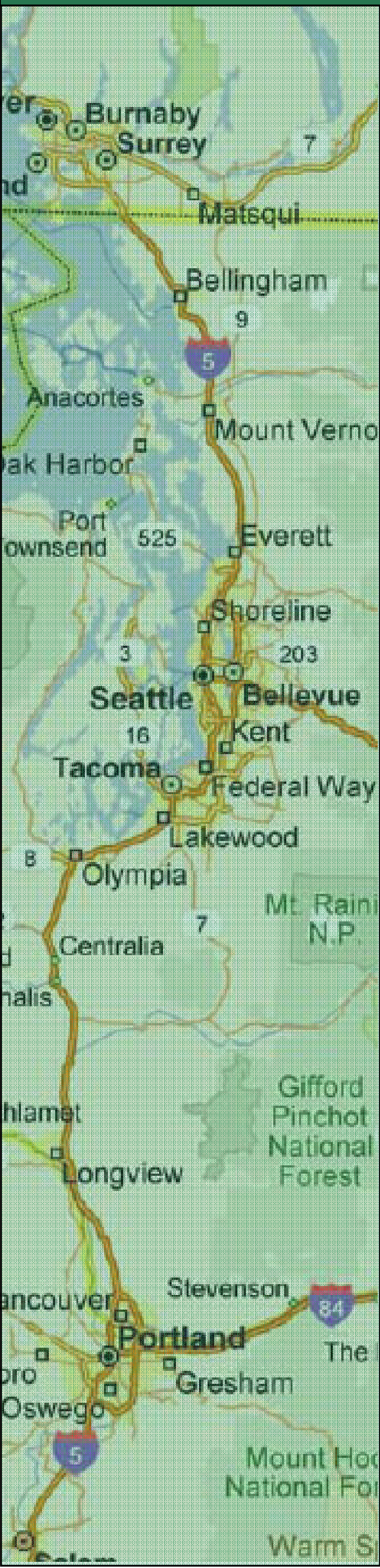

Alternative Fuels Corridor Economic Feasibility Study

Final Report

Executive Summary

January 23, 2009

<u>Prepared For:</u>

Washington State Department of Transportation

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100 YEARS

Washington State Department of Transportation

Executive Summary

The U.S. transportation sector is heavily dependent on petroleum-based gasoline and diesel, as these fuels provide about 95% of U.S. transportation energy needs. Vehicles using alternative fuels are being developed by private industry to serve a growing market of people, businesses, and the public sector, but a limited retail market through which to purchase these fuels has, to some degree, constrained the use of these vehicles.

The Washington State Department of Transportation, through its Transportation Partnerships Office has commissioned a study to examine the underlying economics of the retail alternative fuel industry to see how it could, through the use of State-owned land at rest areas, incentivize station operators to begin selling alternative fuels in the Interstate-5 corridor. I-5 has also been designated by USDOT as one of the "Corridors of the Future" and has received funding in order to promote the use of alternative fuels. This Final Report presents the research effort and results of the economic analysis, providing background information on the fuels' supply chains and station costs as well as estimates of potential demand and revenues from operations.

Analysis Framework

The consultant team developed a framework based on a typical gasoline fuel station that projects capital and operating business metrics including costs of goods sold, station operating costs, and revenues.

The majority of the data used in the traditional gasoline station model was obtained through the Association for Convenience and Petroleum Retailing, and was supplemented by a survey of fuel stations currently operating in the I-5 corridor. This data revealed that the retail gas station industry operates on very thin margins, earning only five to eight percent profit on each gallon of gasoline sold. The many gasoline retailers sell gasoline simply to get customers to their store in hopes they will purchase other sundry items or service that carry a higher profit margin more typical of retail sales. The average convenience store in 2007 (across the US) sold approximately 1.6 million gallons of fuel, yielding $4.1 million in revenue and gross profits of about $233,000 (6%). Non-fuel sales for the same period averaged $1.4 million in revenue with gross profits of $440,000 (31%).

The cost to open a retail gas station in 2007 averaged between $2.0 and $2.4 million depending on the location. Land and building represented the majority of costs at about $790,000 and $710,000, respectively. The capital costs of fueling, food service, and merchandising equipment round out the total station costs, accounting for about $730,000. Average annual operating costs for a convenience store and gas station were approximately $423,000 in 2007, not including credit card fees which amount to about 2% of revenues.

This framework was subsequently used to analyze conceptual retail stations selling alternative fuels, given assumptions of specific alternative fueling equipment capital costs, cost of goods sold, and revenues estimated to be earned in the I-5 corridor. This framework provided a mechanism to forecast cash flows from operations over time. These cash flows were then used in a conceptual lease-based transaction between the State and the operator where the costs of station development may be shared as well as revenues from the operation, depending on the division of risk. The results of this analysis (the Alternative Fuels Operating Feasibility), where ethanol, biodiesel, electricity, and hydrogen were evaluated, are discussed below.

Supply Chain Overview

The supply chain network for gasoline and diesel has evolved and expanded over the past century into a complex and interconnected system that ties together oil production, distribution, refining/processing, and distribution to customers. Decades of infrastructure and system development have resulted in a supply chain network that usually works efficiently to distribute oil and finished products throughout the country.

The supply chain analysis considered potential barriers and opportunities in the supply chain network for five alternative fuels: ethanol, biodiesel, compressed natural gas, electricity, and hydrogen. Although various incentives are available to promote the use of all of these alternative fuels and infrastructure development, supply chain barriers are, in some cases, limiting the degree to which alternative fuels can compete with petroleum-based fuels. The following are some of the key supply chain barriers for these alternative fuels:

Ethanol (for the purposes of this study, E85 is implied)**:**
- Rail / barge / truck feedstock transport is expensive (lack of pipelines similar to petroleum);
- Lack of blending and storage facilities in the Northwest.

Biodiesel:
- Feedstock cost and availability;
- Cost to transport feedstocks (lack of pipelines, terminals, blending facilities);
- Competition with petroleum-based diesel (substitutes compete on price).

Compressed Natural Gas:
- Non-renewable fuel;
- Limited domestic natural gas resources for expanded transportation use;
- Additional pipelines and LNG terminals needed for increased imports.

Electricity:
- Few electric cars currently available although plug-in hybrid vehicles expected to be in production within a couple of years;
- Lack of public / on-the-road charging facilities;
- Increased demand for low-carbon power generation.

Hydrogen:
- Fuel-cell vehicles are likely to need at least another 10-15 years of research, development, and demonstration before major deployment efforts can begin;
- Lack of hydrogen delivery and refueling station network (pipelines, etc.);
- Need for increased capabilities for low-carbon hydrogen production.

While these supply chain challenges are taken into consideration in the estimation of potential demand for alternative fuels in the I-5 corridor, they are presented in detail in Chapter 2 of this report to provide background on why certain fuels are likely to be more or less successful penetrating the market in Washington. Generally, biodiesel and ethanol must compete on price with traditional diesel and gasoline (as they are considered substitutes), therefore unit production costs must be reduced. Electricity and hydrogen have a different set of challenges associated with technology development and vehicle availability. All fuels noted above will likely be incorporated into a "cap and trade" or "carbon tax" framework at some point in the future, which will impact their relative cost competitiveness, though these potential impacts were not estimated as part of this analysis.

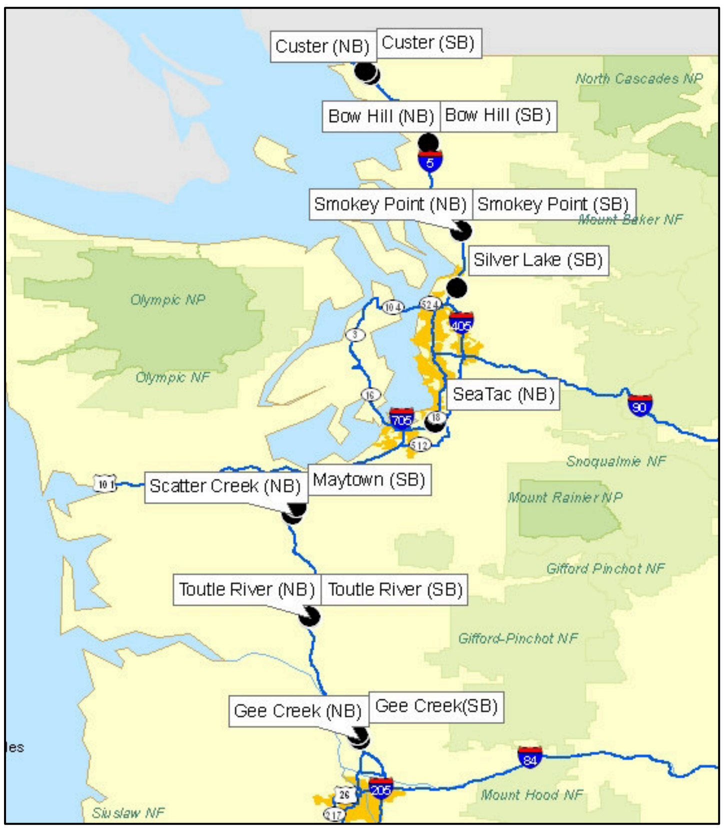
Station Spacing Analysis

The total investment by WSDOT and the potential success or failure of the program depends on the I-5 corridor's ability to provide a sufficient number of fueling stations to ensure drivers can use the corridor for inter-city travel. The station spacing analysis, presented in Chapter 3 discusses the driving range of vehicles and the number of rest areas that should be considered for the various alternative fuel station scenarios to complete a viable network of fueling options. The number and spacing of stations in the inter-regional context (focusing on vehicles traveling on I-5) is dictated by the range of the vehicles and the reliability of the stations. The table below compares the average range of each vehicle.

ES1: Vehicle range by technology

Technology	Range
Gasoline (reference)	> 350 miles
Biodiesel	> 400 miles
Ethanol	> 250 miles
Hydrogen	120 - 300 miles
Electricity	60 -200 miles

I-5 in Washington spans 275 miles from the Canadian border to the Oregon border. Clearly a motorist using just about any of the technologies listed in the table above could traverse the State with one or less refueling events, but a level of redundancy is necessary for safety and convenience. If one station fails (is for whatever reason unable to provide fuel on a given day or week), travelers should feel confident that another station will be available within a reasonable distance to accommodate them before they run out of fuel. Therefore, station locations should be frequent enough that a failure of one station should not affect a traveler's ability to move efficiently within the I-5 corridor. On the other hand, the stations contemplated in this study are not meant to compete with existing or future stations on non-state owned land (although this is inevitable to a degree). As such, a limited number of rest area stations in more rural locations is preferable.



Although not a perfect solution because sites are not equally accessible from both sides of the freeway, the comprehensiveness of the rest area network is a major advantage. The map (right) shows the rest area network in the I-5 corridor noting directional access (NB = Northbound, SB = Southbound).

In the case of hydrogen and fast charge electric vehicles, rest area locations would represent a vital corridor connecting regions together. A conservative limit of 120 miles between stations can be easily accommodated by the rest area network enabling both hydrogen and fast charge electric vehicles to travel between regions and throughout the I-5 corridor. A minimum of two stations and a maximum of seven stations at rest areas provide the ability to travel through the state using either fuel. The minimum case assumes stations would be in place in Vancouver, BC; Seattle, WA; and Portland, OR and thus the only stations located on State land would be those in the "gaps" between these major cities. It should also be noted that the drivers may have to turn around and head in the opposite direction in order to reach a fueling station before running empty under the minimum scenario.

For biodiesel and ethanol, there are stations currently operating in the corridor, but there are gaps in the station networks of the two fuels. To avoid directly competing with established private operators, stations should be sited at rest areas in these gaps. Since both fuels are compatible with existing fuels, it is not necessary to create a comprehensive network. However, to provide adequate availability, gaps in the networks suggest that 3 biodiesel and 4 ethanol stations could be initially used to provide access throughout the corridor. If biodiesel and ethanol are co-located, a total of 5 stations would be needed. A minimum scenario would require one combination station to fill the gap in the existing station network for these fuels.

The table below summarizes the minimum, maximum, and suggested number of stations located along the I-5 corridor by fuel.

ES2: Number of Stations Needed in the I-5 Corridor

Fuel Type	Minimum	Maximum	**Preferred**
Hydrogen	2	7	**5**
Fast-Charge Electricity	2	7	**5**
Ethanol and Biodiesel	1	6	**5**

Alternative Fuels Operating Feasibility

Chapter 4 outlines the feasibility analysis of operating the conceptual alternative fuel stations at rest areas in the I-5 corridor. Forecasts for cost and revenue data are presented for the following four retail fuel combinations that were screened and evaluated in the operating framework discussed above and presented in Chapter 1.

1. **Electricity (standalone):** For this service offering, facilities for electric vehicles (plug-in electric hybrid vehicles are expected to be the primary patron group but regular fully electric vehicles could also use the facilities) would be provided on a slimmed down retail format that would not include the convenience store component, which is part of the other three service platforms. A kiosk interface, similar to an ATM, would be provided which would require minimal capital and operating costs outlays. It was assumed that high power fast chargers would be used to allow travelers to charge a typical PHEV battery in 10 to 15 minutes. The electricity infrastructure required for the fast charge equipment would be compatible with a battery swapping approach, though additional building infrastructure and personnel would also be needed for this type of operation. Battery swapping facilities were not modeled in any scenarios.
2. **Electricity paired with Hydrogen:** A full service convenience store would be provided in a standard gasoline station layout with a portion of the service station footprint dedicated to the electricity kiosks described in #1. Hydrogen would be delivered regularly to the station by truck

and stored in tanks located on the property (as opposed to on-site production). Typical convenience store revenues are included with hydrogen and electricity sales.

3. **Biofuels:** A full service convenience store would be provided in a standard gasoline station layout. Both ethanol (E85) and biodiesel (B99) would be sold. Typical convenience store revenues are included with biofuel sales. The station configuration would not provide for heavy truck / semi refueling and the convenience store is not envisioned to provide the types of services to truckers offered at traditional truck stops. This deliberate rest area station platform was conceived to minimize the competitiveness of the rest area stations with truck stops in the I-5 corridor.
4. **Biofuels paired with Electricity:** This station concept would be identical to #3 while also providing electricity charging kiosks as outlined in #1.

While land is a considerable cost component of the traditional gas station model (about one third of the cost), land is assumed to be provided at no cost to the concessionaire, depending on the expected return, as outlined below. Net income from the operating model was used in a concession framework that was developed to help judge and compare the feasibility of the fuel station scenarios. This framework focuses on the internal rate of return (IRR) of the alternative fueling station. The IRR is calculated from an annual stream of cash flows, represented by total net income after estimated federal and state taxes, from an individual station for a given demand scenario. Cash flows over 15 years were examined as well as a longer 30-year structure.

A 15% IRR target was established as a minimum reasonable return and is expected to represent the lower bound of what a concessionaire would likely require for a venture of this type. The calculated IRR of each fuel station's cash flows was adjusted upward or downward to achieve a targeted 15% overall return to the concessionaire. In situations where the base IRR was below 15%, the IRR was adjusted upward by modeling an up front State capital contribution that could be used to offset some capital costs of station implementation. Alternatively, if the base IRR was initially above 15%, it was adjusted downward by modeling an annual land rent that would be paid by the concessionaire to the State in the form of a percent-of-revenue fee.

The exhibit presented below is a comparison of the alternative fuel scenarios' concession IRRs. Scenarios which fail to meet the target IRR may still be viable if the State is willing to provide contributions to enhance the cash flow for the concessionaire in the early years while the technology is being adopted by consumers. Conversely, scenarios which produce excess IRR may provide an opportunity for the State to share in revenues generated by the concessionaire in the form of a rent-sharing program. This rent share would be a fixed percentage of revenue which the concessionaire would be required to pay on a regular basis (i.e. - annually). These rent share payments would effectively lower the concessionaires IRR to the target level while providing income for the State in return for the use of the land.

ES3: Estimated IRR for 15- and 30-Year Concession: Base Case

Fueling Station Offering	15-Year Concession IRR	30-Year Concession IRR
Electricity Kiosk (Standalone)	0% to 15% IRR	> 15% IRR
Hydrogen / Electricity Kiosk	< 0% IRR	0% to 15% IRR
Biofuels (Standalone)	0% to 15% IRR	> 15% IRR
Biofuels / Electricity Kiosk	> 15% IRR	> 15% IRR
All Fuels Combined	> 15% IRR	> 15% IRR

Generally, the biofuel scenarios were the strongest due to the fact that vehicles are already being sold and used in the I-5 corridor. As such, these concessions are expected to have a positive cash flow after only five to six years, while the stand alone electricity and hydrogen scenarios are expected to lose money in each of the first 8 to 10 years of operation. While the biofuels scenarios have the benefit of momentum in the market, they are also hindered by the price competition with regular gasoline and diesel, which are considered substitutes. As such, the biofuels must be priced competitively, which means slim unit profit margins of less than 10%. Operating with such slim margins creates a situation where the IRR can range widely, with relatively small shifts in capital and operating costs and unit profitability.

The scenario showing biofuels paired with electricity provides a return to the concessionaire in excess of 15% while making three alternative fuels available. The electricity kiosks are not expected to have strong profit potential in the early years due to the low number of electric cars on the road today, though these kiosks are expected to grow in use in the latter years of the forecast period and provide substantial profits due to the low costs of the operations and high unit margins. The excess revenues earned by the concessionaire could be shared with the State through a land rent agreement generating over $4 million over the course of a 30-year concession.

If all four fuels were offered, the station would still be expected to yield an IRR greater than 15%, though not as strong as the biofuel / electricity scenario, due to the slow penetration hydrogen vehicles and the high cost of operations related to hydrogen equipment.

Convenience revenues are included in all scenarios except the standalone electricity kiosk scenario. The team performed a limited analysis on the contribution that the convenience store made to the overall operation and concluded that removing the convenience operations would have a clear negative impact on the concession performance. The total net income earned over the 30-year concession period would be expected to fall by 25% to 35%. This would cut the 30-year IRRs stated in the tables above roughly in half and cause many of the 15-year IRRs to turn negative. In all scenarios, the State would need to provide an up-front capital contribution to help the concessionaire achieve the target 15% IRR.

Alliance Opportunities

Alternative fuels and vehicles have been successfully introduced in small demonstration programs with personal users, in public and private fleets (e.g. municipal, state, federal, regional trucking, taxis) and in niche markets (e.g. airports, school buses, transit vehicles) where vehicles, fuels and fueling infrastructure were made available to users concurrently. While some fundamental technological and economic challenges remain, the primary challenge to alternative fuel (AF) commercialization is how to "build a market simultaneously for new vehicle technologies, new fuels, and new infrastructure to support them."

The decision-making problem is highly complex as it requires decisions to be made in parallel by a large number of stakeholders who pursue separate goals, respond to different incentives, and are each facing decisions of a different nature:

1. Governmental bodies making public policy decisions,
2. Private companies making capital investment decisions, and
3. Users making consumer choices.

In other words, automotive manufacturers would not distribute alternative fuel vehicles (AFV) (even in demonstration programs) within a given market where refueling stations are not available; fuel producers, distributers and stations owners would only invest in support infrastructure if enough AFVs are in circulation to support the demand for the fuels they produce and distribute; and users would not purchase vehicles they cannot refuel conveniently.

A wide array of stakeholders from the public and the private sectors have already expended a vast amount of resources in promoting alternative fuels and have a vested interest in helping the new technologies take these last steps toward larger market implementation. These stakeholders form a heterogeneous body of individuals, governmental and not-for-profit entities, and small and large corporations, each with their own goals and responding to different sets of incentives.

Private stakeholders include wide-ranging types of organizations that are primarily motivated by economic profit, including: automotive industry, petroleum-based fuel producers and distributers, alternative fuel producers and distributers (most of which are specialized on a single fuel source), public and private utility companies, fuel station owners and concessionaires, infrastructure and station builders, and private vehicle fleet owners.

Public stakeholders include policy-makers as well as State, regional and local government and agencies concerned with the implementation of policies and enforcement of regulations. Public agencies concerned with transitioning to an alternative fuel economy are found at all levels of government and providing leadership, resources, and experience. Public agencies also own large vehicle fleet that can provide a customer base to a new AF station.

All stakeholders are poised to benefit eventually from the transition from petroleum-based fuels to alternative fuels; but for those benefits to be realized, these decisions must be coordinated. At the current stage of development, industry stakeholders concur that the adequate availability of alternative fuel stations is the major barrier to a commercial transition toward AF technologies, though several public and private stakeholders are working, generally in parallel, to reduce dependency on traditional petroleum fuels.

Industry and public stakeholders alike are mindful of the necessity of coordinated action and a general consensus has been developing around the primary elements that a successful alliance strategy would need to address to transition successfully to an alternative fuel future. These include:

- Policy leadership and consistency of the political message, based on coordinated policy, regulations, and incentives for all branches of government, public and industry outreach initiatives, and strategic planning.
- Regulatory framework adapted to the AF industry including building codes for AF stations, fuel quality and emissions standards, testing procedures, to metering standards required for retail activity.
- Any initiative focusing on AF deployment must realistically consider the expectation for profit of the private industry and the level of risk associated with initial capital investment as well as long-term

operation of AF fueling infrastructure. Financial incentives, including direct subsidies and tax breaks, are a key component to reduce the financial risk of private stakeholders, but must be guaranteed over a long-enough period of time to secure the necessary return on investment.

- Large-scale infrastructure projects cannot be built on the "build it and they will come" premise. Past experience with alliances and public-private partnerships in AF demonstration programs have highlighted the importance of obtaining the upfront commitment of automotive manufacturers to produce and deliver AFVs in the market.

- Deployment strategies must remain focused on the end user. Surveys highlight that individual users are in general very sensitive to convenience (availability of station, fueling process, and vehicle maintenance), cost, vehicle and fuel performance, reliability and safety, and are generally unfamiliar with or misinformed about most AF and AFV technologies. Successful alliances must therefore focus on overcoming these barriers. In that respect, public outreach, education programs, and financial incentives are instrumental.

- Numerous coalitions, leadership, technology and resource centers, and programs aimed at fostering the transition to alternative fuels exist at the local, state, and federal levels. Through a limited number of interviews, most have expressed interest in supporting WSDOT by sharing knowledge, industry contacts, and in providing active support.