are available today, while others are in various stages of research, development and demonstration. You will find that we have not offered a silver-bullet approach to solve the challenges associated with energy security, the environment and the economy. However, you will find a wealth of opportunities that can be achieved with bold action and strong leadership.

James D. Boyd
Vice-Chair and Commissioner
California Energy Commission

David Fleischaker
Oklahoma Secretary of Energy

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Preface

Prior to October 5, 1973, little thought was given to the need for alternative transportation fuels or for improved vehicle fuel efficiency. The cost of oil was $3 a barrel, and gasoline was just under 30 cents a gallon.

On that day, the Arab-Israeli War broke out, followed by the Arab Oil Embargo and a quadrupling of petroleum prices over the next two years. The economic upheaval and geopolitical instability caused by this "Petroquake," combined with an increasing awareness of the environmental impacts caused by vehicle emissions, led many of our country's leaders to call for a gradual transition to alternative transportation fuels. They vowed to move forward.

Three decades later, we are not much further along in making that transition, putting our country's security, environment and economy at even greater risk due to an ever-increasing list of global reasons:

- The September 11, 2001 attack on the U.S., crystallizing the fact that the world immediately became a more insecure and unstable place.
- The continued political instability of the countries, and regions, where the bulk of the world's petroleum resource exists.
- Petroleum on the world market now reaching record highs, and no petroleum analyst can capably predict the future short-, mid- or long-term world petroleum price.
- The demand for petroleum in the developing world surpassing the demand of the developed world within three years, and not appreciably abating into the future.
- The urgency to achieve sharp and sustained greenhouse gas and criteria emission reductions to mitigate the likely impacts of global climate change and to improve climate health.

With these events in mind, the Western Governors launched their "Transportation Fuels for the Future" initiative with the adoption of a resolution in 2006. Six working teams were formed to examine the opportunities and obstacles to developing and expanding the use of six alternative fuels: ethanol, hydrogen, bio- and renewable-diesel, coal-to-liquids, natural gas/propane and electricity. A separate report was prepared on vehicle fuel efficiency. Combined, these reports provide a policy roadmap for making viable these fuels of the future, while addressing our country's energy security and global warming, as well as contributing to the West's economic vitality.

WGA's lead Governors for this initiative are Arnold Schwarzenegger (CA), Brian Schweitzer (MT), Brad Henry (OK), Mike Rounds (SD), Jon M. Huntsman, Jr. (UT), and Christine Gregoire (WA). Representatives from many of these Governors' offices have served as a steering committee to oversee this initiative.

An Advisory Committee comprising Governors' representatives and stakeholders reviewed each team's report and examined the synergies among all the fuel types to produce the overarching policy roadmap outlined in this report. In addition to determining what is technically and economically feasible over a given period of time, the teams' reports lay out what would be needed in the way of infrastructure, including vehicle systems, vehicle refueling facilities, distribution, storage facilities, refineries and conversion facilities.

The Western Governors' Association thanks all those who worked earnestly over many months to produce their excellent reports. It is clear in reading each fuel report and this overarching policy roadmap that it is not only possible, but also absolutely necessary to make the transition to alternative fuels and improve vehicle fuel efficiency. Implementing

these recommendations will improve our country's energy security, reduce vehicle emissions that contribute to global warming, and create jobs and economic opportunities in our region and across the country. We must start taking the next steps now; we do not have another 30 years to waste.

I. Introduction

Transportation fuels are the major component of our energy portfolio. Of the 20 million barrels of petroleum consumed each day in the United States, 68 percent is used in the transportation sector.

Over the last 30 years, America's demand for energy has grown unabated. The auto industry has improved vehicle fuel efficiency greatly since the 1970s, but a larger population and vehicle fleet, consumer demand for larger, safer, and more powerful vehicles and increased driving has overwhelmed any fuel savings from improved vehicle technology. Since 1990, much of the increased fuel consumption can be directly attributed to the growth in sales of light duty trucks and SUVs. (See Figure 1.) Alternative fuel programs received significant attention and investment in the 1970s, but lost ground every time the price of petroleum-based fuel declined.

Figure 1 and 2:
Source: U.S. Department of Energy, EIA

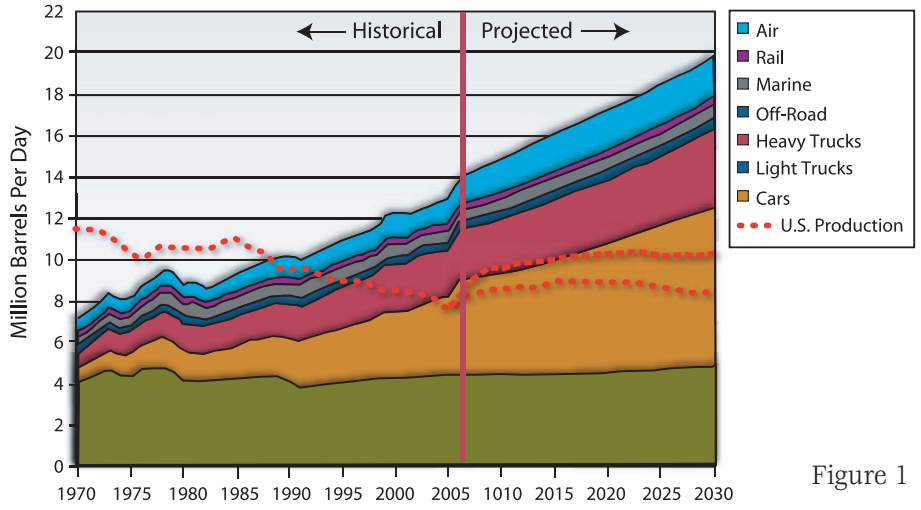


Figure 1

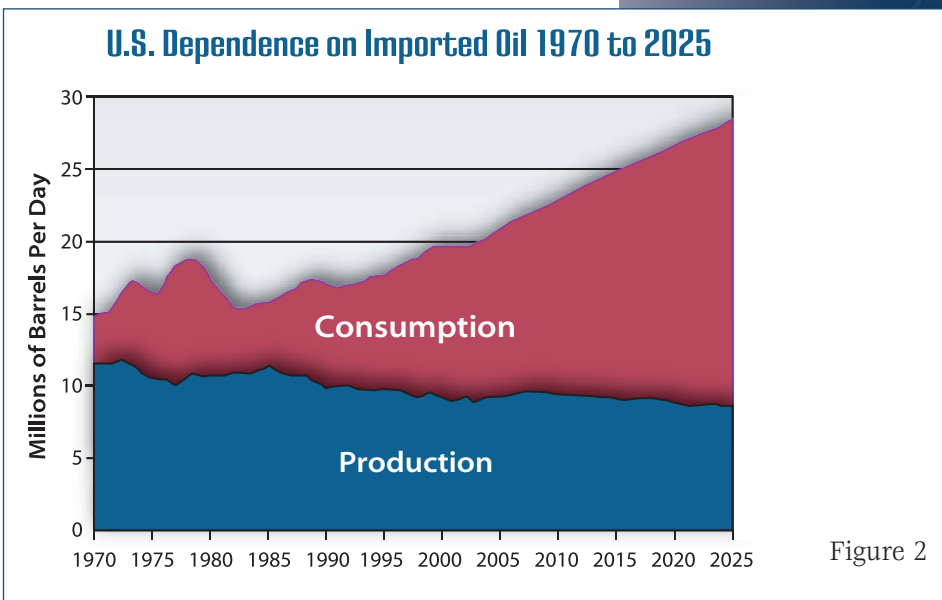


Figure 2

All the while, the energy production companies were fighting a losing battle to increase domestic oil production. U.S. daily oil production has fallen from over 11 million barrels per day (mbpd) in 1970 (domestic "peak oil") to 6.8 mbpd in 2005.[1] To make up the difference between the oil we consume and the oil we produce domestically, we have increased our dependency on imported foreign oil from 30 percent of our supply in 1970 to over 60 percent today.[2]

Much of that oil is imported from foreign nations that are fragile, at best, and hostile, at worst. Imported oil leaves the nation continually vulnerable to oil supply shocks and dependent upon the willingness of other countries to provide the supply we need.

This dependency has considerable economic consequences. In 2008 we are likely to spend more than $340 billion a year on imported oil, almost $1 billion a day, if oil prices exceed $75 per barrel on average.[3] That outlay will likely grow as world oil prices continue to rise in response to the growing demand for oil associated with the rapid industrialization of China and India. These nations have a combined population of approximately 3.4 billion people.

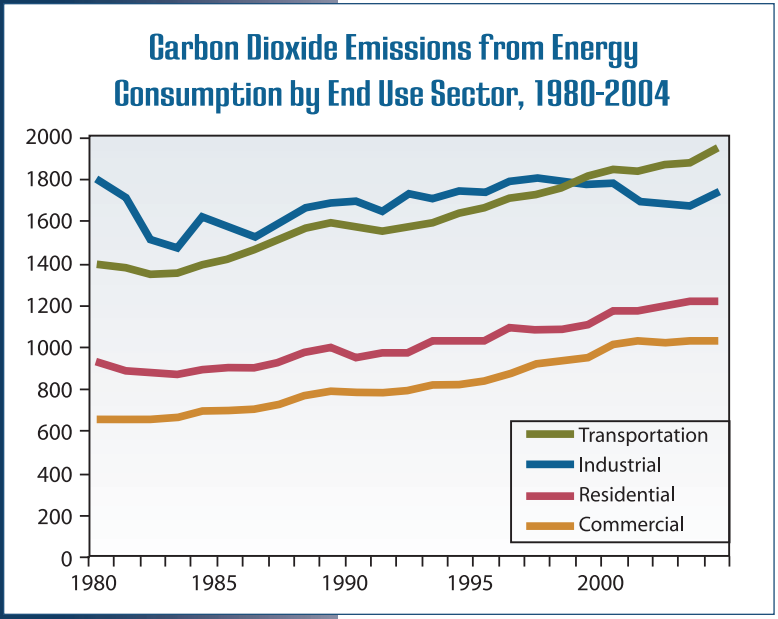


Figure 3
Source: U.S. Department of Energy, EIA

In addition to the revenues that are lost to overseas interests and contribute to the growing U.S. trade deficit, the transportation fuel price volatility which results from imported oil dependency is an impediment to our economic productivity and growth. Industry is continually reacting to price fluctuations and must be conservative in planning for growth and expansion as the uncertainty in fuel prices raises risk levels.

Technology solutions will be key to reducing the U.S. transportation system's use of petroleum-based fuels. And, as those clean energy and energy efficiency technologies are developed and fielded, we need them to be domestic solutions such that we do not substitute overseas oil resource dependence with overseas technology dependence. Keeping the technologies home-grown also helps to ensure that the resulting jobs stay onshore. A recent study found that our economy could create approximately two million jobs from clean energy over the next 10 years if we move towards getting 25 percent of our electricity and motor fuel needs from renewables by 2025.[4] And, aggressive energy efficiency improvements over the next decade could help create more than one million new jobs in California alone over the next decade, and as many as five million nationwide.[5]

The threat to our national security and economic wellbeing are reason enough to curb our oil consumption and thereby reduce our dependency on imported oil. More recently we have become aware of another compelling reason: the threat of global warming. Most scientists agree that human activity contributes significantly to global warming. CO_2 emissions from using oil-based transportation fuels are the second largest contributor in the U.S., the first being CO_2 emissions from coal-burning electrical generating plants. Transportation contributions have increased by 25 percent since 1990 and now account for approximately two billion metric tons annually of U.S. CO_2 emissions, as shown in Figure 3. The most prudent course requires that we reverse this trend.

In addition, global warming raises the specter of fresh water shortages in the West. The Western states are facing chronic drought conditions. The impact of global warming on fresh water supplies is likely to be further exacerbated by expected growth in population and economic activity.

With all of this in mind, the Western Governors decided a policy roadmap was needed to integrate alternative fuels into a transportation fuels portfolio, taking into account the specific resource attributes of the West. The Advisory Committee took the Alternative Fuels and Vehicle Fuel Efficiency Teams' recommendations and developed the roadmap outlined in this report. It addresses:

- Potential resources, technologies and capabilities of the Western states to develop alternative fuels and the policy measures needed to achieve this potential.
- Issues surrounding sustainable feedstock development, environmental impacts, and availability of conversion technologies.
- Infrastructure that will be necessary for the full range of alternative fuels to succeed.

Section II discusses the challenge of changing a century-old practice of fueling our transportation sector with oil.

Section III sets out "cross-cutting" recommendations. These recommendations apply to multiple fuels and fuel efficiency. They address:

- Leadership and the tools available to change the status quo.
- Measurable goals and developing a set of analytical tools that will enable states to determine and mitigate the environmental impacts of the new fuels.

- Challenges common to the five fuel types and propulsion technologies: electricity, biofuels, coal-to-liquids (CTL), hydrogen and natural gas/propane.

Section IV addresses five fuel types, as well as fuel efficiency measures, and presents recommendations for each.

II. The Challenge

This year the U.S. will consume approximately 140 billion gallons of conventional gasoline and approximately 70 billion gallons of conventional diesel fuel. Gasoline and diesel fuel consumption have increased every year since 1945, with brief fluctuations.

The Western states are no exception to the rule, consuming significant amounts of transportation fuels to travel the vast distances in the West. Projected future fuel consumption is set out in Figure 4 at right.

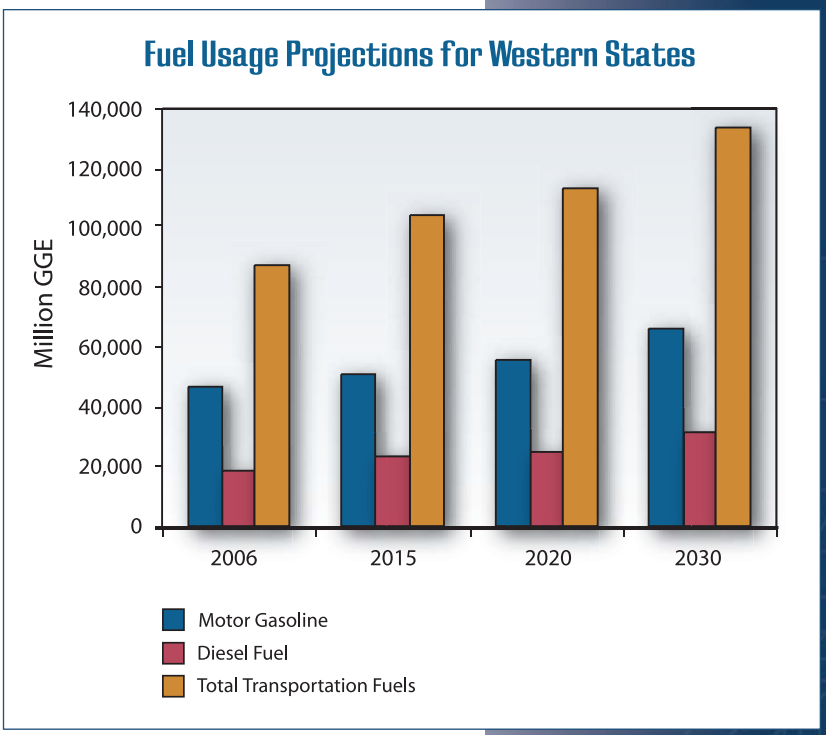


Figure 4
Source: National Renewable Energy Laboratory

The depth and breadth of U.S. investment in conventional transportation fuels is immense. There are 243,023,000[6] conventionally fueled vehicles on the roads today; 168,000[7] stations dispensing conventional gasoline and diesel fuel; 300,000 miles of interstate and intrastate transmission pipelines carrying conventional fuels across the country[8]; and a capital investment of $11 billion[9] in oil refineries producing gasoline and diesel transportation fuels as a major product.

This transportation system run on conventional fuels has served America well for over a century. This is particularly true in the West where travel over great distances in personal vehicles is taken as a fact of life. Many who have a stake in the existing fossil fuel based economy view the migration to alternative fuels as threatening to their livelihood. For others, change heralds unnecessary expenditures and is viewed as a nuisance.

We are tethered to the current slate of conventional fuels by powerful ties. It will require bold leadership and a significant investment of our money and our time in a consistent manner to secure an alternative-fuels future. Success of alternative fuels will depend on consumer adoption. This will require education and reducing costs and subsequent fuel prices to an acceptable level.

Development of alternative fuels will vary from region to region and state to state. For example, fueling public fleets with natural gas may be more appropriate to a state like Oklahoma, which is the third largest gas producing state, while using biofuels may be more appropriate for South Dakota, which produces soybeans, a primary feedstock for biodiesel.

Using financial incentives and allowing free market principles to operate, states should play to their strengths, taking into consideration such factors as indigenous feedstocks, infrastructure availability, population patterns (e.g. states with large urban centers may find electric vehicle penetration easier to develop than a rural state), and the focus of their economies and the strengths of their research institutions.

III. Cross-Cutting Themes and Recommendations

In seeking to meet the Governors' objectives of energy security, environmental improvement and economic vitality, the Advisory Committee has found themes common to the Western states regardless of the alternative fuel under consideration for development and deployment. The section that follows contains recommendations addressing those themes.

Leadership

Governors set the tone for public attitudes. They can be a powerful force for change, educating the public, fashioning state spending priorities and setting an example for the public to see. The Advisory Committee recommends that the Western Governors put the full force and authority of their offices into an effort to develop an alternative transportation fuel sector. The following are recommended priority actions:

- Promote fuel efficiency and encourage the public to value fuel efficiency by repeatedly emphasizing it in themes and messages and by setting a positive example with their own choices and the state fleets.
- Procure alternative fuel vehicles for state fleets and ensure that the vehicles use alternative fuels. This may require constructing refueling stations or centers.
- Work with industry to bring to market vehicles that are affordable, fuel efficient and capable of using alternative fuels.
- Create partnerships for alternative fuel vehicles and alternative fuel use between public and private fleets.
- Identify critical research needs in universities and provide funding so they can create centers of excellence on alternative energy technologies, energy efficiency and climate change.
- Provide information and demonstrations on alternative fuels to gain experience, explain options, and dispel myths and questions. Help companies publicize their alternative fuel vehicle offerings and provide information on the location of alternative fuel retail stations.
- Reduce fuel use by encouraging urban and community planners to consider mass transit options.
- Promote alternative fuels that simultaneously reduce global warming pollution and petroleum usage.

Setting measurable goals to chart a state's progress in integrating alternative fuels into the transportation fuel pool serves several purposes. It establishes a framework for planning and budget allocation. It provides themes that can be easily expressed to garner and direct public support. Finally, it serves to encourage continued effort and avert backsliding.

The Advisory Committee recommends that the Western Governors consider the following in establishing and measuring state-specific goals:

- Total research and development spending on alternative fuel options.
- Number of pilot and/or demonstration-scale projects being developed in state by a specific year.
- Percent of conventional fuels consumed within the state that will be displaced by alternative fuels by a specific year. (This can include the amount and type of blends deemed most appropriate for a state.)
- Percent of transportation fuel that will be produced from alternative sources within the state by a specific year.
- Amount of reduction in greenhouse gases attributed to alternative fuel use and vehicle fuel efficiencies.

Environmental Stewardship

The Governors have expressed specific concern over how our transportation fuel choices affect air quality, contribute to global warming, and stress our water resources. How do we choose among competing alternative fuel technologies to minimize adverse environmental impacts? How do we track the numerous unintended consequences as we deploy new technologies and reallocate our resources?

To answer these questions, the Advisory Committee recommends that the Governors develop tools to evaluate and monitor new alternative fuel technologies for their impact on the environment. Specific recommendations are the following:

Life Cycle Analytic Methods to Evaluate Greenhouse Gases and Land, Air and Water Impacts to Support Policymaking

- Adopt a common methodology and modeling structure to evaluate greenhouse gas emissions and land, air and water impacts. The life-cycle assessment will provide metrics that steer each state's development choices, including where to target incentives, R&D and demonstration spending, market supports, etc. (Appendix B discusses life cycle assessment modeling.)
- Regional cooperation on a single, widely accepted set of assumptions and methods would improve cost-effectiveness of monitoring and will be essential to allow trading of credits among states, if and when a carbon credit trading system is established.

Performance-based Greenhouse Gas Standards for Transportation Fuels

As shown in Figure 3, the transportation sector is a major contributor to greenhouse gases. There are several strategies needed to reduce greenhouse gases including technological improvements in vehicle technology, reducing vehicle and fuel use, and reducing greenhouse gas emissions related to fuels.[10] The latter can be accomplished through a low-carbon fuel standard, a performance standard to reduce emissions per unit energy basis. A low-carbon fuel standard creates a durable yet flexible framework to guide the transition to a low-carbon future. Secondly, it stimulates innovation and investment in low-carbon and very low-carbon fuels and vehicles.

Under a low-carbon fuel standard, fuels are analyzed and measured in terms of their life-cycle, global warming impact. Fuel providers would be required to measure the impact of their products on global warming on a per-unit basis and reduce this impact by a specified amount. Fuel providers will choose how they reduce the carbon intensity of their products from options such as blending low-carbon biofuels into conventional gasoline; selling low-carbon fuels, such as hydrogen; or buying credits from providers of other low-carbon fuels. However, variation among producer choices still needs to result in fuels that are fungible or interchangeable. (See Appendix C for more information on California's Low-Carbon Fuel Standard.)

The trucking industry advocates a national, rather than a state, approach to managing greenhouse gases. The industry believes that a consistent, uniform fuel is necessary to avoid operational and price disparities across state lines.

While keeping in mind the desirability to ensure state efforts in this area are as compatible as possible with each other and with any future national greenhouse gas standard, the Governors are urged to consider:

- Implementing a regional framework for cooperation on the development of a performance-based greenhouse gas standard for transportation fuels, such as California's Low-Carbon Fuel Standard, that could be considered for adoption by other WGA states or at a Western regional level. Such a standard can be used by states to evaluate and regulate technologies.
- States should have the flexibility to calculate the life-cycle emission metrics for fuels produced in their region so as to reflect local circumstances. For instance, the carbon intensity of electricity will vary by state depending on the source of electricity.

- Allowance could be made for differences in state targets for carbon intensity reductions as long as a significant decrease in the transportation fuel carbon intensity is achieved. The reduction target for California's Low-Carbon Fuel Standard is a minimum 10 percent reduction in carbon intensity by 2020.
- A regional approach should acknowledge that on-road diesel fuel should maintain as much specification uniformity as possible to minimize price differentials across state lines and to ensure compatibility with existing engines and equipment.

The Advisory Committee recommends that WGA work with the Environmental Protection Agency (EPA) on the national greenhouse gas transportation rule, which may well include a national low-carbon fuel standard.[11]

Financial and Economic Support

Investment in the transportation fuels sector is capital intensive, risky and requires a long investment horizon before results are known. This combination of negative financial attributes historically has been unattractive to the investment community in general, and Wall Street in particular. Today, however, billions of dollars of investment capital sit on the sidelines waiting for "things to sort themselves out," waiting for the winning strategies and technologies to emerge. The "financing gap" for the first plant using new technologies is particularly problematic.

The oil and gas industry is moving at a cautious pace to invest in alternative fuel infrastructure and retail outlets. There is good reason for their caution. Substantial investments are required, the best locations for those investments may be unclear and which alternative fuels will succeed best in the marketplace remains unknown.

The correct prescription under these circumstances is for the government to step in and provide financial incentives that will overcome many barriers that have impeded the development of alternative fuels. These financial incentives must be of sufficient term to demonstrate a commitment to build out a sector or at least fully test its viability. The on-again, off-again, short-term nature of many governmental financial incentives leave investors guessing about the government's policies and, therefore, are unwilling to make sustained financial commitments.

In addition, investors are seeking to have regulatory rules established and kept consistent, predictable and transparent. Establishing regulatory rules will increase investors' confidence that their financial analysis has properly accounted for regulatory costs and risks.

The Advisory Committee recommends that the Western Governors consider supporting the following financial incentives, and that support be scaled according to projected environmental and energy security benefits:

State

Create a dedicated funding stream to support the development of alternative transportation fuels. Consider creating a task force to identify alternative funding mechanisms. Funds could be used for the following purposes:

- Fund state alternative fuel pilot plants on a pre-commercial scale to test, validate and serve as models.
- Seek federal funds that would match state funded initiatives.
- Develop investment partnerships with academia and industry to investigate and develop alternative fuel production.
- Consider cost-share incentives for demonstration and deployment of alternative fuel vehicles.
- Consider public or public/private grants to provide incentives to alternative fuel producers.
- Consider offering incentives for early adopters of alternative fuels, for example, reimbursing municipal and non-profit fleet operators for the added cost of purchasing alternative vehicles and/or fuels.
- Offer state matching funds to leverage federal grants.

Federal

- Increase federal R&D in clean non-petroleum technologies to be on par with, for example, healthcare at $28B by 2009.
- Increase support for pilot- and demonstration-scale projects.
- Tie infrastructure incentives to the increased penetration of alternatively fueled vehicles, i.e., for every one percent increase in flex-fuel vehicles sold, additional dollars will be made available for helping to increase the infrastructure development for that technology. Such incentives could build on corresponding private sector efforts. For example, several vehicle manufacturers have publicly committed to producing more flex-fuel vehicles (FFVs) as the E85 (85 percent ethanol blended with 15 percent conventional gasoline) infrastructure grows.

Infrastructure

When motorists pull up to a pump, rarely, if ever, do they consider the vast infrastructure — pipelines, storage facilities, refineries, blending and fueling stations — required to ensure the fuel is readily available to power their vehicles. This vast infrastructure, developed over the past century, represents planning, investment and engineering efforts of enormous magnitude.

The alternative fuels sector will likewise require a vast infrastructure to succeed. It makes sense to utilize the existing conventional-fuel infrastructure, to the maximum extent possible, whether the new fuel is liquid, as in the case of biofuels, or electrons. However, as the teams' studies readily demonstrate, whatever the form of fuel, it also will require development of significant new infrastructure.

For example, electric vehicles will depend on adequate electric generation facilities and transmission lines, as well as the proliferation of recharge facilities. Biofuels will require an infrastructure to move mass quantities of biomass daily from the farm to the refinery and from the refinery to the retail outlet; the installation of storage facilities and pumps adapted to an alcohol-based fuel also will be needed. Coal-to-liquid fuels would require an infrastructure that could transport significant amounts of coal from the mine mouth to the gasification facility; to import biomass in the case of co-processing; and to export the CO_2 by-product to locations for geologic sequestration or, in the case of either enhanced oil or natural gas recovery, to the oil or gas producing locales.

The Advisory Committee stresses that the costs for building a new infrastructure will be extremely high and should not be underestimated.

The change to an alternative fuels infrastructure will thus require capital and will likely take time. To advance the development of this alternative fuels infrastructure, the Advisory Committee recommends the following:

Feedstock transportation

- Develop maps showing potential feedstocks and refinery locations to address future transportation needs. Convene workshops of stakeholders to evaluate and address environmental infrastructure impacts, including new transportation needs and impacts on the existing transportation system.

Fuel distribution

- Plan for distribution of high-volume alternative fuels and other infrastructure components, including storage, rail and tanker trucks. Ethanol distribution of scale greater than 15 billion gallons of gasoline equivalent is likely to occur by 2015; plans for a distribution system, such as pipeline conversion, need to begin now.
- Explore fuels that are compatible with existing fuel distribution infrastructure, such as biobutanol and renewable diesel.

Fueling stations

- Increase higher-blend ethanol refueling stations.
- Establish alternative fuel corridors across the West and/or facilitate concentrations of alternative fuel vehicles and infrastructure in cities. Early fueling needs include biofuels,

natural gas and propane. Begin planning public recharging facilities for electric vehicles.

- Monitor technical developments, such as new fuel quality standards adopted by ASTM or EPA, that would enable higher-level conventional and non conventional blends to be used with existing vehicles, such as higher-level blends (>5 percent) of biodiesel. Before allowing such changes, states must pay attention to fuel compatibility with existing vehicles, off-road products and infrastructure, as well as warranty coverage, the potential for misfueling and the need for labeling as appropriate to avoid market problems and consumer rejection of new fuel blends. States may need to help educate the public about any changes in fuel cost on a BTU basis.

Feedstocks

The feedstock is the fundamental building block for a transportation fuel. For conventional fuels – gasoline and diesel fuel – it is oil. For traditional (starch-based) ethanol, it is corn or sugar cane. In the case of cellulosic ethanol, it is crop residues, such as wheat straw or corn stover, or perennial energy crops, such as switchgrass or even organic waste generated in large urban areas.

There are multiple considerations in developing a feedstock. Can you produce enough to make a significant dent in our transportation fuel appetite? What is the impact from a rapidly expanding feedstock on water resources, air quality and soil conditions in the case of biofuels feedstock and miner's safety in the case of CTL. Today there is concern about food vs. fuel. However, it is anticipated that in the future, cellulosic ethanol will offer alternatives to food competition by using a wide variety of waste streams, including crop residues. Estimating parameters, such as the adequacy of feedstock supply and developing the tools to measure the impact of a rapidly developing feedstock sector are critical in evaluating alternative feedstocks and land uses.

In the end, feedstocks must be developed in the quantity and of the quality that will yield a superior transportation fuel, as efficiently as possible, while minimizing environmental impacts.

The Advisory Committee recommends the following to the Western Governors:

- Feedstock research: Identify research into feedstocks that are new to a state. Of particular importance will be examining agronomy and water conditions necessary for production, the costs of production and yield.
- Incentives for feedstock production: Encourage producers to change to new cropping regimes. This will require education and risk mitigation for evolving feedstock development, e.g. extending crop insurance programs. Additionally, new farm equipment may be needed, and this may require low interest or no interest loans.
- Feedstock availability: Highlight benefits gained through utilization of biomass waste streams. Address issues regarding access to forest residues and urban waste streams.

Workforce Development

Developing an alternative fuel sector requires a workforce trained in the required disciplines, foremost in the basic and applied sciences, such as chemistry, plant biology, microbiology, and chemical and electrical engineering. We have fallen far short of other advanced nations in attracting our youth to pursue these disciplines, to the point that many leaders in the private economic sector are beginning to voice concern.

The Advisory Committee recommends that the Western Governors take the following steps to enhance workforce development and to promote the career opportunities associated with the emerging alternative fuels sector:

- Obtain industry advice on needed directions in workforce development.
- Evaluate state university programs to identify new or modified curricula needed for future technologies. Agriculture and engineering will be critical areas for attention.
- Evaluate alternative fuel pathways to identify new opportunities. For example, batteries for electric vehicles offer new manufacturing, maintenance and disposal opportunities.
- Develop state universities as R&D centers for emerging technologies and fuels.

IV. Recommendations for the Specific Fuel Types, Including Fuel Efficiency

Vehicle Fuel Efficiency

Fuel Savings Potential for the West

- Vehicle efficiency is important. Past improvements in vehicle efficiency have significantly reduced transportation's petroleum use over what it would otherwise have been, and increasing vehicle efficiency in the future will do the same.
- Improved vehicle efficiency also will help reduce greenhouse gas emissions, and policies to improve fuel efficiency and reduce GHG emissions will help reduce oil consumption and dependence.
- Beyond vehicles and fuels, smarter land-use and transit policies and practices are needed to help reduce oil consumption.
- Increasing the use of alternative fuels and powertrains – such as hybrids, diesel, E85/FFVs, biodiesel and hydrogen – are also important ways to significantly reduce consumption of conventional crude oil.

Source: National Renewable Energy Laboratory

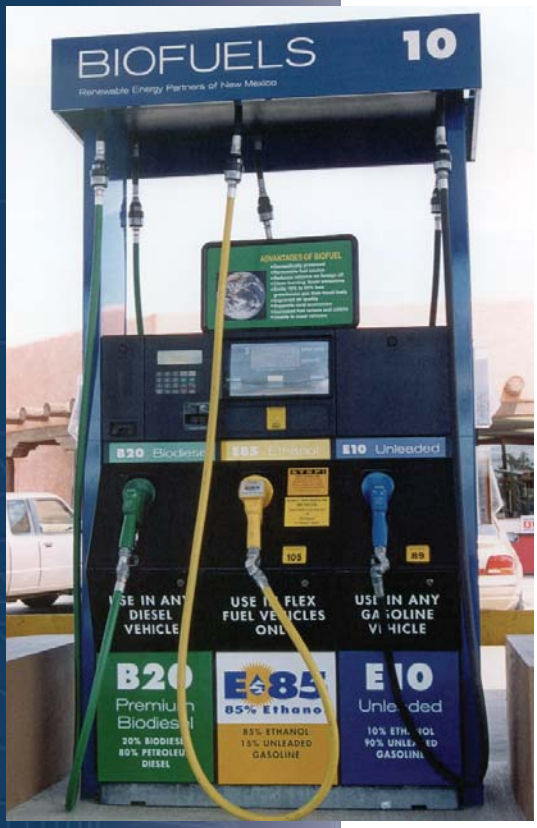
Challenges

- Vehicle fuel economy standards are important. The federal government controls fuel-economy standards, which is the single most important policy tool currently in place for improving fuel efficiency, but the Governors can influence federal policy and also take actions on their own – for example, through leadership and state fleet management – that will make a difference. Until passage of the Energy Security and Independence Act of 2007, the Congress had not enacted tougher standards over the last 22 years.
- Vehicle fuel economy, growth in vehicle miles traveled (VMT) and the use of alternative fuels are the three most important factors in the amount of petroleum consumption. Efforts to reduce petroleum consumption should address all three of these factors.
- During the past two decades significant advances have been made in vehicle technology. In the absence of direction from Congress, many advances were directed toward other attributes besides fuel economy to meet consumer demand. But, today, consumers are much more interested in buying products with better fuel economy or alternative powertrains.
- Land-use decisions historically have not factored in climate or oil-dependence considerations.

Priority Recommendations

- Each Western state should adopt a goal and a timeline for cutting its petroleum consumption, on a statewide basis, while also reducing greenhouse gas emissions by at least 10 percent. For example, the California Energy Commission and Air Resources Board approved goals of reducing petroleum-based fuel by 15 percent and increasing utilization of alternative fuels by 20 percent in 2020, despite expected growth in human and vehicle population during that time period.
- The Governors should continue supporting federal action to strengthen and improve federal fuel economy standards for passenger and light-duty vehicles.

- The Governors should encourage Congress to extend and improve current alternative fuel and efficient vehicle tax credits by at least 10 years. Long-term tax credits will help encourage private sector investment. The states should consider providing incentives of their own.
- The states should lead by example. States should set petroleum reduction goals for their own fleets and enact plans to achieve these goals.
- The states should try to provide as many incentives for efficient vehicles as possible. California recently enacted a law, for example, that would generate more than $120 million/year to encourage alternative and renewable fuels and the use of more efficient and climate friendly light-, medium- and heavy-duty vehicles.
- The Governors should support reducing greenhouse gas emissions from the transportation sector through some type of cap and trade or other management program. In developing such a program, any regulation applicable to transportation fuel should be applied at an upstream point (e.g., refinery) and not at the end-user point (e.g. individual transportation companies), due to the impracticality of managing such a large number of mobile sources.



Source: National Renewable Energy Laboratory

Alternative Fuels and Propulsion Technologies

Biofuels Part I: Ethanol

Fuel Potential for the West

- A recent report by the U.S. Department of Energy and Department of Agriculture found that land resources in the U.S. are capable of producing a sustainable supply of 1.3 billion tons per year of biomass. This is sufficient to produce biofuels equivalent to 30 percent of today's fuel use.[12]
- Western feedstock opportunities for biomass conversion include agricultural crops; forestry and agricultural residues; and non-food crops, such as sorghum and switch grass.
- Producing energy crops and increasing farmer/rancher participation in biorefinery projects would provide a needed boost to rural economies.
- Research at universities in the West and in government laboratories, such as NREL and the Idaho National Laboratory, are making significant progress in:
  1. developing plant germplasm for use as dedicated energy crops,
  2. modifying farm equipment for feedstock harvest and transport, and
  3. developing new or improved processes (both biological and thermal/chemical) for converting feedstock to fuels.
- E10 (10 percent ethanol blend) is the easiest way to increase use of ethanol in transportation fuels; it is compatible with virtually all highway and non-road engines and requires little investment in new fueling infrastructure.

Challenges

- Starch-based ethanol production, for which there is proven feedstock – corn – and a mature conversion technology, will likely peak at 12-15 billion gallons per year, which is less than 10 percent of current annual gasoline consumption on a volumetric basis and less than six percent on a BTU adjusted basis.[13] Making further inroads into the conventional fuel pool will require the build-out of a cellulosic-based biofuels industry for which feedstocks and conversion technologies are in early stage development.
- Harvesting and transporting massive amounts of biomass remain a significant economic challenge. Densification and preprocessing techniques and technologies have been insufficiently explored.
- The expansion of energy crop production, even with switchgrass and other perennial prairie grasses, raises concerns relating to the impact on soil systems and water resources.

- While most studies find that conventional corn ethanol reduces emissions modestly and cellulosic ethanol can dramatically cut pollution, emissions can vary widely, depending upon farming practices, previous use of the land and fuel processing techniques.
- Infrastructure and education to support E85 (85 percent ethanol blend) are limited. Currently, there are fewer than 1,500 E85 stations in the U.S., compared to 180,000 gasoline stations.
- Attracting capital to fund the cellulosic ethanol sector has proved challenging.
- Access to cellulosic waste feedstocks is challenging.
- Even with government support, alternative fuels may cost more to consumers on a BTU basis compared with conventional fuels. Some price fluctuations should be expected, but large price swings may discourage consumers.
- Extension of E85 infrastructure needs to be accompanied by consumer education to avoid unintended consequences, such as misfueling and related emission impacts.
- Allowing the use of intermediate blends (greater than E10 and up to E85 by volume) of ethanol in conventional gasoline would increase the market for alternative fuels. However, intermediate blends have been limited in acceptance in the U.S. due to concerns about compatibility with conventional engines and emissions impacts.

Priority Recommendations

- Fund state research directed at the production, harvest, transport and conversion of cellulosic biofuels feedstock to transportation fuel. At the same time, provide financial support to collaborations among state research facilities and private industry to further feedstock development, reduce the costs of production, and establish demonstration-scale biorefineries through appropriate tax incentives. Consider loan guarantees as an incentive to commercialization.
- Urge the federal government to provide financial assistance to growers willing to plant dedicated energy crops consistent with greenhouse gas reduction and other environmental goals.
- Consistent with greenhouse gas reduction and other environmental goals, support implementation of the expanded Renewable Fuel Standard (RFS).
- Advocate for full funding of the U.S. Department of Agriculture's biomass research and development program at its authorized level, as well as for the full funding of the U.S. Department of Energy's biomass research and demonstration activities.
- Encourage investigations of engine and vehicle compatibility with intermediate blends (greater than E10 and up to E85) to resolve questions about the fuels' impact on compatibility and emissions.
- Establish goals for increasing higher blend ethanol infrastructure and then consider supporting those goals with incentives.
- Urge that the Volumetric Ethanol Excise Tax Credit be reformed to encourage advanced and low-carbon biofuels and those appropriate to Western feedstocks.

Biofuels Part II: Biodiesel and Renewable Diesel

Fuel Potential for the West

- Biodiesel and renewable diesel are produced from a diverse array of feedstocks grown in the West, including soybeans, sunflowers, canola, cotton and peanuts. These fuels can also be produced from non-conventional feedstocks such as cooking grease and tallow, also available in large quantities in the West.
- Growing feedstocks and possibly participating in biorefinery projects provide a needed boost to Western rural economies.
- The conventional technology for producing biodiesel, transesterification, is relatively well known and mature. In addition, new processes are emerging that can accommodate biofeedstocks at conventional oil refineries and that are compatible with existing infrastructure; these are refered to as renewable diesel. Hydro-treating, for example, is now being deployed to produce "green diesel" from traditional biodiesel feedstocks.

Source: National Renewable Energy Laboratory

Challenges

- The expansion of annual crop production, which typically requires generous amounts of water and nutrients, raises concerns relating to the impact on soil systems and water resources.
- Much of the feedstock currently utilized in biodiesel production, e.g. canola oil, soy and sunflower oil, has alternative markets, and may become too expensive or unavailable for use for fuel production.
- While most studies find that conventional biodiesel reduces global warming pollution, emissions can vary widely depending upon farming practices, previous use of the land and fuel processing techniques.
- Biodiesel product quality in the marketplace has troubled the industry in the recent past. Poor fuel quality would be a barrier to market growth.
- Conventional biodiesel requires build out of a separate infrastructure, because the fuel is not compatible with the existing diesel fuel infrastructure, i.e. pipeline, storage and blending facilities and retail pumps.
- Biodiesel and renewable diesel are more expensive than conventional diesel fuel.

Priority Recommendations

- Fund research at state institutions to determine the impact on soil systems and the water resources from expanding oil seed crops. Establish procedures through the agricultural extension services to monitor these factors.
- Support incentives in federal legislation for growers of crops that have oil-producing qualities consistent with greenhouse gas reduction goals. Provide R&D funding for crop selection of novel oilseed crops, such as camelina, castor and jatropha.
- Encourage USDA to make long-term, low-interest loans to infrastructure, refinery, oil mill and/or production agriculture directly involved in the biodiesel industry.
- Promote strong state and federal enforcement and corresponding funding for fuel quality and labeling for biodiesel.
- Continue research on "big splash" and "sustainable production" items, such as algae.
- Support research to reduce the cost of producing biodiesel and renewable diesel fuel.

Electric

Fuel Potential for the West

- The West has ample energy resources from which electricity can be produced.
- The West has an excellent electrical infrastructure in place and immediately available. Electric utilities have substantial unused off-peak capacity available for overnight or other charging.
- Plug-in hybrid electric vehicles (PHEVs) are available today in the marketplace though not as original equipment. Automakers have unveiled some prototype PHEVs and continue their research on the technology to enable eventual introduction to the marketplace.
- Improvements in technology for charging vehicles are expected soon.

Source: Natural Renewable Energy Laboratory

Challenges

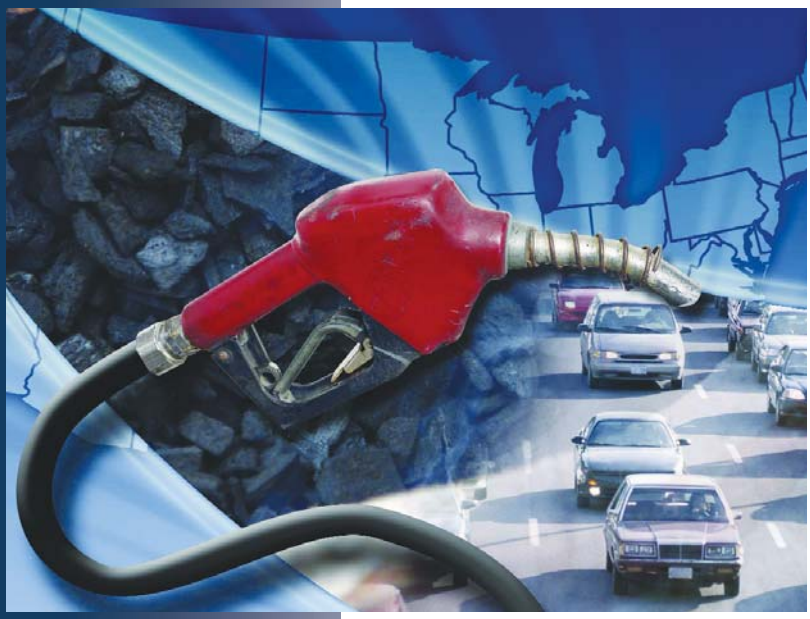
- Current battery technology makes electric and PHEVs more expensive, limits electric range and increases vehicle weight.
- Consumer acceptance could be slow for new and more expensive technology.
- The following will be needed to fully take advantage of electricity use for transportation: consumer education regarding home refueling, off-peak utility pricing, public and on-the-road charging facilities, and possible utility buy-back provisions from two-way charging connections.
- Because of high emissions from coal-produced electricity, environmental benefits from electric vehicles will not be fully realized until there is more widespread renewable energy electricity generation.

Priority Recommendations

- With the passage of the 2007 energy bill, the states should prepare to match federal dollars for electric power R&D.
- Support the widespread use of electricity as a transport fuel in the Western states through consumer education and by promoting long-term commitment from key parties, including utilities and government agencies.
- Provide stable funding at the federal and state levels for battery research.
- Support federal, state and local demonstrations of PHEVs by public and private entities.
- Revise government fleet purchasing programs to provide market certainty to manufacturers and promote technology demonstrations.
- Encourage state-level cooperation with utilities to address off-peak utility pricing.
- Increase state-level communications with utilities, mortgage companies and others to develop new mechanisms to mitigate the upfront cost of PHEVs, such as rebates, lease programs, tax credits and financing through mortgage equity.
- Encourage Renewable Portfolio Standard goals be met to produce cleaner electricity for powering vehicles.

Coal-to-Liquids (CTL)

Members of both the Coal-to-Liquids (CTL) Team and the Advisory Committee have widely differing views on the subject of the CTL technology. Because of this, neither the CTL Team nor the Advisory Committee was able to produce a consensus statement or set of recommendations – beyond what is stated here – with respect to CTL. To accommodate the different perspectives, the Advisory Committee is setting out three sets of alternative recommendations on CTL, which represent the different approaches for addressing CTL that have emerged in this process.



Source: Pacific Northwest National Laboratory

Fuel Potential for the West

- The West has large coal reserves that, using a Fischer-Tropsch (F-T) technology, are technically feasible to convert into a liquid fuel for transportation.
- CTL production technology (F-T) has long been in use in South Africa and is a subject of significant interest in the United States and elsewhere.
- CTL can produce a premium and stable diesel fuel with ultra low sulfur and aromatics, high cetane, and high Btu content.
- CTL's attributes, in addition to the fact that CTL fuels are produced from domestic coal, make it attractive to the U.S. Department of Defense. CTL jet fuel is being qualified for use in all U.S. Air Force aircraft and other commercial aircraft as well.
- F-T diesel can be blended with petroleum-based diesel fuel to assure compliance with some environmental specifications.
- Co-firing coal and biomass to produce liquid fuels (CBTL) could utilize the West's supply of biomass, such as crop and forest residues and grasses. CBTL, with capture and disposal of the carbon dioxide produced at the plant, could result in reductions in life-cycle GHG emissions as compared to petroleum.
- The West contains a CO_2 pipeline network with established enhanced oil recovery (EOR) operations, as well as extensive geological formations with potential for permanent CO_2 sequestration.

Challenges

- The life-cycle (mine to wheels) carbon emissions associated with CTL is approximately double that of conventional petroleum (well to wheels) if CO_2 is vented into the atmosphere. With the capture and disposal of virtually all of the carbon produced at a CTL plant, life-cycle carbon emissions from CTL fuel will be roughly equal to petroleum. Some stakeholders believe that the development of a CTL industry is incompatible with achieving a 50 to 85 percent reduction in global greenhouse gases by 2050.[14]
- There are no CTL plants operating in the United States.
- CTL plants will require a massive infrastructure build out, including rail transport, water supply and treatment facilities, transmission lines, carbon capture facilities, and carbon dioxide pipeline transport to storage sites.
- The very high costs of CTL plants and the uncertainties associated with future carbon regulation make obtaining financing for CTL development difficult.
- Water availability will be a constraining factor in siting and developing CTL plants in the West.
- A mature CTL industry will use up underground carbon dioxide storage capacity which may compete with the storage capacity needs to dispose of carbon dioxide arising from the use of coal for electricity generation.
- Coal reserves data has not been updated since the 1970s, and a recent study by the National Research Council suggests that economically recoverable reserves may be lower than previously estimated. The report notes that the nation's reserves will be sufficient through 2030, but that long-term reserves are less certain and need to be reevaluated. Consequently, it is uncertain whether there is sufficient coal for both fuel production and electricity generation
- There are several obstacles to the development of a CBTL industry, including the immaturity of gasifier technology and issues surrounding the availability, transport, handling and processing of biomass in quantities required for co-processing.
- Coal mining in the West has impacts on land and water resources and remains controversial.

Alternative Recommendations

The order of the recommendations that follow does not indicate agreement by the entire Advisory Committee on a priority or preference for one set of recommendations over the others.

The first set of recommendations is based on the belief that there are critical issues that need to be analyzed further and resolved before society commits to CTL. They encourage federally supported research and additional WGA process to:

- Analyze and report the economic risks and/or potential benefits associated with developing a CTL industry, in light of the likelihood of future regulatory controls on carbon.
- Evaluate the water consumption needs of the various CTL technologies and prospective plants and consider the availability of surface, ground or fossil water to meet those needs.
- Analyze and report on impacts to the West's natural resources and to workers' health from increased coal mining to supply a prospective CTL industry, as well as any mitigation measures that may be available.
- Assess the sufficiency of sequestration capacity to accommodate CO_2 from both CTL plants and electric generation units.
- Evaluate the sufficiency of biomass supplies to support a CBTL industry, along with a consideration of infrastructure requirements necessary to collect and transport that biomass for CBTL use.
- Analyze and determine what is the best transportation fuel, or combination of fuels, to address the nation's climate and oil security concerns in the most economical way.

The second set of recommendations represents the priority recommendations from the main body of the CTL Team report.[15]

- Promote and establish market-based incentive structures to help overcome the high capital cost and associated financial risks with CTL plant construction. Federal incentives that could be offered include expanded existing self-pay loan guarantees, long-term off-take agreements for products, floor pricing with a cap for crude oil, accelerated investment tax credits for CCS equipment, and tax incentives for the fuel similar to those that currently exist for other alternative transportation fuels.
- Establish federal, state and private programs to help develop a trained/educated workforce for design/construction/operation of CTL plants.
- Develop robust infrastructure (rail/pipeline/biomass transport/CO_2 storage), as well as develop the permitting, siting and regulatory/oversight environment to foster a CTL industry.
- Promote and incent infrastructure development and develop incentives that would encourage CTL plants to be sited in locations where captured CO_2 could be used for EOR.
- Undertake RD&D, including an accelerated full-scale demonstration of coal plus biomass co-processing.

The third set of recommendations is derived from the appendices of the team report and seeks to promote the CTL industry, while explicitly accounting for issues related to carbon impacts from CTL. Recommendations include the following:

- Encourage support for financial incentives for early plants, which would be awarded in a competitive context to those projects offering fuel at the lowest price that meets the requisite specifications and assumes a CO_2 shadow price high enough to enable by mid-century deep reductions in CO_2, e.g. $50 per ton. To qualify, any project must, at a minimum, meet the requirement that 85 percent of the carbon not contained in the energy products be captured and stored.
- Encourage support of off-budget, performance-based financial incentives for the routine deployment of CTL, such as the low-carbon fuel standard, CO_2 cap and trade, carbon tax or CO_2 sequestration tax credits for industry, and fee-bate systems.[16]
- Restrict financial incentives for CTL plants in the West to those that use fossil (non-hydrological) water for meeting plant water requirements.

- Encourage locations of projects where they can provide relatively low-cost CO_2 for megascale geological storage projects to assist in the determination of the "gigascale" viability of CO_2 storage.
- Condition the widespread adoption of CTL technologies on general acceptance by the scientific community that geological CO2 storage is viable at "gigascale."

Source: National Renewable Energy Laboratory

Natural Gas/Propane

Fuel Potential for the West

- Natural gas is a secure, domestic resource with 98 percent of the U.S. supply coming from North America. Proven domestic reserves exceed 75 years at current production.
- Five of the nation's largest natural gas producing states are in the West (CO, NM, OK, TX, WY).
- In addition to current conventional supplies of natural gas, the U.S. Department of Energy estimates that the U.S. can feasibly produce 10 billion gallons of gasoline equivalent biomethane annually from sources, such as landfills, animal waste processing and sewage.
- Compressed natural gas (CNG), liquefied natural gas (LNG), and propane are well known alternative transportation fuels. Natural gas and propane vehicle engine and fueling technology are already developed and in current deployment.

Challenges

- There are only a small number of Original Equipment Manufacturers making CNG, LNG, and propane vehicles in North America.
- EPA emissions certifications are expensive and preclude wide-product variety for the small volume manufacturers that produce conversion systems. Economies of scale are difficult to reach.
- Fueling infrastructure and conversions are costly. Vehicle deployment primarily lies in niche markets or return-to-base fleets, such as taxicabs, street sweepers, transit buses, refuse haulers, school buses, delivery vehicles, trucks and trailers, and airport shuttles.
- Natural gas production has impacts on land and water resources. Technology challenges include reducing the surface footprint of exploration and production, and developing methods to reduce the volume of water and other fluids injected and/or produced to the surface.
- As the volume of biomethane use increases, the greenhouse gases generated in the feedstock gathering and biomethane production process will need monitoring.

Priority Recommendations

- Encourage and support federal legislation that will provide incentives or credits to vehicle manufacturers, many of whom build natural gas and propane vehicles for the international market, to develop and deploy those vehicles for the North American market.
- Encourage Governors to review state alternative fuel incentives to determine if they enhance niche market deployment of natural gas and propane vehicles and fueling infrastructure. Also, review to determine if end users from the public and private sector are able to realize the intended benefits of state incentives.
- Encourage all energy uses of renewable biogas. Specifically, encourage Governors to support incentives or credits at both state and federal levels for biogas used or gathered for all energy applications, including biogas converted to pipeline quality methane.

Hydrogen

Fuel Potential for the West

- The Western states have well established research programs to advance the hydrogen technology at both universities and national laboratories, as well as demonstration programs in various cities.
- Hydrogen can be produced from a variety of energy sources plentiful in the Western states, including fossil fuels, biomass fuels and electricity.
- Automakers have unveiled and are testing prototype fuel cell vehicles. The most recent announcements by these automakers target initial production of fuel cell vehicles beginning in the 2010 - 2015 timeframe.

Challenges

- Hydrogen and energy feedstock storage and delivery present particular challenges in Western states given the distances involved, energy demand and population densities. Delivery to island states/territories and to Alaska may be impractical, so localized hydrogen production using indigenous energy resources may be necessary. For other Western areas, longer delivery distances may ultimately require delivery of hydrogen via a network of pipelines and electric transmission lines.
- Producing hydrogen through electrolysis will require significant cost reductions and technology improvements.
- Fuel cell technology for use in vehicles still requires significant work in order to match the performance, cost and convenience provided by gasoline or diesel-fuel vehicles.
- Codes and standards need to be established for hydrogen as a transportation fuel.

Priority Recommendations

- Promote and support early-market Polymer Electrolyte Membrane fuel cell applications and hydrogen demonstration projects.
- Expand hydrogen demonstration projects that bring together hydrogen-powered vehicles and refueling infrastructure.
- Support state and federal funding for development research of hydrogen fuel cells and infrastructure.
- Establish and maintain tax incentives for renewable hydrogen production, refueling infrastructure and vehicles.
- Support the accelerated adoption of national standards and model codes that, among other things, define hydrogen as a transportation fuel, not a hazardous chemical.

Source: National Renewable Energy Laboratory

Summary

Alternative fuels are evolving at various rates of development. Natural gas/propane, biodiesel and renewable diesel, starch-based ethanol, and hybrid electric vehicles are all available today. Their market penetration and the development of the other alternatives – advanced biofuels (cellulosic and biobutanol), hydrogen, PHEVs, battery electric vehicles (BEV), and coal-to-liquid fuels – will depend on a variety of factors, including: technology advancements, market acceptance, environmental impacts, feedstock availability and infrastructure. The following roadmap depicts the potential market deployment.

Whether market deployment occurs will depend upon the success of addressing the above factors. The Western Governors can play an important role in determining the results based on taking the cross-cutting recommendations and the fuel-specific priority recommendations described above.

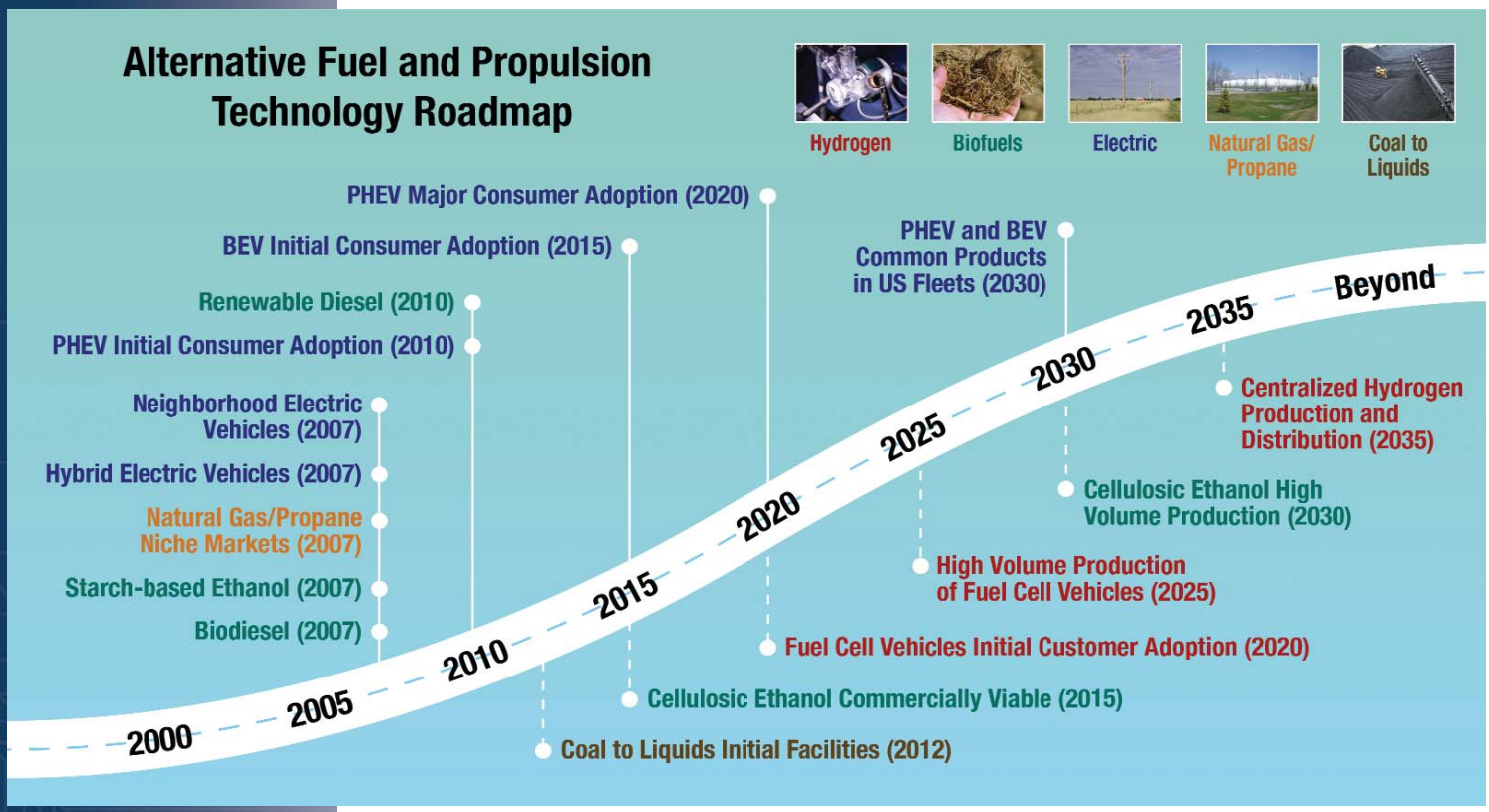


Figure 5:
Source: National Renewable Energy Laboratory

Appendix A

Project Structure

This report is the result of the collaboration among three groups comprising the Transportation Fuels Task Force:

1. The Advisory Committee
2. The Steering Committee, and
3. The Alternative Fuel/Vehicle Fuel Efficiency Teams.

The Advisory Committee guides the work of Alternative Fuel/Vehicle Fuel Efficiency Teams and authors the final report for the Governors. The Advisory Committee consists of stakeholders from the private sector, recognized experts in transportation fuels, the public sector, and representatives from the environmental community.

The Steering Committee is composed of representatives of the lead Governors and serves to provide input to the Advisory Committee and the team efforts.

The Alternative Fuel/Vehicle Fuel Efficiency Teams prepared detailed technical reports on the transportation fuel/vehicle fuel efficiency options with recommendations. There are six teams, each focusing on a fuel or group of fuels and one on vehicle fuel efficiency. The membership consists of stakeholders from the private sector, recognized experts in transportation fuels, including members from universities and environmental groups, and the national laboratory community.

The teams developed individual reports, which are posted on the WGA web site and were open for public comment. The Advisory Committee considered all of the teams' findings and developed priority recommendations for the Governors. The Governors are encouraged to consider the detailed team recommendations and adopt them in their states, as appropriate for their states' conditions and interests. The work of the Advisory Committee and the teams followed the Western Governors' Enlibra principles, a doctrine created to guide natural resource and environmental policy development and decision-making in the West.

Advisory Committee

Co-Chairs

James D. Boyd, Vice Chair, California Energy Commission
David Fleischaker, Oklahoma Secretary of Energy

Members

Yvonne Anderson, Association of Central Oklahoma Governments
Jacques Beaudry-Losique, U.S. Department of Energy, Office of Biomass Programs
John Boesel, Westart/Calstart
Will Coleman and Marianne Wu, Mohr, Davidow Ventures
Doug Faulkner, United States Department of Agriculture
Dale Gardner, National Renewable Energy Laboratory
Roland Hwang, Natural Resources Defense Council
Tammy Klein, Global Biofuels Center
Kirk Marckwald, California Environmental Associates
Jay Mckeeman, California Independent Oil Marketers Association
Patricia Monahan, Union of Concerned Scientists
Rich Moskowitz, American Trucking Association
Ben Paulos, Energy Foundation
Ellen Shapiro, Alliance of Automobile Manufacturers
Dan Sperling, Institute of Transportation Studies at UC Davis
Ed Sughrue, ConocoPhillips, Inc.
Duane Yantorno, Arizona Governor's Office
Jeff Yingling, JP Morgan Chase

Steering Committee

James D. Boyd, California
Evan Barrett, Tom Kaiserski, Montana
David Fleischaker, Oklahoma
Hunter Roberts, South Dakota
Dianne Nielson, Utah
Matt Stuerwalt, Washington
Tony Usibelli, Washington
Steve Ellenbecker, Wyoming

Teams

Biofuels (ethanol, biobutanol and biomethane)

Chair: David Terry, Governors Ethanol Coalition

Charles Bensinger, New Mexico Biofuels Retail Distributor
John Brenner, USDA Natural Resources Conservation Service
Jeff Fox, Poet Energy
Ray Huhnke, Oklahoma State University
Kehau Kincaid, Prometheus Energy
Vance Kopp, Suncor
Phillip Lambert, National Ethanol Vehicle Coalition
Bob Mailander, Rocky Mountain Farmers Union
Fernando Martinez, New Mexico Energy Conservation and Management
Nick Nagle, National Renewable Energy Laboratory
Gordon Schremp, California Energy Commission
Stacey Simms, Colorado Energy Office
Alan Weverstad, General Motors
Paul Wuebben, South Coast Air Quality Management District, California

Biodiesel and Renewable Diesel

Chair: Richard Nelson, Kansas State University

John Brenner, USDA Natural Resources Conservation Service
Wade Deerman, New Mexico grower and producer
Neville Fernandes, Neste Oil Corporation
Ray Hobbs, Arizona Public Service
Vance Kopp, Suncor
Lance Lobban, University of Oklahoma
Kim Lyons, Washington State University
Bob Mailander, Rocky Mountain Farmers Union
Bob McCormick, National Renewable Energy Laboratory
Colin Messer, Energy, Mineral and Natural Resources Department, New Mexico
Rich Moskowitz, American Trucking Association
Jeff Probst, Blue Sun Biodiesel
Ed Sughrue, ConocoPhillips
Bryan Willson, Colorado State University
Gary Yowell, California Energy Commission

Natural Gas and Propane

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Curtis Donaldson, CleanFuel USA
Bob Meyers, Western Propane Gas Association
James Orsulak, Clean Energy
Bill Platts, Delta Liquid Energy
Rick Teebay, Los Angeles County, Department of Public Works

Coal-to-Liquids

Chair: Graham Parker, Pacific Northwest Laboratory

Paul Bollinger, U.S. Air Force
Dave Perkins, Rentech Inc.
Greg Schaefer, Arch Coal
Dick Sheppard, Rentech, Inc.
Robert Williams, Princeton University

Electric

Chair: Bob Graham, Electric Power Research Institute

Rich Feldman, Advisor to the Mayor of Seattle
Ray Hobbs, Arizona Public Service
Michael Kintner-Meyer, Pacific Northwest Laboratory
Philip Misemer, California Energy Commission
Diarmuid O'Connell, Tesla Motors
Keith Parks, Xcel Energy
Terry Penney, National Renewable Energy Laboratory
Bill Reinert, Toyota
Bob Spotnitz, Battery Design Co.
Dean Taylor, Southern California Edison
Brian Wynne, Electric Drive Transportation Association

Hydrogen

Chair: George Sverdrup, National Renewable Energy Laboratory

Andy Abele, Quantum
Anthony Dean, National Renewable Energy Laboratory/Colorado School of Mines
Kevin Harris, Hydrogenics
Alan Lloyd, International Council on Clean Transportation
Matt Miyasato, South Coast Air Quality Management District, California
Frank Novachek, Xcel Energy
Daniel Rabun, Air Products
Todd Ramsden, National Renewable Energy Laboratory
Rick Rocheleau, University of Hawaii
Gerry Runte, Mountain States Hydrogen Business Council
Craig Scott, Toyota
Ken Stroh, Los Alamos National Laboratory
John Turner, National Renewable Energy Laboratory
Alan Weverstad, General Motors

Vehicle Fuel Efficiency

Chair: John Boesel, Westart/Calstart

David Greene, Oakridge National Laboratory
Gerry Harrow, National Renewable Energy Laboratory
Ken Kurani, University of California at Davis
Tim O'Connor, Environmental Defense
Martha Roberts, Environmental Defense
Tom Trueblood, International Truck and Engine Corporation
Peter Ward, California Energy Commission
Al Weverstad, General Motors

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Gayle Gordon, WGA Program Director

Karen Deike, WGA Communications Director
Matt Futch, WGA Program Associate
Alex Schroeder, WGA Program Director
Peter Ward, CEC, Program Manager, Alternative Fuel Infrastructure

Contractor Support

Heather Bergman, The Keystone Center
Kathleen Rutherford, Kearns & West
Will Singleton, Singleton Strategies LLC

Appendix B

Life Cycle Assessment

A life cycle assessment (also known as life cycle analysis, well-to-wheels analysis, and dust-to-dust energy cost) is the assessment of the environmental impact of a given product or service throughout its lifespan. The goal of a LCA is to compare the environmental performance of products and services. The term 'life cycle' refers to the notion that a fair, holistic assessment requires the assessment of raw material production, manufacture, distribution, use and disposal, including all intervening transportation steps. This is the life cycle of the product. The concept also can be used to optimize the environmental performance of a single product or to optimize the environmental performance of a company.

The pollution caused by usage also is part of the analysis. For a hydroelectric power plant, for example, construction pollution is considered, but so is the decay in biomass on land flooded to create the dam because it cannot absorb carbon dioxide anymore. This biomass decay is called "CO_2 equivalent." Common categories of assessed damages are global warming (greenhouse gases), acidification, smog, ozone layer depletion, eutrophication, ecotoxic and anthropotoxic pollutants, desertification, land use, as well as depletion of minerals and fossil fuels.

Life cycle assessment can also be applied to alternative transportation fuels. The analysis of a transportation fuel's life cycle, also known as a fuel cycle, is often reported in two distinct phases, as shown in Figure 6. The well-to-tank (WTT) phase includes resource extraction, feedstock production, refining, blending, transportation and distribution, whereas the tank-to-wheels (TTW) phase includes refueling, consumption and evaporation.

The complete fuel cycle analysis is referred to as a well-to-wheels (WTW) analysis.

There are several life cycle GHG emission models for transportation fuels. The two most sophisticated and prominent that have been subject to the most peer review are

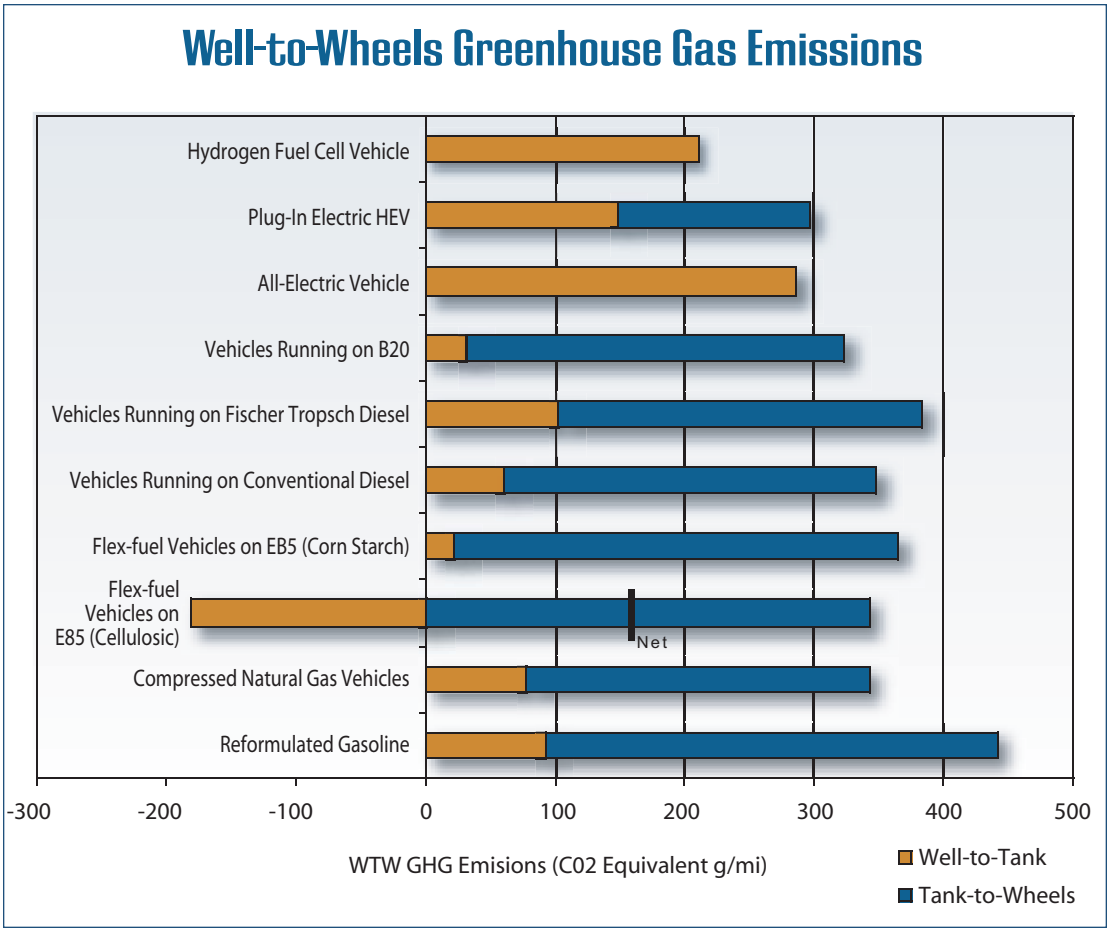

Figure 6: Illustration of Well-to-Wheels Analysis of Greenhouse Gas Emissions. GREET (Greenhouse Gases, Regulated Emissions, Energy use in Transportation)

GREET, developed by Argonne National Laboratory, and LEM. The LEM model (Life Cycle Emissions Model) was developed by Dr. Mark Delucchi of UC Davis. It provides somewhat more depth and breadth, but it is not a public model, as is GREET, nor does it have an easy-to-use interface. The LEM model is the basis of the life cycle emissions model used by the Canadian government. It provides similar results to GREET for most fuel paths.

Note: Figure 6 on page 24 is illustrative only. It is not meant to be interpreted as a definitive life cycle analysis of alternative fuels. GREET is the most commonly used model for LCA analysis even though it is imperfect and the input assumptions are debated.

Description:

Figure 6 on page 24 serves as a visual description of total well-to-wheels GHG emissions from one of many potential alternative fuel pathways. In this instance, specific fuel pathways have been chosen, such as compressed natural gas, conventional diesel, and E85 from starch corn feedstock. GREET has calculated the well-to-wheels greenhouse gas emissions in CO_2 equivalent grams per mile.

As in any model, there are many assumptions about upstream production, power generation, and feedstocks that must be made in order to produce final calculations of the fuel's environmental impact. GREET has the advantage of offering a user friendly graphical user interface, which lends itself to higher usage amongst policymakers and researchers. Unfortunately, this means that basic assumptions, which drive the fuel pathway results, remain hidden from an inexperienced user. For example, one of the assumptions built into this particular data run is that coal will provide 48 percent of all electrical baseload power in the year 2020. The two major production assumptions for Fischer-Tropsch diesel are a 95 percent rate of carbon sequestration and a 52.4 percent efficiency rating by the year 2020. Any number of arguments could be made about what the mix of energy production will be for national baseload power by the year 2020. These arguments could lead the modeler to increase or decrease this percentage. Altering this input variable would subsequently change the comparative results for certain fuel pathways. Similar examples can be found regarding assumptions about production methodologies of biofuel feedstocks.

Model Assumptions:

In order to accurately assess WTW emissions, GREET makes critical assumptions about sources of energy generation and the calculation of energy emissions across the energy supply chain.

Detailed emissions data for Volatile Organic Compounds (VOCs), CO_2, Nitrous Oxide (NOx), particulate matter (PM10) and Sulfur Oxide (SO_X) were obtained from EPA emissions inventory data. There were limitations in the EPA data related to Methane (CH_4) and Nitrous Oxide (N_2O) emissions from fuel combustion; as a result, these particulates are not taken into account.

Energy efficiency in GREET is calculated by taking the energy output divided by energy input, including energy in both process fuels and for a given well-to-tank activity. The energy input per unit of energy product output is calculated in GREET from the energy efficiency of the activity.

Emission factors for VOCs, CO_2, NOx, PM10, CH_4 and N_2O for different combustion technologies fueled by different process fuels are continuously updated from original sources: EPA's AP-42 document (EPA 1995) and the NEI database consists of emission inventory information for point sources collected from state and local air agencies. Data in this inventory are commonly used for air quality monitoring and human local air agencies.

Combustion CO_2 emission factors (in g/mmBTU of fuel throughput) are calculated by using a carbon balance approach. Carbon contained in combustion emissions of VOCs, CO, and CH_4 is assumed to convert to CO_2.

Appendix C

California's Low-Carbon Fuel Standard

Overview:

Under the low-carbon fuel standard (LCFS), fuel providers would be required to track the life cycle, global warming intensity (GWI) of their products, measured on a per-unit energy basis, and reduce this value over time. The term "life cycle" refers to all activities included in the production, transport, storage and use of the fuel. The term "global warming intensity" is a measure of all the mechanisms that affect global climate, including not only greenhouse gases (GHGs) but also other processes. The unit of measure for GWI is grams of carbon dioxide equivalent per megajoule used to propel a vehicle (gCO_2e/MJ), adjusted for powertrain efficiency. The LCFS is a comprehensive policy mechanism, which contains a carbon credit-trading program, certification and monitoring mechanism. The goal of the LCFS is to reduce the average fuel carbon intensity for all transportation fuels, measured in units of adjusted gCO_2e/MJ.

An Integrated Market and Regulatory Mechanism:

The ability of regulated firms to trade and bank credits is critical to the cost-effectiveness of the LCFS. When implemented carefully, tradeable emission reduction credits have proven to be effective in both reducing pollution and reducing costs. At the same time, careful accounting to maintain the integrity of the emissions reduction is a pre-condition to the flexibility of emissions trading. The LCFS is structured like an emission reduction credit program in which firms must document credit, based on performance beyond a regulatory standard. The LCFS is not a cap-and-trade program, in which regulators create a finite number of allowances that must be obtained by any firm in order to emit a regulated pollutant, like CO_2. In some case, LCFS credit transactions may be with third parties, not the organization that originally created the credits. The successful administration of the Acid Rain market is a good example to follow. As in other successful environmental markets, there should be no limit on the ability of any legal entity to sell, purchase or own LCFS credits. An important thing to remember is that the LCFS structure is flexible enough to be revised in a manner appropriate to a specific state's transportation scheme.

Appendix D

Alternative Fuel/Vehicle Fuel Efficiency Teams' Recommendations

The Advisory Committee identified cross-cutting and priority recommendations. The following are all of the teams' recommendations for the Governors. These recommendations provide a menu of policy options for states to consider and implement as appropriate for each state.

Vehicle Fuel Efficiency Recommendations

- Promote fuel efficiency by repeatedly emphasizing themes and messages of fuel efficiency and by setting a positive example with choices for a state fleet.
- Support state-level programs to reduce truck idling.
- Enroll state vehicle fleets in efficiency initiatives, such as the "Green Fleets" program, that measure fuel-use/greenhouse gas emissions, set reduction targets, and implement a variety of fuel-use reduction strategies to meet these goals. The Governors should actively recruit private sector partners to participate in their initiatives.
- Provide incentives for purchase of medium- and heavy-duty hybrid vehicles in order to stimulate the introduction of these vehicles into the market.
- Promote federal action to strengthen federal fuel economy standards.
- Study and support innovative insurance policies, such as pay-at-the-pump or pay-as-you-drive insurance.
- Collaborate with the U.S. Environmental Protection Agency's "SmartWay" fleet program.
- Promote smart growth planning, including developing within city centers; encourage apartments near jobs and transit; create and nurture thriving, mixed-use centers of activity outside of city centers; and require use of up-to-date, transportation-demand models.
- Support a national cap-and-trade policy for carbon dioxide that includes emissions from transportation.
- Consider adopting individual feebate programs,[16] although the team was unable to reach consensus on this recommendation.
- Support the use of tax incentive programs for fuel-efficient vehicles by promoting their expansion at the federal level and creating and expanding state level incentive programs. The Governors should identify specific funding sources for incentive programs to ensure continuing, substantial financial support.
- Consider adopting a state goal for reducing demand for on road gasoline and diesel to 15 percent below 2003 levels by 2020.
- Direct state research funds towards efficiency programs and promote increased federal support for efficiency research.
- Create educational and labeling programs that help consumers make more informed choices related to fuel efficiency.

Biofuels Recommendations – Ethanol, Biobutanol and Biomethane

Research, Demonstration and Technology Transfer

- Advocate for full funding of the Department of Energy's (DOE) research and demonstration activities.
- Advocate for full funding of Department of Agriculture's (USDA) biomass research and development program at its authorized level.
- Complement federally sponsored research with state efforts in delivering appropriate feedstock production and residue removal.
- Structure federal incentives in a manner that provides additional per-gallon amounts for cellulosic biofuels, based on the energy efficiency of the production process (including feedstock production); environmental impacts, including water and land use; and the resulting carbon emissions.

Cellulosic and Other Biofuels Feedstock Supply

- Provide government assistance to implement short- and medium-term burden sharing for producers.
- Expand technical assistance from the Natural Resources Conservation Service and the cooperative extension services.
- Make funds available to cost-share purchases of new bioenergy harvesting machinery.
- Establish a low-carbon, renewable fuels loan guarantee program.

Increasing the Demand for Biofuels

- Support implementation of the Renewable Fuels Standard (RFS).
- Determine market infrastructure needs for distributing biofuels and expand the market capacity to maximize current and projected future consumption patterns.
- Consider the monetization of the cellulosic ethanol trading credit contained in the current RFS.
- Promote renewable fuels and procurement of flex-fuel vehicles in the federal, state and municipal governments, and ensure the availability of fueling facilities for E85 and other renewable fuels, as long as the net result is reduced fossil fuel consumption.
- Federal and state agencies should help establish income streams with long-term cellulosic ethanol supply contracts for federal and state purchases.
- Support research into the compatibility of emerging biofuels, such as biobutanol, with vehicles and distribution infrastructure.
- Consider state adoption of a low-carbon fuel standard similar to that adopted by California.

Innovative Approaches Renewable Fuels Infrastructure

- Adopt a city-to-region approach to solve the infrastructure challenge by encouraging DOE to fund a high-profile competition that would provide funds to three metropolitan areas.
- Establish goals in states for increasing E85 infrastructure and support those goals with tax incentives.
- Adopt incentives for retailers to sell E85.
- Establish grants for renewable fuel infrastructure corridors in the West that serve all of the renewable and advanced biofuels.

Funding Alternative Fuel Actions

- Consider a 1 cent/gallon "sustainable energy transition fee" to invest in alternative fuels.

Biofuels Recommendations – Biodiesel and Renewable Diesel

- Continue the "blenders" tax credit.
- Promote strong federal enforcement of fuel quality and labeling for biodiesel.
- Continue research on "big splash" items, such as algae.
- Investigate the "sustainability" of feedstocks for use as diesel substitutes.
- Encourage funding for land grant university research in agriculture, engineering, business and extension service.
- Encourage USDA to make long-term low interest loans to infrastructure, refinery, oil mill, and/or production agriculture that are directly involved in the biodiesel industry.
- Educate and fund state agencies to ensure adequate fuel quality in the petroleum distribution network.
- Grant Title I subsidies for current subsidized crops that have oil producing qualities.
- Adequately fund USDA to oversee inspection and implementation of standards that fall under their authority
- Carefully evaluate subsidies to non-domestic feedstocks, including full life cycle impacts.

Electric Recommendations

Near term, within three years (See the Electric Team Report for mid- and long-term recommendations.)

- With the passage of the 2007 energy bill, Western states should be prepared to match federal dollars for electric power R&D.
- Provide stable funding at the federal and state levels for battery research and development and distribute the results to the public as widely as possible.
- Support federal, state and local demonstrations of plug-in hybrid electric vehicles (PHEVs) by public and private entities.
- Revise government fleet purchasing programs to provide market certainty to manufacturers and promote technology demonstration.
- Include fleet purchase requirements that set fuel consumption and emission requirements to promote early purchases of PHEVs.
- At the state and local level (financial and regulatory agencies) provide incentives for consumers, including preferential tax treatment and parking benefits, such as plug-in parking slots with parking structures powered by renewable energy.
- Conduct a review of individual state electricity infrastructure in partnership with the utility industry. This review will help outline system compatibility with electric drive market penetration in on- and off-road applications.
- Establish federal and state manufacturing incentives to mitigate the risk of new product development and promote domestic industry and employment.
- Establish regional coordination among utilities and public utility commissions to develop and implement an off-peak rate structure for vehicles that utilize fuel from the electricity grid and especially renewable energy.
- The Western region should encourage changes to federal law to begin a transition to a fuel-neutral system that allows electric transportation to compete in federal emission, petroleum and greenhouse-gas reduction laws and incentives.
- Apply the same 120 v and 240 v standards to Electric Vehicles and PHEVs, and keep the charger on the vehicle.
- Seek niches for electric transportation, such as post office vehicles, low mileage city fleets, utility bucket trucks, etc.

Coal-to-Liquids

The team report is based on the contributions of the individuals and organizations listed in the report. While the team strived to reach consensus, this report does not represent a consensus view, but rather attempts to reflect the participants' spectrum of viewpoints on the state of the CTL industry and recommendations on its development and deployment.

- Advocate for the federal government to promote CTL development through performance-based financial incentives that would provide public benefits and parity among alternative transportation fuels.
- Consider promoting alternative incentive structures in lieu of traditional incentives. These could include the establishment of off-budget incentives that would allow the market — not government — to pick winning transportation fuel technologies using approaches designed to account for climate, energy security and other public benefits and institutional challenges.
- Further incentivize development of co-firing/co-processing biomass in CTL plants.
- Clearly define the permitting process for CTL facilities, which reduce the uncertainty, time and cost required for permitting, while retaining regulatory process and oversight.
- Seek to amend the federal mineral leasing statutes that require one percent of the reserves in the federal coal lease be produced within the 10th anniversary of the issuance of the lease, in order to allow additional time for the development and construction of advanced coal utilization facilities such as CTL plants.
- Undertake regional efforts to support the development of a state-based regulatory framework for CO_2 storage, including liability issues, measurement, and monitoring and verification protocols.

- Consider promoting infrastructure development and incentives that would encourage early CTL plants to be sited in locations where captured CO_2 could be used for CO_2 storage demonstration projects and/or enhanced oil recovery (EOR).
- Consider the creation of infrastructure improvement authorities and planning organizations to support the development of a CO_2 pipeline and storage infrastructure throughout the Western region.
- Collaborate with coal and biomass producers and the transportation industry to develop a robust biomass transportation infrastructure that will facilitate the development and maturity of a coal/biomass co-processing industry in the Western states.
- Encourage the federal government to update the nation's coal resource assessment.
- Ensure adequate funding and appropriate oversight of the coal industry. In addition, states should evaluate their regulatory programs to ensure they are well-functioning and sufficiently protective of worker safety, public health and the environment, to the extent of their authority.
- Alleviate the severe shortage of trained and qualified workers for the CTL industry by increasing education and training opportunities for engineers and skilled labor through universities, community colleges, trade schools, academies and Web-based learning.
- Recommend that the federal government develop a roadmap for CTL R&D. Similarly, Western states should consider collaborative R&D efforts among universities and other research institutions. R&D efforts should include, but not be limited to, Fischer-Tropsch (F-T) micro-channel technologies, F-T catalysts, brines for CTL process water needs, CO_2 reforming and re-use, advanced EOR using CO_2 enhanced natural gas recovery, and enhanced coalbed methane recovery.
- Actively participate in integrating the efforts of the U.S. Department of Energy's Regional Carbon Sequestration Partnerships with the commercialization of CTL in the West by seeking to host CCS projects within the region and using CTL facilities as the source for CO_2
- Undertake a full-scale demonstration of co-firing/co-processing coal with biomass using Western coals and biomass.
- Encourage the establishment of a national laboratory in the West to conduct research on CO_2 storage.
- Encourage coupling CTL with Integrated Gas Combined Cycle (IGCC) power plants to allow for a more efficient use of both project's assets, lower capital costs for each project and result in reduced operating and maintenance costs for each entity.
- Target incentives for electric generators/utilities and encourage state regulatory agencies, such as public utility commissions, to explore options for rate recovery and reasonable rates of return for combined CTL and IGCC electricity generation projects.

Natural Gas/Propane Recommendations

- Review state alternative fuel incentives to determine if they enhance niche market deployment of natural gas and propane vehicles and fueling infrastructure.
- Encourage support of state legislation that presents the same opportunities for key interests across the alternative fuels spectrum.
- Support the creation of state grant funds that can be used to offset the cost of adding alternative fuel vehicles to public and private sector fleets or constructing an alternative fueling station.
- Support and encourage local and state decisions to use natural gas and propane vehicles where they are most effective and economical.
- Encourage continued review of funding programs and tax credits.
- Encourage all energy uses of renewable biogas. Specifically, encourage support of incentives or credits at both state and federal levels for biogas used or gathered for all energy applications, including biogas converted to pipeline quality methane.
- Encourage and support federal legislation that will provide incentives or credits to vehicle manufacturers to develop and deploy vehicles for the North American market.
- Encourage and support the extension of federal financial incentives for alternative fuels, alternative fuel vehicles and the installation of alternative fueling stations.
- Encourage and support federal financial incentives for alternative fuel off-road vehicles.

Hydrogen Recommendations

- Actively support funding for federal hydrogen programs.
- Identify and establish funding sources for hydrogen infrastructure.
- Expand hydrogen demonstration projects that bring together hydrogen-powered vehicles and refueling infrastructure.
- Pursue hydrogen infrastructure; a well-planned strategy for implementing hydrogen demonstration projects and siting hydrogen-refueling stations is critical to creating a network that best serves the Western states.
- Implement recommendations on permitting, codes and standards.
- Perform public outreach and education activities.
- Promote and support early-market, fuel-cell applications and hydrogen demonstration projects.
- Develop and adopt state hydrogen-for-transportation plans.
- Support the accelerated adoption of national standards and model codes.
- Encourage improved industry-university-national laboratory involvement.
- Establish tax incentives for hydrogen production, refueling infrastructure and vehicles.
- Define hydrogen as a transportation fuel, not a hazardous chemical.
- Develop education programs that will create a skilled hydrogen work force.
- Establish and ensure environmental guidelines are met.
- Maintain tax incentives for renewable hydrogen production, refueling infrastructure, and vehicles.

End Notes

[1] Department of Energy, EIA, International Petroleum Monthly

[2] EIA, World Energy Outlook, 2006

[3] The price of oil imported into the U.S. in 2002 – five (5) years ago - averaged $23 per barrel. In the third quarter of 2007, it was $71.10 per barrel. EIA, U.S. DOE. "World Crude Oil Prices Report." This increase can be attributed largely to increased demand. However many experts believe that today's oil price also includes a "security premium" of approximately $10 - $15 per barrel reflecting concerns over international stability.

[4] University of Tennessee, *25% Renewable Energy for the United States by 2025: Agricultural and Economic Impacts*, November 2006

[5] U.C. Berkeley, *Economic Assessment for Climate Action in California*, 2007

[6] DOT, Bureau of Transportation Statistics, 2005

[7] National Petroleum News, 2004 Station Count

[8] EIA, "About Natural Gas Pipelines," 2007

[9] EIA, Forecasting, 2006

[10] A Low-Carbon Fuel Standard for California, Part I – Technical Analysis, Final Report, University of California

[11] While appreciating the value of a national approach, the Advisory Committee recommends initiating a Western standard, given the uncertainties with the EPA work. By starting to think about what a standard will mean and how it can be implemented, the Western states will be better positioned to work with EPA on a national approach. The Western Governor's Association (WGA) needs to open a dialog with the Environmental Protection Administration (EPA) on the issue of its forthcoming Greenhouse Gases rulemaking. The WGA needs to take an active role in helping the EPA develop this new rule to ensure that it will:

- Preserve the states' ability to develop state or regional low-carbon fuels standards.
- Be compatible with any EPAct and Clean Air Act requirements affecting the western states now or in the future.
- Consider potential fuel fungibility or interchangeability issues.

[12] Billion Ton Report, DOE and USDA, April 2005

[13] The energy content of ethanol is approximately two-thirds that of gasoline.

[14] Intergovernmental Panel on Climate Change (IPCC): *Climate Change 2007 Mitigation of Climate Change*, November 2007.

[15] The team report is based on the contributions of the individuals and organizations listed in the report. While the team strived to reach consensus, the report does not represent a consensus view, but rather attempts to reflect the participants' spectrum of viewpoints on the state of the CTL industry and recommendations on its development and deployment. Appended to the CTL team report document are statements of alternative viewpoints from team members. These alternative viewpoints are also noted in the main body of that document to provide for a robust and thorough discussion of CTL. As originally constituted the team included a representative from the Natural Resources Defense Council (NRDC). However, the individual representing NRDC resigned from the team in September, after ascertaining that the report would not adequately represent the organization's views.

[16] Feebate is a financial incentive structure that charges users of socially or environmentally undesirable items (e.g., low gasoline-mileage vehicles) and distributes that money toward more socially or environmentally desirable items (e.g., hybrid vehicles).

Team Reports

The working group reports for each fuel type are detailed and informative. Due to their length, they were not included in the printed version of the Advisory Committee Report. The following reports are available on the WGA Web site at www.westgov.org.

Biofuels - Ethanol, Biobutanol and Biomethane
Biofuels - Biodiesel and Renewable Diesel
Coal-to-Liquids
Electric
Hydrogen
Natural Gas/Propane
Vehicle Fuel Efficiency

Acronyms

Following is a list of acronyms used in this report:

ASTM	American Society for Testing and Materials
BEV	Battery electric vehicle
BTU	British thermal unit
CAFE	Corporate average fuel economy
CBTL	Coal/Biomass-to-liquids
CCS	Carbon capture and sequestration
CNG	Compressed natural gas
CTL	Coal-to-liquids
DOT	Department of Transportation
E10	10% ethanol blend fuel
E85	85% ethanol blend fuel
EOR	Enhanced oil recovery
EPA	U.S. Environmental Protection Agency
FFV	Flexible-fuel vehicle
F-T	Fischer-Tropsch
GHG	Greenhouse gas
LCFS	Low-carbon fuel standard
LNG	Liquefied natural gas
Mbpd	Million barrels per day
NREL	National Renewable Energy Laboratory
PHEV	Plug-in hybrid electric vehicle
RFS	Renewable fuel standard
SUV	Sport utility vehicle
USDA	U.S Department of Agriculture
VMT	Vehicle miles traveled
WGA	Western Governors' Association

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