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E85 Retail Business Case: When and Why to Sell E85

C. Johnson and M. Melendez

Technical Report
NREL/TP-540-41590
December 2007

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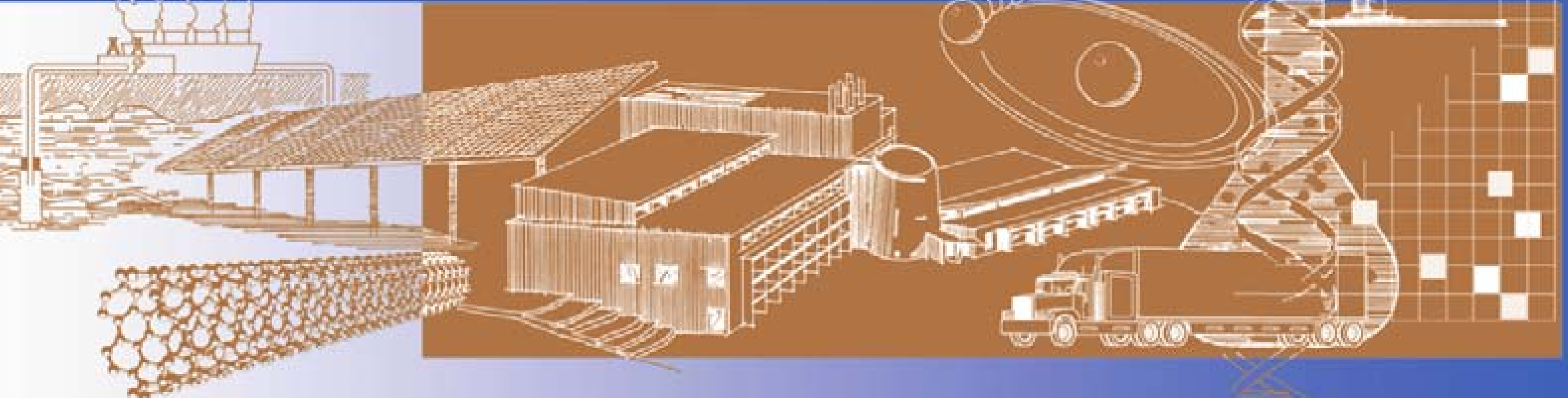

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Contents

Acronyms and Abbreviations

AFDC	Alternative Fuels and Advanced Vehicles Data Center
ASTM	American Society for Testing and Materials
DCFA	Discounted cash-flow analysis
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FFV	Flexible fuel vehicle
GIS	Geographic information systems
IRS	Internal Revenue Service
M&O	Maintenance and operation
MPGE	Miles per gallon of gasoline equivalent
NACS	National Association of Convenience Stores
NEVC	National Ethanol Vehicle Coalition
NREL	National Renewable Energy Laboratory
NPN	National Petroleum News
OPIS	Oil Price Information Service
P&M	Premium and mid-grade gasoline
RFA	Renewable Fuels Association
RM	Required (gross) margin
ROI	Return on investment
SAE	Society of Automotive Engineers
SIGMA	Society of Independent Gasoline Marketers of America
UL	Underwriters Laboratories
UST	Underground storage tank

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The authors also appreciate the time and insight shared through personal communications, as indicated in the bibliography.

Executive Summary

Selling E85 can be a sound business decision for many gasoline retailers. This product can help alleviate some of the pressure they are experiencing in the competitive gasoline market. This market is characterized by thin margins (the price received minus the price paid) that have been decreasing by more than $0.005 per year over the past 12 years, largely due to increased pricing and location competition. E85 offers relief from this competition by differentiating a station as green, cutting edge, patriotic, and pro-farmer.

In addition to offering a competitive advantage to gasoline stations, E85 projects can be profitable investments. However, their profitability depends on numerous factors, which increases the investment risk level. The National Renewable Energy Laboratory (NREL) developed a model to test some of these factors' influence on investment profitability. When investigating equipment scenarios, the model found that E85 projects meet investment goals most easily when the gas station can convert its mid-grade gasoline tank to hold E85. The next most profitable scenario is adding a new tank, followed by converting the premium tank to hold E85.

The NREL model was then used to analyze the relative importance of various aspects of an E85 project. It revealed that in all equipment scenarios the throughput of E85 was the most important variable and base taxable income was the least important variable. Equipment costs were the second most influential factor when a new tank was installed but one of the least influential factors when existing tanks were used. The required return on investment and annual maintenance and operation costs had similar influences on profitability.

Since E85 throughput was identified as the most important project variable, guidance is offered to help the station owner assess potential E85 throughput. A good benchmark is the annual throughput of the average Minnesota station, which is 74,000 gallons per year (Minnesota Department of Commerce 2006). An E85 station's throughput is highly dependent on the price difference between E85 and gasoline, fleet partnerships, customer awareness, and station location.

The model outputs are given in required gross margin to make the E85 project profitable. Therefore, guidance is offered to help retailers assess the gross margin they might expect to earn on E85. Finally, a checklist is offered to help retailers assess whether E85 is likely to be a profitable investment for them. This checklist includes robust local competition in the gasoline market, access to low E85 costs, mid-grade tanks available for conversion, large potential throughput of E85, and state or local incentives for E85 infrastructure.

Introduction

The United States has an ambitious goal of displacing 35 billion gallons of annual petroleum use with renewable and alternative fuels by 2017 (Bush 2007). Meeting this goal will most likely require a significant increase in the use of E85 (a blend of 85% ethanol and 15% gasoline). A key to this increase is for retail gasoline stations to adopt E85 fueling capabilities. Fortunately, this adoption makes sound business sense in many cases.

The aim of this business case is to help gasoline retailers decide whether offering E85 is a good business decision for them. It does this by first assessing the current state and trends of the retail gasoline industry. After finding that the industry is an increasingly competitive business environment, this report points out major challenges and fundamental strategies that innovative station owners have devised to better compete. It then highlights how selling E85 can augment these strategies.

The second section of the business case analyzes E85 equipment as an investment with a discounted cash flow model. Key variables are addressed that affect the profitability of the E85 investment. Some important variables such as personal tolerance of investment risk, regional differences, and the changing business environment for fuel retailers are beyond the scope of the model. Recommendations are then made for how station owners can appraise these key variables for their own stations and assess whether E85 would be a profitable investment for them.

A general overview of the gasoline industry is presented in Appendix A to give context to fleets, policy makers, and other stakeholders interested in E85. Readers who are not familiar with the current gasoline industry should read this appendix before reading the main body of the report. Appendix B discusses how E85 will influence a gasoline retailer's business operations. This appendix includes business relationships and information not covered in the main body of this report.

State of the Gasoline Industry

The U.S. retail gasoline industry is an extremely competitive market. This is why the total number of stations has decreased by more than 2,500 (1.5%) in the past four years, the large oil companies are divesting in retail gasoline stations, and the average net taxable income of a retail station was only $36,000 in 2004 (Eichberger and Scott 2006).

Sale Income
– <u>Purchase Cost</u>
= Gross Margin

One primary indicator of the profitability of any retail industry is the gross margin earned on each item sold. This is the income a retailer receives from selling a good minus what the retailer pays for the item (purchase cost). The gross margin is the amount available to run the entire retail business (e.g., maintain and operate equipment, pay rent, taxes, salaries, insurance) and result in a profit.

In the gasoline industry, sale income is best represented by the Energy Information Administration's (EIA) "pooled"[1] retail price of gasoline (before excise taxes). The purchase cost is best represented by EIA's wholesale rack prices.[2] Therefore, for trend purposes, the gross margin of gasoline is the difference between these two prices, as represented in Figure 1. This rack price does not include transportation to the retailer—a fee that is subtracted in margin calculations later in this report.

[1] "Pooled" refers to the sales-weighted combination of regular, mid-grade, and premium gasoline.
[2] Rack prices are taken at the distribution terminal where gasoline is sold for pickup and delivery to retailers.

Causes of Decreasing Margins

Product Is Difficult to Differentiate

A rule of business is that differentiated products can fetch a higher margin than uniform products. One example can be seen in the grocery store. An undifferentiated item such as flour has a much smaller margin than cereal (Cornell 2000), which can appeal to customers based on everything from flax seed to clover-shaped marshmallows.

Gasoline as a product is predisposed to relatively low margins, largely because differentiating one type from another is difficult. The main attempt to differentiate gasoline is by "branding," when oil companies give their gasoline a brand name and often proprietary additives. Regardless of these additives, all gasoline must meet the same standards set by the American Society for Testing and Materials (ASTM).

As a relatively undifferentiated product, gasoline attracts customers primarily on two merits: price and location. The National Association of Convenience Stores' (NACS) 2000-2005 "Future Study" found that "heavy users" (who fuel more than once per week) primarily took price into consideration and "light users" (who fuel less often than once per week) focused on location (NACS 2006). Pricing and location, therefore, must be investigated to better understand why the industry is becoming more cutthroat and margins are decreasing.

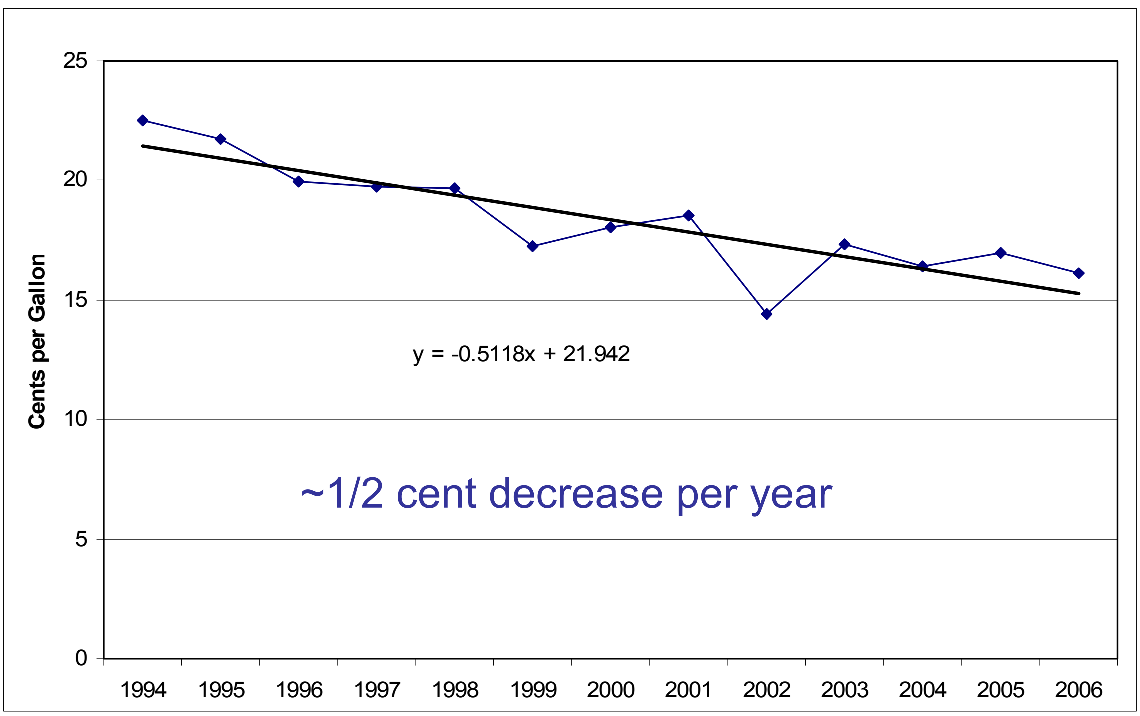

Figure 1. EIA motor gasoline gross margin (rack minus retail price) in 2006 U.S. dollars. This figure shows that gross margins have been decreasing by more than $0.005/gal/year over the past 12 years.

Increased Pricing Competition

Ease of price comparison (price transparency) largely determines pricing competition and therefore gross margins. An example of this comes from the service industry. Hair cutters, with their prices clearly marked on the wall, are much more price competitive than plumbers. The price transparency of the salon enables customers to easily compare prices and shop around, as opposed to a plumber, who may not reveal the full price of services until substantial time and effort have been invested. Therefore, a salon typically has much lower margins than a plumber.

The gasoline retail industry has even more transparent prices than salons, and this transparency is increasing. Prices are posted on billboards for drivers to read and compare. Furthermore, Web sites such as Gasbuddy.com and Mapquest Gas Prices enable drivers to compare gas prices from home and plan their routes so they can fuel at the cheapest convenient location (see Figure 2).

Increased Location Competition

Gas stations are becoming more strategic in the way they locate themselves to be convenient for the customer to use. The art of location planning is increasing in complexity because it is aided by a growing number of spatial analysis tools associated with geographic information systems (GIS). Improved location planning means that even though the total number of gas stations has decreased over the past 5 years, the number of stations that the average motorist drives by has actually increased.

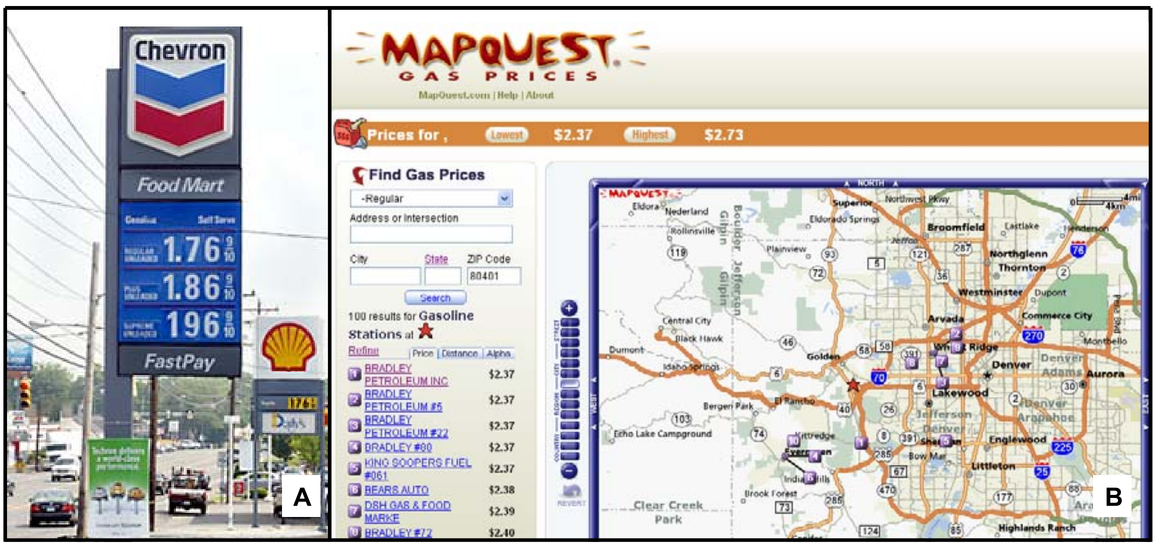

Figure 2. Price transparency in the gasoline retail industry. Transparency is high because prices are posted on billboards and websites for easy comparison.

> **"It is, though, an undeniable fact that more organizations are committed to store location research than ever before …"**
>
> **- Graham Clarke, "Changing Methods of Location Planning for Retail Companies"**

Location planning is particularly important for the gasoline retail industry because it has few other competitive attributes. Therefore, large oil companies devote substantial resources to their location analysis teams and associated software. Likewise, a growing number of consultants are available in the field to help independent or chain retail owners with location analysis (Gaskins 2007).

Hypermarts (Volume Retailers)

Hypermarts are the large retail outlets, grocery stores, and discount clubs (shown in Figure 3) that now sell gasoline. They have an advantage over convenience stores in terms of location (because they are located where people need to go anyway) and price. They typically price their gasoline extremely low for two reasons:

- They purchase their gasoline in bulk. In 2004, the typical hypermart site sold approximately 3 times as much gasoline as the industry average. Most gasoline terminals and jobbers reward this bulk purchasing by lowering their prices and promising them priority in times of shortages.
- They often sell gasoline as a "loss leader." This means they sell gasoline at an extremely low price to attract people to their gas stations; the plan is that once they arrive at the gas station they will shop in the main store. Hypermarts can even sell at prices so low that they don't cover the gas stations' operating costs, which means independent gas stations cannot match their prices.

Figure 3. Hypermarts. These 11 companies accounted for more than 90% of hypermart fuel sales in 2003 (Leto 2003).

Hypermarts are extremely successful. In 2004, they comprised approximately 2.5% of retail gasoline stations, yet sold 7.7% of the gasoline. This means that the average hypermart sold more than 3 times as much gasoline as the average gas station. Furthermore, the number of hypermarts is increasing. In 2004, 62% of the planned grocery stores had gas stations in their blueprints (NACS 2006).

Solutions to Decreasing Margins

Retail gasoline stations have found innovative ways to survive in this increasingly difficult market. This section lists strategies that stations use to remain competitive. It also shows how selling E85 can augment these strategies.

Attract Customers to Higher Margin Goods

One way gasoline stations have compensated for reduced gasoline margins is by increasing the sales of their higher margin goods. These are generally the goods sold inside the store—of which sales increased nearly 10% between 2004 and 2005 (NACS 2006). Sample gross margins for various goods are given in Table 1. (In this table the margins for gasoline were taken after transport, whereas in Figure 1 they were taken before transport for purposes of trend analysis.)

Table 1. Gross Margins of Various Items Sold at a Convenience Store

Product	Margin
Gasoline*	6%
All In-Store Goods	30%
Prepared Food	48%
Car Wash	56%
*Gross margin of pooled gasoline after transport	
Sources: EIA Petroleum Navigator 2007, NACS 2006, and National Petroleum News (NPN) 2006a	

A primary strategy for increasing the sales of these higher margin goods is to increase the flow of customers who come into the convenience store. Once in the store, the customer is much more likely to purchase a high-margin item.

E85 could help increase the number of customers exposed to these higher margin goods in three ways:

- **E85 Can Secure Reliable Fleet Customers**: Many federal, state, and local governments, as well as private fleets, are required to use E85. By securing these fleets as customers, a retail station increases its non-fuel sales along with its E85 sales.
- **E85 May Also Draw New Non-Fleet Customers to the Store**: Flexible-fuel vehicle (FFV) drivers who desire to use E85 could choose to fuel at the station that offers E85 instead of their usual gasoline station.
- **E85 Customers Fuel More Often**: Even if E85 drew no new customers but merely converted gasoline customers from the same store, the number of customer visits would increase. This is because a vehicle's range is reduced by 23% to 28% when operating on E85 because of ethanol's lower energy content compared to gasoline (see Appendix E).

Upgrade to a Growing Market

E85 can be a better selling product than premium and mid-grade (P&M) gasoline. Higher sales volume means more customers at the store purchase more product, which allows even low-margin products to be profitable. E85 outsells the higher grades at an increasing number of stations as the average per-station E85 throughput rapidly grows and throughput of the higher grades declines. Figure 4 shows that sales of the higher grades are declining, largely because most modern cars no longer require them to prevent knocking (Tse 2006).

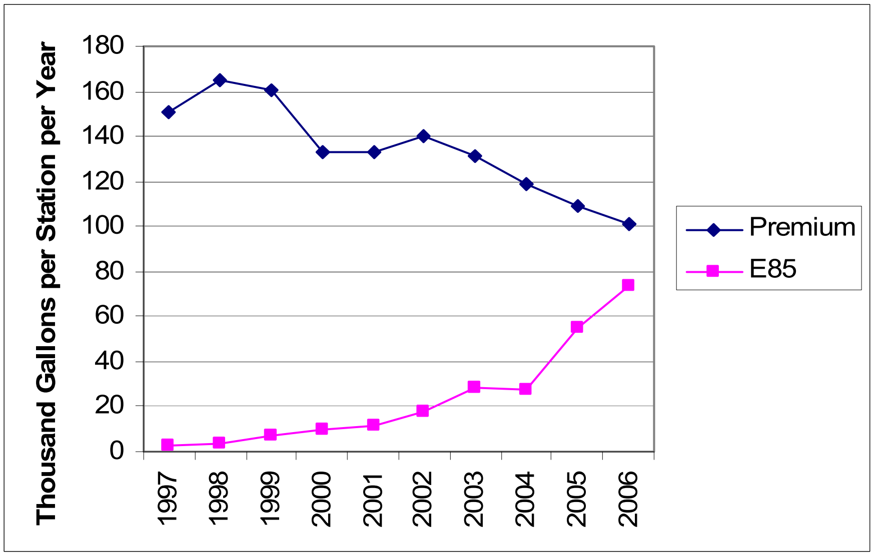

Figure 4. Average U.S. Total Premium[3] versus Average Minnesota E85 Throughput. E85 throughput per station in Minnesota is increasing while nationwide average total premium (sold directly and used to blend mid-grade) throughput is decreasing. Minnesota data are used because they represent more than one-fourth of the nation's E85 stations and are aggregated monthly. Data Sources: EIA Petroleum Navigator 2007, NPN 2006b, and Minnesota Department of Commerce 2006.

Figure 4 contrasts the decreasing premium throughput with the increasing throughput of E85. As both a direct product and a blending ingredient for mid-grade gasoline, total premium is a good indicator of the sales trend of the higher grades of gasoline.

The sales trend of E85 versus the higher grades is important because the fuels often compete for the same equipment. Station operators can greatly reduce the up-front costs of E85 equipment if they convert the tank and dispenser that had previously been used for premium or mid-grade. These trade-offs are discussed further in the "Equipment as an Investment" section.

Differentiate the Fueling Station

Given that the undifferentiated characteristics of gasoline are largely responsible for gasoline's low margins, many retailers are trying to differentiate their stations. The goal of this differentiation is to give customers something other than price and location to compare when deciding where to purchase their gasoline. If successfully differentiated, a station could sell fuel even if its gasoline price was slightly above its competitors' or if the station was in a slightly less convenient location. Therefore, differentiation is worth a lot to retail stations, as reflected in the costs they are willing to pay for it (see Table 2).

[3] Total Premium is the premium gasoline that is both sold directly to the customer and the premium gasoline that is blended to make mid-grade gasoline. For trend purposes, it is assumed that all mid-grade is comprised of 1 part regular gasoline and 1 part premium gasoline. This mixing agrees with the Society of Automotive Engineer's (SAE) definition of at least 87 octane for regular, 89 for mid-grade, and 91 for premium (SAE 2000).

Table 2. The Costs of Differentiation

Form of Differentiation	Action	Cost	Source
Appearance (new, clean, well-lit)	Remodel every 11.5 years	$228,000 per remodel	NACS 2000
Branded gasoline	Additional cost of branded in California for 2001-2002 time span	$54,000 per station per year	Based on EIA 2003 and CA Energy Commission 2007
Green marketing	British Petroleum rebranded to BP or "Beyond Petroleum"	$7,800 per station	Based on Lubers 2002 and BP 2007
Green, cutting-edge, patriotic image	Offer E85	$2,500 to $200,000	Listed in Appendix C

Table 2 shows several actions that can be undertaken to differentiate gasoline stations (including installation of E85 equipment), and their costs. E85 equipment is an investment that should last more than 15 years and is much less expensive than the remodeling project that the average station does every 11.5 years. Branded gasoline is a form of differentiation that cost $0.10/gal in California in 2001 and 2002, which aggregated to $54,000 per store for each of those years. BP's $200 million rebranding campaign cost $7,810 per station. If this project met the stringent payback standards of an oil major, it would presumably meet those of an independent retailer that has more limited investment options. Finally, E85 equipment is listed on this table because it can differentiate a station as being green, cutting-edge, pro-farmer, and patriotic. Its costs of $2,500 (for simple conversion of a gasoline tank) to $200,000 (for all new equipment in an expensive location) for equipment that lasts at least 15 years can be a reasonable investment as a differentiation tool, but fortunately E85 equipment can pay itself off even when the advantages of differentiation are not taken into account.

E85 Equipment as an Investment

E85 can be an attractive investment to a retail station in addition to being a valuable form of differentiation. Its profitability depends on multiple factors—some that can be controlled by the retailer and some that can't. To make a sound investment decision, the retailer must first know the relative importance of these factors to the overall profitability of the investment. The model presented in this report provides this key information to the station owner.

The model is based on a discounted cash-flow analysis (DCFA), a standard protocol for assessing such investments. The DCFA takes the initial investment, the terms of the loan, income, and operating costs into account. It then calculates the annual net income (or loss) throughout the life of the project and "discounts" them at a specified rate. This rate is the targeted annual return on investment (ROI) that the retailer wants to make.

Model Run #1: Equipment Configurations

The first run of the model tests the various equipment configurations used to sell E85. Before listing these E85 equipment scenarios used in the model, we need to assess what gasoline equipment retailers are starting with.

Gasoline Equipment Configuration

The effort and cost to install or upgrade equipment so E85 can be used depends on the equipment a gasoline station already has. Gasoline stations have a wide variety of equipment configurations, but it is helpful to note some industry averages and some trends for comparison purposes.

Storage Tanks

Gasoline stations in the United States have an estimated average of 3.3 underground storage tanks (USTs) each (Miller 2007). This average includes regular gasoline, premium, mid-grade, diesel (which tend to be concentrated at large truck stops), and kerosene. Stations often dedicate two of these tanks to regular unleaded (Kaiser 2007) and one to premium. Mid-grade tanks are increasingly rare because dispensers that blend premium and regular gasoline to make mid-grade are rendering separate mid-grade tanks as unnecessary. USTs come in sizes ranging from 4,000 gallons (in older stations) to 12,000 gallons. Smaller tanks tend to be used for premium and mid-grade.

Dispensers

The average fueling station has 8.6 fueling positions (NACS 2006), with approximately half the number of dispensers servicing these positions. Today, most dispensers are connected to all tanks and can offer all grades of gasoline. Most dispensers sold after 1995 route all three grades through the same hose (Negley 2007), but dispensers with separate hoses for each grade are still very common. These multi-hose dispensers are needed to offer E85 so the handle can be properly labeled.

E85 Equipment Configuration

The various gasoline equipment configurations that stations start with help determine the possible E85 equipment configuration and upgrades. Retail stations use three general equipment configurations to sell E85. These configurations are used throughout this report, and are listed below.

New Tank

The retailer installs a new UST and retrofits or replaces dispensers, pumps, and piping with E85-compatible components.

Mid-Grade (or Regular Unleaded) Replacement

The retailer fills the mid-grade tank with E85 after cleaning the tank and replacing or retrofitting non-compatible dispensers or equipment with compatible ones. In this scenario, mid-grade gasoline is still offered by blending regular and premium gasoline together. This means that there is no opportunity cost (the elimination of a previous income due to equipment changeout). Mid-grade tanks are increasingly rare, but due to the lack of opportunity cost and similar setup costs, this scenario also represents cases where one of a station's multiple regular gasoline tanks is converted to E85. It can also represent cases where E85 replaces diesel or kerosene at a station where sales of those fuels were deemed negligible.[4]

[4] Diesel has been replaced by E85 in small stations that had very low diesel sales (Christopher 2007). Diesel is not modeled independently in this business case because cases where diesel can be replaced by E85 are completely dislocated from sales statistics of baseline or "average" diesel retailers. This is because "average" diesel retailers are large truck stops whose diesel sales are increasing (total diesel sales in the United States have increased by 33% in the past decade) (EIA Petroleum Navigator 2007).

Premium Replacement

The retailer fills the premium-grade tank with E85 after cleaning the tank and replacing non-compatible materials and components. The retailer can therefore no longer offer either mid- or premium-grade gasoline, which represents an opportunity cost.

Indicator of Profitability

Relative profitability for the three equipment configurations is indicated by the required gross margin (RM) for E85. This is how much money the retailer needs to make on each gallon of E85 to meet its investment goal. The lower this value is for any given level of E85 throughput, the easier the retailer can achieve investment goals.

Determinants of Profitability

The profitability of various equipment configurations is determined by a suite of parameters based on the operation of E85 projects. These parameters are of greater interest than those listed as "inputs and assumptions" (in the next section) because they can be assessed or controlled by the retailer.

- **Throughput of E85**: How many gallons of E85 does the retailer sell each year?
- **Cost of Equipment**: What is the cost to equip the station to sell E85? Default values for this are $60,000 for a new tank and $20,000 to use an existing tank. (See Appendix C for how these numbers were derived.)
- **Return on Investment (ROI)**: How much does the retailer need to make (in terms of percent growth per year) on this investment? The default value for this is 10%, which has been the average rate of return for the past five years on another relatively risky investment—junk bonds (as represented by the Lehman high-yields index).
- **Maintenance and Operation (M&O) Costs of the E85 Equipment**: The default value for this is assumed to be the same as for gasoline equipment. It is $2,000/year base costs (for corrosion, weathering, customer abuse, electricity) rising with throughput to $10,000/year when the system is dispensing 200,000 gallons annually. This default was developed through interviews with three E85 project managers (Kerth 2007; Koster 2007; Richardson 2007).
- **Base Taxable Income**: Taxable net income before the project starts determines the tax brackets in which the E85 project will operate. It also determines the number of years the station will need to use all the tax credits associated with the E85 project. The default value for this is $36,000, which was the average net taxable income for a retail station in 2004 (Eichberger and Scott 2006).
- **Annual Throughput of Mid-Grade and Premium**: This is a major opportunity cost when replacing the premium-grade gasoline with E85. This opportunity cost is calculated by multiplying the national average margins of mid-grade and premium gasoline ($0.16 and $0.175, respectively) (EIA 2007) by their annual throughputs. Default throughputs are 62,400 gallons of premium and 87,900 gallons of mid-grade, which were derived by multiplying the EIA 2006 gasoline throughput (821,700 gallons per station) times the NACS 2005 percentage breakdowns of 7.6% premium and 10.7% mid-grade. M&O costs

for premium and mid-grade equipment, which are assumed to be the same per gallon as those for E85, are then subtracted from this value.

Model Inputs and Assumptions

In addition to these parameters, the model required numerous other inputs and assumptions related to costs, funds, operations, depreciation, and taxes. These parameters are less variable than the "determinants of profitability," have negligible impact on profitability, or cannot be assessed by the station owner.

Funds

- **Money Down:** Equipment paid for with 20% equity and 80% debt. This adheres to the loan-to-value requirements set by Petromac, a financing company that specializes in loans to petroleum marketers and convenience store owners.
- **Loan Term**: 10 years (Petromac)
- **Interest Rate**: 8.5% (Petromac)

Operations

- **Project Life:** 15 years. This length was reached after interviewing one equipment manufacturer (Hutchinson 2007) and two project managers (Doenges 2007 and Kerth 2007).
- **Downtime Losses:** $0 for the new tank scenario because the station can usually stay operational while a new tank and dispensing equipment are installed. However, if a station converts a tank it must close down for about 3 days. Therefore, downtime costs are the annual net income times (3/365) (Doenges 2007; Koster 2007; and Richardson 2007).
- **Startup Time:** E85 sales are assumed to be up to their full level immediately after opening. This assumption is supported by the Dobrovolny case study (in which sales spiked when a station opened) and interviews with project manager Steve Walk (2007). However, these immediate sales require adequate advertising and signage before E85 is added.
- **Initial tank of E85 is Assumed to Cost $14,400**: This assumes that one entire 8,000 gallon truckload is purchased, which most stations try to do to reduce transportation costs (Koster 2007). It also assumes that the purchase price was $1.80/gal, which was 15% of the January 2007 EIA wholesale cost of gasoline and 85% the Oil Price Information Service (OPIS) Ethanol and Biodiesel Information Service Ethanol contract price in February 2007. Annualized contract prices are not available because OPIS just recently started tracking contract ethanol prices.

Depreciation

- **Type of Depreciation**: 200% declining balance (IRS Revenue Procedure 87-56)
- **Period of Depreciation**: 5 years (IRS Revenue Procedure 87-56)

- **Depreciation Incentive:** Tax Code Section 179 allows retailers to depreciate up to $108,000 of equipment cost in the year of purchase (IRS 4562). However, this "expense deduction" is subtracted from the amount eligible for the Refueling Infrastructure Tax Credit. Therefore, this expense reduction is assumed to be taken only for costs in excess of $100,000 (the price at which the tax credit is maxed out). The reduction can be carried forward if it is not fully usable in the first year because of limited taxable income.

Taxes

- **Federal income Tax Rates**: 15% for incomes less than $50,000, 25% for every dollar of net income between $50,000 and $75,000, 34% between $75,000 and $100,000, and 39% between $100,000 and $335,000 (Endowment Development Services 2005).
- **State Income Tax Rate**: This was assumed to be 6.6%. This is the average weighted corporate income tax rate for 2006 (Chamberlain 2006).
- **Alternative Minimum Tax (AMT)**: This affects only corporations with gross annual receipts of $7.5 million/year or greater (IRS 2003). This amount is approximately 3 times the amount of gross receipts earned by the average gasoline retailer, which is above the range of scenarios run for this analysis.
- **Infrastructure Tax Credit**: E85 Equipment Costs are partially compensated through the Infrastructure Tax Credit set up in section 1342 of EPAct 2005, which is active through December 2009. This credit is for 30% of the infrastructure cost to a maximum of $30,000. The credit is treated as a general business credit. If it cannot be fully used in the first year it can be used retroactively for a refund on the previous year's taxes. Furthermore, the unused portion of the credit can be forwarded 20 years (IRS 2006).

Baseline Relationship

When the model was run with the baseline values for the variables and assumptions previously listed, the following relationship was discovered between the RM for E85 and the required throughput (Figure 5). At the average Minnesota station throughput (about 70,000 gal/year), the required margin is $0.15/gal for the mid-grade replacement, $0.19/gal for a new tank, and $0.39/gal for premium replacement.

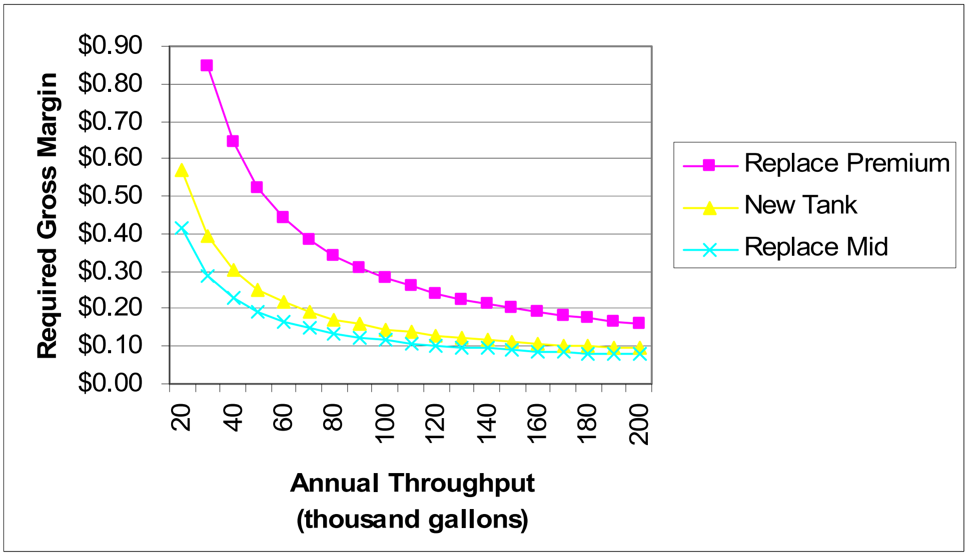

Figure 5. Comparison of RM and throughput for the three primary equipment configurations. Replacing mid-grade gasoline is the most economical at any throughput, and replacing premium is the least economical.

The graph shows that under "base case" or common conditions, the following relationships hold:

- The RM to meet investment goals is greatly reduced as throughput increases.
- There are diminishing returns to added throughput. An additional 10,000 gallons is more likely to be make-or-break for a project if it is added to a base of 30,000 gallons rather than 190,000 gallons.
- Replacing premium is the least profitable scenario at any throughput.
- Replacing mid-grade is the most profitable scenario at any throughput. Even at 200,000 gallons its RM is $0.02 less than for the new tank and $0.08 less than for the premium replacement scenario.

When assessing the margins of E85, using the gasoline margin as a reference point may be helpful. The average margin for regular gasoline in 2006 was $0.12 (after transportation costs were taken out). This is the most important margin to compare to because regular gasoline is the product that E85 needs to be priced below—as opposed to the "pooled margins" (multi-grade) shown in Figure 5. Although a good reference point, $0.12/gal is by no means a cutoff for project profitability—it all depends on the wholesale price of the two products and how close the retailer feels the retail prices can be to one another. These two factors will be further explored in the "Assessing Potential Gross Margin" section.

Model Run #2: Varying the Determinants of Profitability

The "base case" scenario represented in model run #1 is dependent on some large assumptions. The base values given for each determinant of profitability (equipment cost, maintenance costs, ROI, etc.) vary widely. The purpose of model run #2 is to assess how and to what degree these variations affect the profitability.

To test these variations, each determinant is halved from its baseline value, then doubled. For example, the baseline cost of a new tank is assumed to be $60,000. Therefore, the model tests the impact of $30,000 equipment and $120,000 equipment. The half- and double-values are chosen rather than a symmetrical percentage deduction/addition because they cover a larger spread within the range of realistic possibilities.

The first output from this test run consisted of 10 graphs like Figure 5, which show RM verses volume. There is one graph for each scenario such as "double equipment cost," "half equipment cost," and "double M&O." These graphs are best summarized by words, and they revealed the following:

- Replacing mid-grade gasoline is the best investment under each scenario.
- Adding a new tank is the second-best investment in all scenarios, but only slightly (RM is less than $0.01 greater than mid-grade when volume is more than 150,000) or when equipment costs are halved.
- Replacing premium gasoline is the worst investment, especially in scenarios where the original premium throughput is doubled and equipment prices are halved.

These scenarios were not cross-compared, which would result in comparisons such as "new tank with 2× ROI" versus "mid-grade with ½ ROI." These comparisons were not deemed realistic because the variables apply to the station regardless of its equipment configuration.

Scenario-Based Analysis of Variables

To analyze the effect each factor has on the profitability of a given investment, we must look at one configuration-based scenario at a time. Figure 6, Figure 7, and Figure 8 reflect the influence that halving or doubling each variable has on the RMs for a profitable investment.

In these figures, throughput is treated the same as the other five variables so that one may be isolated at a time. Therefore, throughput was given a default value of 70,000 gal/year, which is roughly the average annual throughput at a Minnesota E85 station. Minnesota data are used because they represent one-fourth of the nation's E85 stations, are aggregated monthly, and generally agree with the findings of Underwriters Laboratories' (UL) survey of E85 stations (UL 2007). Therefore, the range tested is 35,000 gallons (half the Minnesota value) to 140,000 gallons (double the Minnesota value).

One variable—base taxable income—is not represented on the following graphs because its effect was negligible (range less than $0.01) for any of the three scenarios. The implications of this will be further discussed in the "Model Conclusions" section.

New Tank Scenario

The first scenario to be analyzed is that of a new UST being added to a gasoline station. Figure 6 shows the effect of doubling or halving the input variables in this scenario.

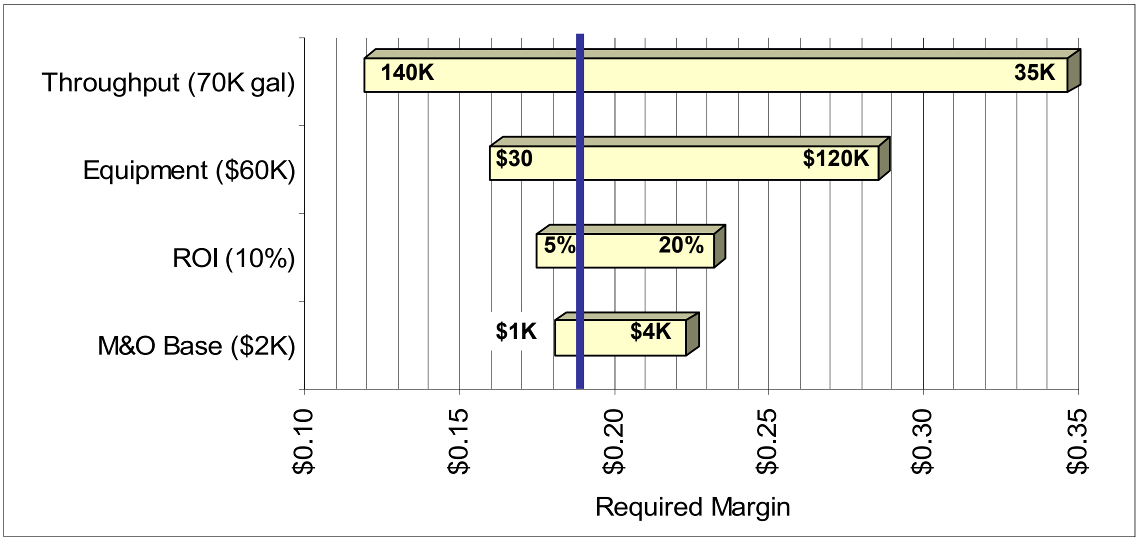

Figure 6. Variance between ½ and 2× base case: new tank scenario. When all inputs are held at their default values (values in parentheses on the Y axis), the required margin is $0.19. Halving and doubling the various inputs extends the required margin to the end of the bars.

Interpreting the Variance (Figure 6, Figure 7, and Figure 8)
The line at $0.19 in Figure 6 represents the RM under the base-case scenario (when all variables are held at the levels represented in parentheses on the left). This corresponds with the point at 70,000 gallons throughput and $0.19 on the new tank scenario in Figure 5. The input value of the given variable (either half or double the baseline) is printed on each side of the bar for that variable.

The variance in RM extends to the left, where each variable is halved except for throughput, which is doubled (as can be seen written on either end of the bar). The opposite is true for the right side of the bar, but the right side extends further. Throughput extends further on the right because the right side is dealing with smaller throughputs and, as established in Figure 5, throughput of E85 gets diminishing returns in terms of reducing the RM. The rest of the variables are larger on the right largely because they vary more widely in real terms. For example, the right side of the equipment bar is $60,000 greater than the baseline, whereas the left side is only $30,000 less than the baseline.

The left ends of the bars do not represent the minimum margin that a project could require, for two reasons: First, the left-end values for the variables are not the most extreme values. For example, many stations have throughput that is greater than 140,000 gallons and would therefore lower their RM to less than $0.12. Second, these variables combine to reduce the RM by more than either one could do by itself (a point to be illustrated later).

Highlights from the New-Tank Variance Test

- Annual throughput is the most important variable for determining the RMs of a new-tank project.

- Halving the cost of equipment is the second most influential way to reduce RMs. This is equivalent to a cost-share project, grant, or state or local incentive that effectively reduces the cost of the project.

Mid-Grade Replacement Scenario

When the mid-grade (or a regular unleaded) tank is converted to E85, the effect of doubling or halving the variables is quite different than for the new tank scenario (see Figure 7).

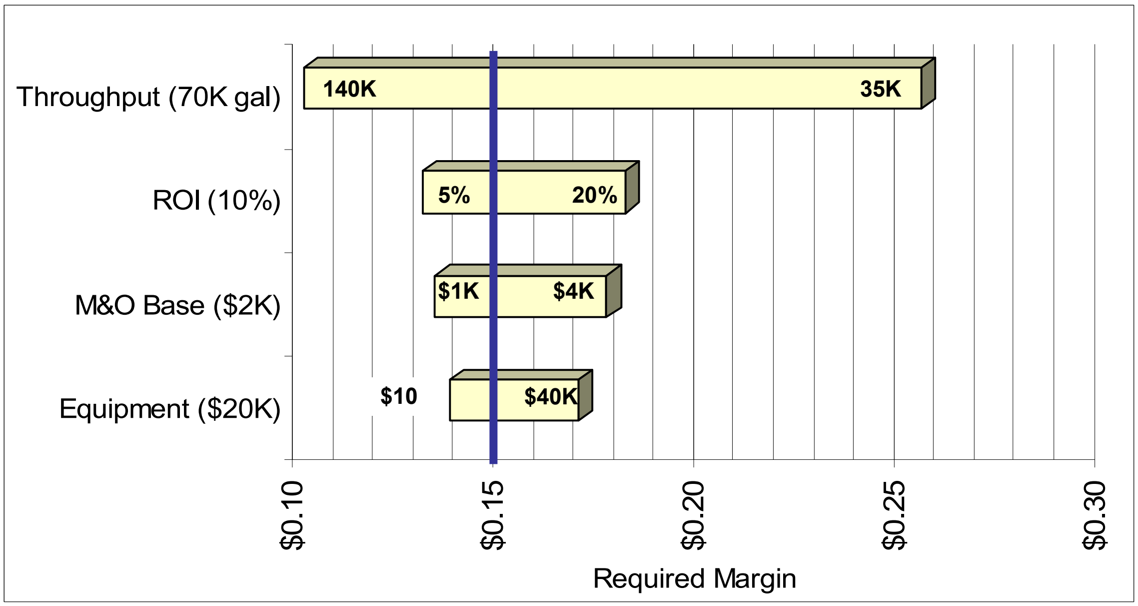

Figure 7. Variance between ½ and 2× base case: mid-grade replacement scenario. When all inputs are held at their default values, the RM is slightly less than $0.15. Halving and doubling the various inputs extends the RM to the end of the bars.

Highlights from the Mid-Grade Variance Test

- Throughput is more isolated as the primary indicator of project profitability in the mid-grade scenario than in the new tank scenario.
- Variance in equipment cost matters much less under the mid-grade scenario because the baseline costs are much lower.

Premium Replacement Scenario

The premium replacement scenario has an additional variable to consider: the opportunity cost of P&M gasoline sales. This is taken into account by halving and doubling the throughput of P&M before the E85 project to volumes represented on the P&M sales bar (see Figure 8).

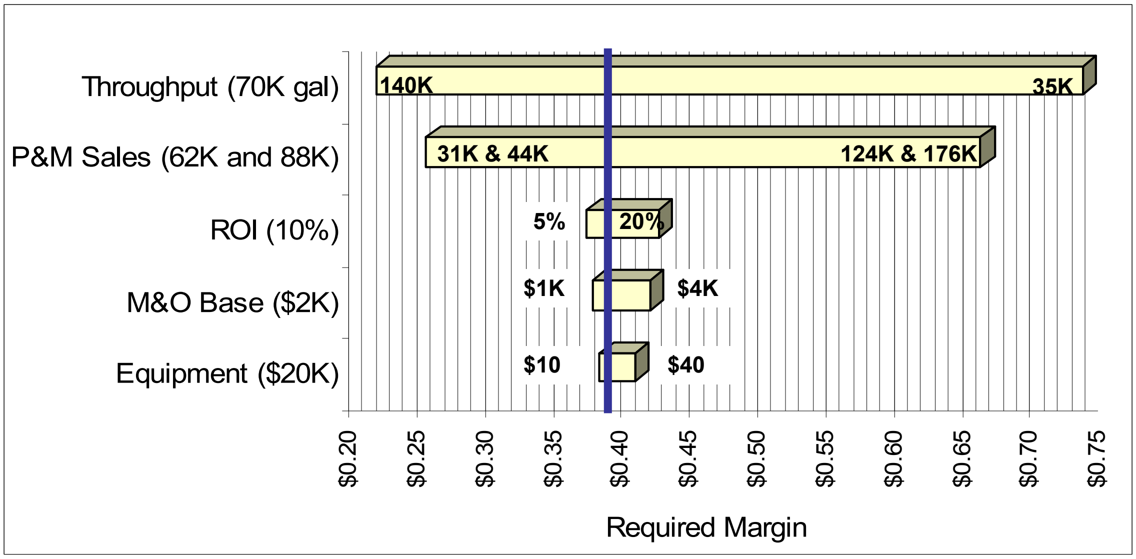

Figure 8. Variance between ½ and 2× base case: premium replacement scenario. When all inputs are held at their default values, the required margin is $0.39. Halving and doubling the various inputs extends the required margin to the end of the bars.

Highlights from the Premium Variance Test

- Overall variance for throughput is much larger than for the other two scenarios. This means this investment is more vulnerable to failure during times of low throughput than are the mid-grade or new tank scenarios.
- The addition of P&M sales greatly adds to the variability and risk of this investment.
- The magnitude of the E85 throughput and P&M sales variables mean that if both are on the positive side of the range, the investment can be profitable. For example, if the throughput is 140,000 and the baseline P&M sales are 31,000 and 44,000 gallons, the RM is only $0.14/gal. Adding other positive assumptions such as low M&O costs can further reduce the RM.
- Although comparatively smaller than the first two variables, ROI and M&O are about the same in the premium scenario as in the other two scenarios, and equipment is the same as in the mid-grade scenario.

Model Run #3: Increases in Non-Fuel Sales

As mentioned earlier, increasing non-fuel sales is a major survival tactic of fueling stations. Furthermore, E85 has the potential of increasing these sales by differentiating the station. There is anecdotal evidence of this second relationship, but a statistical correlation has not yet been documented. Therefore, a third model run was conducted to investigate the potential impact of an E85-induced increase in non-fuel sales on project profitability, as reflected by the required margin.

The third model run translates estimated increases of non-fuel sales into the same "required margin" terms used in earlier runs. It applies the sales increases to the "base case" scenario, with three additional assumptions:

- The average non-fuel sales are $766,000 per year. This estimate is based on EIA fuel data, NPN station numbers, and an average non-fuel to total sales ratio of 31% (NACS 2006).
- The average gross margin for in-store goods is 30% (NACS 2006).
- In-store gross margins are a good representation of all non-fuel goods. This seems to be a conservative assumption based on the margins posted in Table 1. However, the margins of multiple products such as auto repair are not known.
- Increases in non-fuel sales are independent of E-85 sales because they result from station differentiation rather than increased E85 customers. This assumption isolates the impact of differentiation on project profitability.

The effect that a 1% increase in non-fuel sales has on RM is shown in Table 3. This effect is linear, meaning that the decrease in RM is exactly 3 times larger for a 3% increase than for a 1% increase. The decrease in RM is independent of equipment configuration, but highly dependent on station throughput for the reasons stated below.
The RM is reduced more for a project with a low E85 throughput than for a project with a high throughput because the benefits of differentiation are divided between fewer gallons, and are therefore greater, for a low-throughput project. However, this relationship is dampened the more E85 sales correlate with non-fuel sales.

This factor could allow some low-throughput projects, for which the RMs shown seem impossibly high, to be profitable. The third column, RM for base-case new tank, is included in Table 3 to help illustrate this point. A 2% increase in non-fuel sales caused by station differentiation could make a 50,000 gal/year project possible. It would reduce the RM from $0.253 to a more feasible $0.16/gal [$0.253 – (2*$0.046) = $0.161].

Table 3. Decrease in Required Margin Caused by 1% In-Store Sales Increase

E85 Throughput (000 gal)	Decrease in RM	RM for Base-Case New-Tank (for reference)
30	$0.077	$0.395
50	$0.046	$0.253
70	$0.033	$0.192
90	$0.026	$0.158
110	$0.021	$0.137
130	$0.018	$0.122
150	$0.015	$0.111
170	$0.014	$0.103
190	$0.012	$0.096

Highlights from Combined Tests

- Equipment configuration is a very important variable; its order of profitability (mid-grade replacement, new tank, then premium replacement) is not changed by doubling or halving any of the other variables.
- Within each configuration, throughput is the most important variable.
- As mentioned earlier, the variables of any given case can combine to reduce the RM by more than either could do by itself. However, they affect the RM in ways that are less than the sum of the two influences. An example of this relationship is presented in Figure 9. In the new tank scenario, a doubling of throughput reduces the RM by \$0.076 and a halving of equipment costs reduces the RM by \$0.035. These sum to a reduction of \$0.111, which infers an RM of \$0.081. However, when the two influences happen at the same time they actually result in an RM of \$0.098, which is \$0.017 greater than the RM if the variables acted independently and their influence were summed.
- The effects of variation in baseline income were negligible (range less than \$0.01) and therefore omitted from Figure 6, Figure 7, and Figure 8. This indicates that the station's tax bracket and number of years it takes for it to capitalize on the federal tax credit are not very influential on project profitability.
- Even a small increase in non-fuel sales associated with an E85 project can make the project much more profitable.

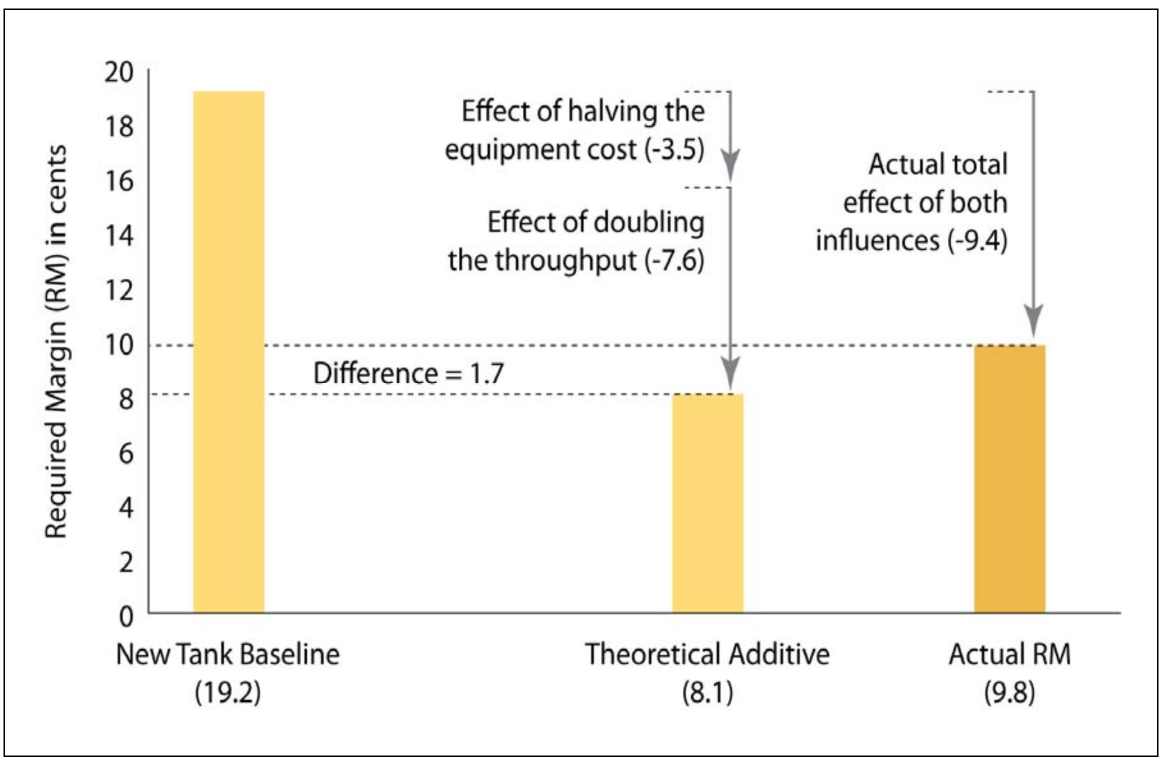

Figure 9. Example of less-than-sum reductions in RM. When two variables are changed to reduce the RM of an E85 investment, their influence is less than if each was applied separately.

Assessing Potential Throughput

The model runs show that throughput is the dominant variable that determines what profit margins need to be achieved under any equipment scenario. Therefore, retailers need to be able to assess what throughput they might be able to achieve. This assessment should be guided by two basic questions:

- How much are other E85 stations selling?
- What station-specific factors influence my throughput?

Figure 10 provides information to help answer these questions.

How much are other stations selling?

The average throughput of a Minnesota station is a good benchmark. This is because of the state's large sample size (291 stations at the end of 2006), monthly aggregation, and accurate tracking by the Minnesota Department of Commerce. This average was 74,000 gallons per station per year in 2006 and, as shown in Figure 5, is growing rapidly. Iowa also has available 2006 E85 sales data. Using quarterly E85 sales from the Iowa Department of Revenue and near-monthly E85 station counts from the Alternative Fuels Data Center (AFDC) historical records, the average throughput for an Iowa station (of which there were 58 by the end of 2006) is 46,000 gal/year. The quarterly aggregation of Ohio throughputs causes the average to be lower than if it were aggregated monthly or weekly, because total throughput is divided by a greater number of stations at the end of a longer accounting period. A UL survey (2007) that reported throughputs of 34 stations in Minnesota, Illinois, Wisconsin, and Michigan can add more landmarks to the realm of throughputs. Figure 10 shows the percentage of those 34 stations whose throughput is within given ranges.

What station-specific factors influence throughput?

After looking at the "average" throughput numbers, a retailer needs to assess whether they are above or below the average station by taking station-specific factors into account:

- **Nearby FFVs**: These are a prerequisite to sell E85. The locations of FFV registrations are available through some state departments of motor vehicles. NREL is currently studying FFV locations and developing maps that show the density of FFVs in given regions. Upcoming maps and reports will be available at www.eere.energy.gov/afdc/.
- **E85 Price Relative to Gasoline (Price Differential)**: This has the largest effect on throughput. The only study known to statistically investigate the relationship between price differential and throughput (Dobrovolny 2005) found that throughput reduced nearly to zero in a nonlinear fashion as the price differential reduced to zero. One of the reasons for this reduction is that E85 contains 23% to 28% less energy than gasoline and therefore reduces fuel economy. Experienced owners of E85 chains have found that a 20% differential maximizes profits (Mills and Gentry 2007). The discrepancy between this price reduction and the reduction in energy content is likely due to customers not understanding the real loss in energy content, to the customers' FFVs running more efficiently (on a miles per gasoline gallon equivalent [MPGE] basis) on E85 than on gasoline, or to the other valued attributes of E85 such as improved torque, horsepower,

and environmental benefits. Please see Appendix E for further discussion of the fuel economy reduction.

- **Fleet Partnerships**: These can make throughput more predictable and greatly increase sales. These partnerships can be as simple as accepting the fleet's payment card or as involved as a cost-share relationship where the fleet helps pay for the fueling equipment. Some of the best fleets to partner with operate under alternative fuel use requirements and are therefore less cost sensitive when purchasing E85. However, many of the fleets (such as the federal fleet) have exemptions to these requirements that are based on cost (Fardanesh 2007). Local Clean Cities coalitions can help identify potential fleet partners.
- **Customer Awareness**: This was found to be the largest non-price factor influencing E85 throughput in a study of the Minnesota E85 market (Dobrovolny 2005). Specifically, a sign advertising E85 on a road near the station increased sales an average of 16%. Customer awareness is often raised through signs, advertisements, limited-time discounts, and grand-opening events. Clean Cities coordinators often help arrange grand openings with high-profile speakers and media coverage. The Ethanol Promotion and Information Council (www.epicinfo.org) and National Ethanol Vehicle Coalition (NEVC) (www.e85fuel.com) are good sources of promotional materials.
- **Station Location**: This is a good indicator of throughput. Sales volumes are greater in densely populated areas, affluent areas, and on busy thoroughfares (Dobrovolny 2005; Massak 2007). Proximity to other E85 stations must also be taken into account, as nearby stations serve as partners in promoting E85 but act as competitors if located too close. Other E85 stations may be located by an online tool at http://afdcmap2.nrel.gov/locator.

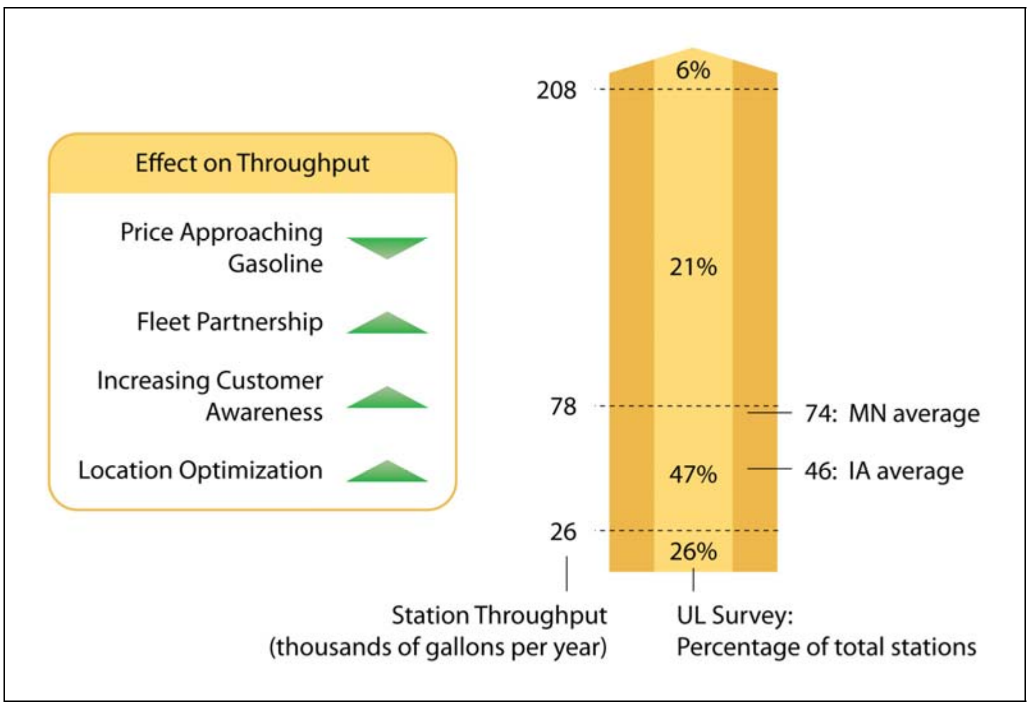

Figure 10. E85 throughput landmarks and influences. The right side of this figure establishes some landmarks for how much E85 other stations are selling. The left side shows the station-specific factors that influence E85 throughput.

Assessing Potential Gross Margin

The model and associated graphs appearing earlier in this report are designed to help retailers estimate the margins they will need to make from E85 for it to be a profitable investment. The next step is for retailers to assess whether these gross margins are achievable. This assessment involves balancing the four components of the retail E85 price with the gasoline retail price, as illustrated in Figure 11.

The retail price of regular gasoline is the upper limit for what the E85 retail price can be. This is because E85 customers drive FFVs that enable them to use regular gasoline if they choose. As discussed earlier, E85 sales drop nearly to zero in a nonlinear fashion as its price approaches that of gasoline, but no statistical relationship between the two on an energy-content adjusted basis has been identified (Dobrovolny 2005). These results and anecdotal sales evidence (Reid 2006) prevent us from assuming that the upper limit for E85 price should be lowered according to energy content at this time. Instead, the energy penalty of E85 is partially responsible for the declining sales indicated in Figure 11.

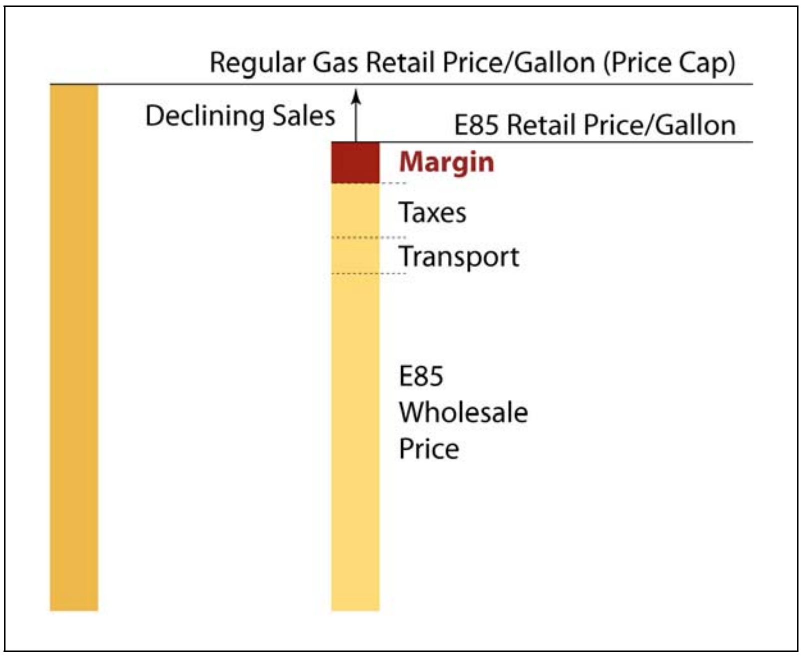

Figure 11. Relationship between the four limiting factors of E85 gross margin. The retail price of gasoline sets a cap that the E85 retail price cannot surpass. The E85 retail price is the aggregate of the E85 wholesale price, transportation costs, taxes, and gross margin. Therefore, if any of the first three prices grows the margin must shrink.

Fortunately, retail gasoline prices are easily found on EIA's Petroleum Navigator, http://tonto.eia.doe.gov/dnav/pet/pet_sum_top.asp. They offer historic and recent weekly prices at national, regional, and state levels. Real-time and station-specific prices can be found at www.gasbuddy.com and www.mapquest.com.

Retail E85 price needs to be less than the gasoline price, but it also needs to be high enough to cover the wholesale E85 price, transportation to the retailer, applicable taxes, and the gross margin. Sales decline to near zero as this price approaches the gasoline retail price, so efforts must be made to keep it lower.

Wholesale E85 price needs to be obtained from a local E85 blender/dealer.[5] This is the only place for relevant wholesale E85 prices for the reasons listed in Appendix D. A dealer can be located through your local Clean Cities coordinator. Prices tend to be lowest if purchased from a regional[6] (as opposed to nationwide) dealer and can be especially low if purchased from an ethanol refinery that also blends and deals E85.

In addition to asking the dealer's E85 price, it is advisable to ask about the terms and length of its current ethanol supply contracts. According to the Renewable Fuels Association (2007), 90% to 95% of ethanol is sold under long-term contracts (6 to 12 months) to the blenders. Many are fixed price contracts, which often lead to a period of relative stability in the price of E85. Some contracts are fixed to the price of gasoline, which makes the spread between E85 and gasoline prices more predictable. It is also best if the blender/dealer has more than one source of ethanol, so if the price at one plant rises it can purchase from another producer.

Transportation from the dealer is often included in the total price when sold on a dealer tank wagon basis. If not included, transportation of E85 should cost no more than the transportation of gasoline on a per-mile basis, as long as the retailer can purchase an entire truck load (8,000 gallons). If the retailer's tank is not large enough to handle this entire amount, he needs to find another station to "split-load" with or face a partial-load surcharge.

NACS (2006) estimates that the average transportation fee for a gallon of gasoline is $0.03. This cost increases with distance. Because not every distribution terminal offers E85, we can assume that average distance, and therefore transportation costs, are greater for E85 than for gasoline. The only information we could obtain to relate costs with distance come from four jobbers in Colorado. How their prices compare to other regions is not known. Their combined price curve allows us to back-calculate from the NACS price that the average distance gasoline is transported is approximately 45 miles. From there, it rises (or decreases) linearly about $0.0042 every 10 miles.

Taxes vary widely according to location. The blender pays the federal excise tax ($0.184/gal) and receives the federal ethanol credits (up to $0.434/gal of E85), so these do not need to be accounted for by the retail station. However, in some locations the retailer needs to pay taxes on E85 as if it were gasoline. These state and local taxes, which average $0.274/gal, are listed online by state on the American Petroleum Institute Web site at www.api.org/statistics/fueltaxes/upload/March_2007_gasoline_and_diesel_ summary_pages-2.pdf. State tax breaks and tax incentives can be found in the AFDC Federal and State Laws and Incentives database at www.eere.energy.gov/afdc/laws/incen_laws.html.

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[5] A blender is a company registered by the IRS to mix ethanol with gasoline and sell it. The blender must pay excise taxes and is eligible for the ethanol tax credit (see taxes section in Appendix B).

[6] Regional blenders tend to be less expensive because most large nationwide chains find it preferable to, and have greater capability to, use their ethanol in E10 instead of E85 (Cook 2007).

Conclusion: Checklist for E85 Favorability

This report assessed the current state of the gasoline industry and recognized E85 as a way to alleviate some of the financial strains retail gasoline owners currently face. It then analyzed E85 equipment as an investment and highlighted the throughput and gross margins necessary for E85 projects to be profitable. Having highlighted these factors, we then provided guidance to help station owners assess the possible throughputs and gross margins. We will now combine these factors into a checklist to help retailers decide whether E85 is likely to be a sound business decision.

- ✓ **Robust Local Competition for Gasoline Customers is Creating a Need to Differentiate**: Gas stations currently spend a lot of money differentiating themselves, and adding E85 as a fuel can distinguish a gasoline station as being green, cutting-edge, and patriotic. Even a small increase in non-fuel sales can turn an unprofitable E85 project into a profitable one.

- ✓ **Access to Low-Cost E85**: Wholesale E85 prices that are substantially less than gasoline enable retailers to earn a higher gross margin from E85. This price can vary greatly by blender, and tends to be lowest with regional blenders (as opposed to nationwide companies), blenders with multiple sources for ethanol, and ethanol distilleries that are licensed as blenders. Access to these blenders is highly dependent on the region of the United States in which the station is operating.

- ✓ **Have Mid-Grade Tank or Extra Regular Unleaded Tank that Can be Converted**: The most profitable E85 investments are those where the station converts one of its mid-grade or regular unleaded tanks to E85. This scenario has the lowest equipment costs and no opportunity cost because mid-grade can still be offered through a blending valve. Replacing a regular unleaded tank represents a similar scenario if the station has excess capacity and can still offer regular gasoline from other tanks.

- ✓ **Large Potential Throughput of E85**: The most important indicator of profitability for any E85 equipment configuration is throughput. Therefore, retailers need to estimate their potential throughput ahead of time. This is a difficult and uncertain practice, but looking at the throughputs of stations in Minnesota, Iowa, and the UL survey can give retailers an idea of the range and relative probability of different throughput levels. From there, retailers can assess their likelihood of success from the strength of fleet partnerships, E85 price relative to that of gasoline, customer awareness, and location. Local Clean Cities coalitions and state departments of motor vehicles can help identify potential fleet partners and FFV populations.

- ✓ **Cost-Sharing, Grants, or State and Local Incentives for E85 Installation**: If a station owner does not have a mid-grade or extra unleaded tank, the next most profitable investment is installing a new E85 tank. The most influential variable on the profitability of this investment (other than throughput) is equipment cost. This cost can be greatly reduced if the retailer has another entity to split the costs with. These entities could be a state or local government through the form of grants or other incentives, or a fleet to partner with. The AFDC lists applicable state incentives and a local Clean Cities coordinator can recommend other sources of funding.

- ✓ **Have Low and Declining Sales of Premium Grades, Diesel, or Kerosene**: This condition means two things: First, E85 could be a better selling item and increase overall trips to the station. This could increase sales of the high-margin convenience store items. Second, if premium, diesel, or kerosene sales are low enough, replacing them with E85 could be a profitable investment.

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Appendix A: Background of Gasoline Industry

To better understand the choices that gasoline retailers face, we must view them in the larger context of the gasoline industry (see Figure 12). The following discussion will define the general players and relationships that comprise the current gasoline industry in the United States. Please bear in mind that the industry varies greatly according to region, so aspects might be different in your region.

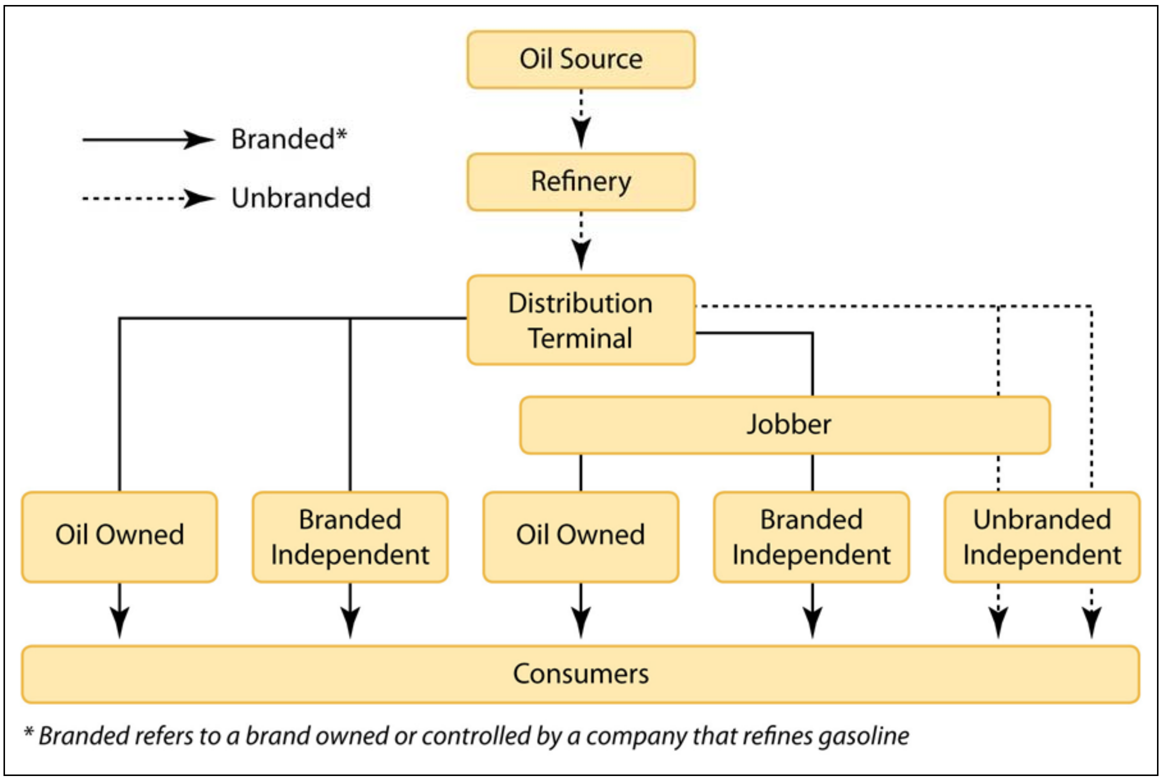

Figure 12. Gasoline market channels. The market channels that branded and unbranded gasoline can take from the oil source to the final consumer. *Based on figure in EIA 1996 and data from NACS 2006.*

Oil Source

Oil exploration and extraction is a highly profitable business, and the companies that do it are protected from new competition by extremely high barriers of entry and economies of scale. These high barriers of entry and subsequent failure of the private sector to enter the market has led many countries to start government-owned oil companies. The huge economies of scale have led the non-government companies, or "oil majors," to merge to be large enough to compete. Oil is claimed as "reserves" and owned by oil companies long before it is extracted. Table 4 shows the reserves of the 10 largest oil companies (which are all state owned) as well as the privately owned oil majors.

Table 4. Ten Largest Oil Companies and Oil Majors

Rank by 2004 Oil Reserves	Company	2004 Oil Reserves, Million Barrels
1	Saudi Aramco	259,400
2	National Iranian Oil Company	125,800
3	Iraq National Oil Company	115,000
4	Kuwait Petroleum Corporation	99,000
5	Abu Dhabi National Oil Company (UAE)	92,200
6	Petroleos de Venezuela.S.A.	77,200
7	National Oil Company (Libya)	39,000
8	Nigerian National Petroleum Corporation	35,255
9	OAO Lukoil (Russia)	16,114
10	Qatar General Petroleum Corporation	15,207
16	ChevronTexaco (US)	8,000
17	ExxonMobil (US)	7,813
19	BP (UK)	7,161
20	Total (France)	6,592
21	ConocoPhillips (US)	6,168
24	Royal Dutch/Shell (Netherlands)	4,636

Data Source: PetroStrategies, Inc. (2007)

Once extracted, oil is sold on a global market through a variety of contract arrangements and "spot"[7] transactions. Price transparency, risk reduction, and centralization were added to this market when the New York Mercantile Exchange began selling oil futures in 1981. This exchange provides a format for oil experts to purchase oil for a given price in the future, and the consensus of these transactions serve as a benchmark for oil prices worldwide. Another benchmark is the aggregation of spot transaction prices, gathered by companies such as Platts or the Oil Price Information Service (OPIS). The spot market and futures market are inseparably related, and most contract arrangements, which cover the bulk of oil transactions, are now pegged to their prices (EIA OMB 2007).

The oil market might be transparent, but it is also heavily manipulated. The Organization of Petroleum Exporting Countries (OPEC), which produces about 40% of the world's crude oil (EIA 2006), raises and lowers the price of oil by adjusting the supply from its member countries.

Despite the manipulations of OPEC, the largest vulnerabilities in the market for the past three decades have been political and natural. Two of the largest global price spikes have been caused by war—the Iran/Iraq war of 1980 and the Iraq/Kuwait/U.S. war of 1990. In 2005, increased global demand for oil left little spare capacity to compensate for numerous natural and political supply disruptions, which resulted in the highest oil prices since 1980. Oil makes up 53% of the cost of gasoline, so this volatility in oil prices directly translates to volatility in gasoline prices. This translation is done where the oil is turned into gasoline: the refinery.

[7] EIA defines the spot price as "the price for a one-time open market transaction for immediate delivery of a specific quantity of product at a specific location where the commodity is purchased 'on the spot' at current market rates."

Refineries

Oil refineries purchase crude oil and process it into useful products such as gasoline, diesel, asphalt base, and kerosene. About 94% of gasoline in the United States comes from the 131 domestic refineries in 30 states. The market is not dominated by any particular companies—only 10 companies own more than three refineries (see Table 5). The refineries typically purchase crude oil through contracts with oil suppliers, but they also purchase through the spot or futures market. Refinery costs and profits accounted for 19% of the retail price of gasoline in 2005, (EIA 2006b) so refinery operations have much less impact on gasoline prices. All gasoline coming from a refinery must meet the American Society for Testing and Materials (ASTM) specification D4814, which ensures fuel quality.

Table 5. Companies with More than Three Refineries in the United States

Company	Refineries	Percent
Valero	15	11%
ConocoPhillips	13	10%
Shell	9	7%
ExxonMobil	7	5%
Marathon Oil	7	5%
BP	6	5%
Tesoro	6	5%
Chevron	5	4%
Sunoco	5	4%
Petroleos de Venezuela	4	3%
Total	77	59%

Data Source: Nakamura 2006

For many reasons, refining companies do not want to build new refineries in the United States. No new refineries have been built since 1976, and the percentage of gasoline imported doubled from 2.8% to 5.9% between 1975 and 2006 (EIA 2007).

Distribution Terminals

Distribution terminals are storage facilities to which gasoline is piped, barged, or railed in mass quantities, stored, then sold by the truckload. The area where gasoline exits the terminal to fill up tanker trucks is known as "the rack." Branded gasoline is first differentiated from unbranded at the rack by adding an additives package to the gasoline. The terminal can typically sell branded gasoline for $0.02 to $0.03 more than unbranded (Margonelli 2007). The rack is also where ethanol is usually added to gasoline, either as an oxygenate or as an alternative fuel. Ethanol cannot be added before this point because it cannot share the same pipelines and terminal tanks as gasoline without becoming contaminated.

The IRS currently lists 1,365 terminals in the United States; oil companies and pipeline companies are the largest owners. Oil companies sometimes share a terminal where gasoline of either brand may be purchased. Terminals are also owned by independent companies that purchase their gasoline from a refinery or importer via contracts or on the spot or futures markets. These markets for gasoline parallel the oil markets in relative share of volume and in the key organizations.

Terminals typically sell their gasoline at the "rack price" in accordance to local supply and demand (see Figure 13). Sometimes they set up "fixed-forward" contracts whereby retailers or jobbers agree to purchase gasoline at a set price into the future (which hedges against price volatility). In 2005, shipping to and storing in the terminal added an average of $0.04/gal to the cost of gasoline (NACS 2006).

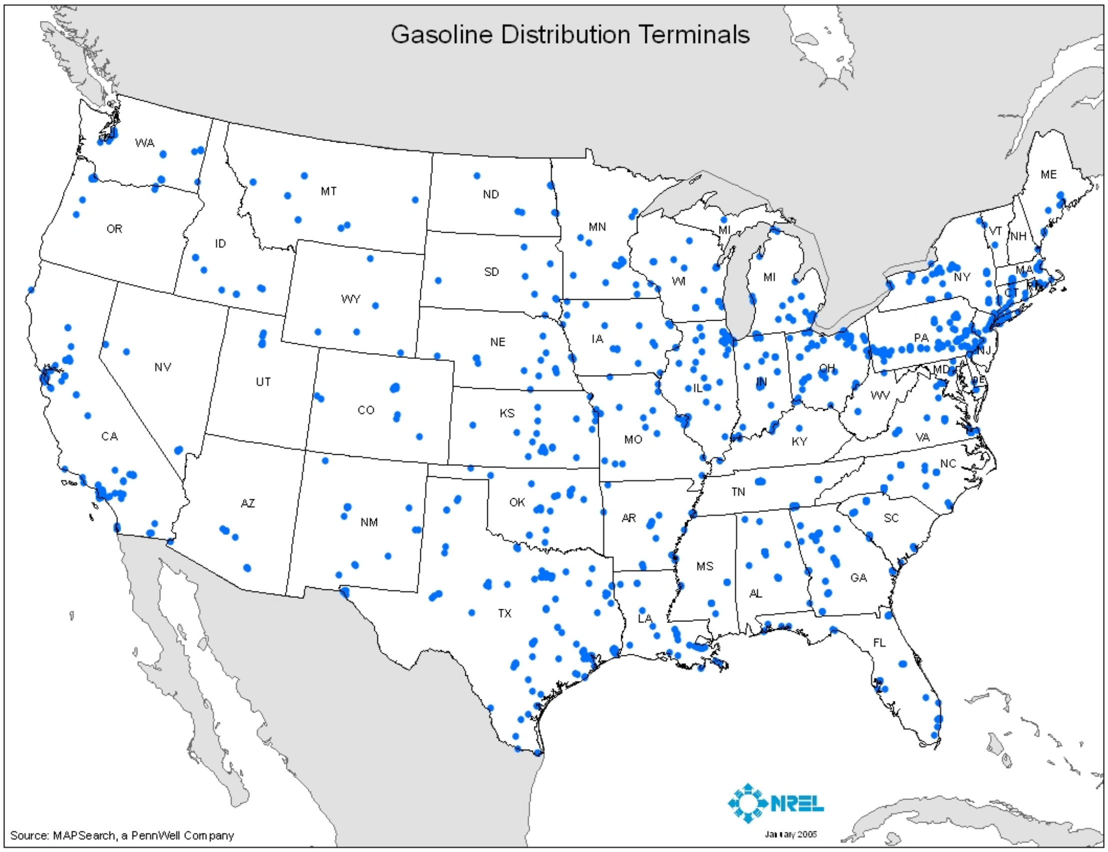

Figure 13. Distribution terminals in the United States. Data Source: MAPSearch (2006).

Jobbers

Fuel is generally trucked from the distribution terminal to the retail station. The trucks may be owned by the refining company, the retail station, or middlemen (called jobbers) who purchase the gasoline at the terminal and sell it at the retail station. The refining company-owned trucks delivered 31% of the fuel to retail stations in 2006; jobbers and retail-owned trucks delivered 69% of the fuel (EIA 2007). Interviews suggest that most of that 69% is delivered by the jobber (Kaiser 2007 and Hill 2007). The trucks used to distribute gasoline can hold 8,000 gallons and are compartmentalized for various grades of gasoline and diesel fuel. Transportation costs are minimized if one station purchases an entire truckload. Transportation from the terminal to the gas station costs an average of $0.03/gal (NACS 2006), but increases with distance. As seen in

Figure 13, terminals tend to be located near densely populated areas to minimize transportation distances.

The boundaries of a jobber's role in the gasoline market vary, but a company ceases to be considered a jobber if it owns a refinery (Marathon 2007). On one extreme, jobbers simply purchase fuel at the terminal and sell it at the retail station. On the other extreme, the jobbers can own their own retail station and a terminal. Such jobbers can include large convenience store chains. However, an increasing number of jobbers are selling their retail stations and focusing on the wholesale market (SIGMA 2007).

Retail Stations

According to *National Petroleum News*, there were 167,500 retail stations in the United States in 2006. These stations can be divided into three categories: (1) those owned by refining companies, (2) those that are independent but sell branded gasoline, and (3) those that are independent and sell unbranded gasoline. The relative advantages of these three station types are compared in Table 6.

Table 6. Retail Station Traits by Type

Type of Station	Share of Stations*	Advantages	Disadvantages
Major Oil-Owned	<5%	Marketing, priority for limited fuel, no franchise fees	Less profitable than upstream operations, minimal ground-level flexibility
Independent Branded	~52%	Marketing, priority for limited fuel, managerial assistance	Fuel surcharge, restricted independence in operations, no purchasing flexibility, probable franchise fees and royalties
Independent Unbranded	~43%	Purchasing flexibility, no franchise fees (unless to chain)	Low priority for limited fuel, no fuel marketing or differentiation

*Based on "How Do Retailers Get and Sell Gasoline" (NACS 2006).

Refiner Owned

Vertically integrated companies such as ExxonMobil, BP/Amoco, ConocoPhillips, and Shell sometimes own the gasoline and processing facilities down the entire distribution line from oil well through fueling station. In these stations, known as *refiner owned* or *company operated*, the parent company sets the retail price and pays employees a salary to run the store. These stations seem to benefit from a number of advantages over other types of retail stations. They are differentiated from the competition through fuel-level marketing and they enjoy first priority for fuel in times of shortage. These benefits to the station come at no cost of royalties or fees that are charged to the independent branded retailers. Despite these advantages, the number of refiner-owned stations declined to fewer than 5% in 2005. This is largely because the oil companies have found the retail stations to be less profitable than upstream operations. The ones they have decided to keep, however, are very successful. This is represented by the fact that this 5% of retail stations sold 15% of the retail gasoline in 2005 (EIA April 2007).

Independent Branded

The independent branded stations must purchase branded gasoline, which is generally \$0.02 to \$0.03 more expensive per gallon (Margonelli 2007) to cover the costs of branding and marketing, and performance additives owned by the oil company. Many independent branded stations are franchises to refining companies. Franchisees typically have to pay a franchise fee, royalties, and rent if the franchiser owns the property. Furthermore, the franchisees must comply with numerous rules and policies concerning how they run their store, a minimum quantity of fuel sales, and which auxiliary goods they can offer. In exchange for this payment and reduced flexibility, the franchisee receives a reliable source of gasoline, volume discounts, brand-specific advertisement, and help managing their stores.

Independent Unbranded

Independent unbranded stations include locally owned stations, chains of stations owned by a person or company (that does not own a refinery), and hypermarts. This owner can be a jobber, who can also own a distribution terminal. The smaller stations can usually shop various terminals for the lowest wholesale price. During a fuel shortage, they have lowest priority and are therefore subject to the greatest price volatility. Larger chains of independent unbranded retailers can negotiate contracts with terminals.

One segment of the independent unbranded gasoline stations is referred to as the *hypermarts*—gas stations that are owned by supermarkets, discount retailers, and warehouse clubs. Hypermarts are extremely effective competitors; in 2004 they comprised approximately 2.5% of the U.S. gas stations but captured 7.7% of the total fuel sales (NACS 2006). Hypermarts are poised for rapid growth. According to the Food Marketing Institute (as cited in NACS 2006), almost 62% of grocery stores that were scheduled to be constructed in 2004 included gas stations in their blueprints.

Appendix B: E85 Influence on the Retailer's Business Relationships

This business case focuses on the major financial effects of selling E85. However, the addition of this product will affect the logistics and management of the station as well. This appendix will briefly broaden the scope to include these issues by focusing on the retailer's business relationships and how they will be affected by adopting E85.

Figure 14 shows the numerous entities with which retail gasoline stations must interact to conduct their business. Each point of interaction constitutes a financial or logistical relationship that affects the success of the retail business. Balancing these relationships to break even or allow for a profit is the essence of the retail gasoline business. The rest of this appendix will address the impact that selling E85 has on these relationships by addressing Figure 14's relationships in a clockwise fashion.

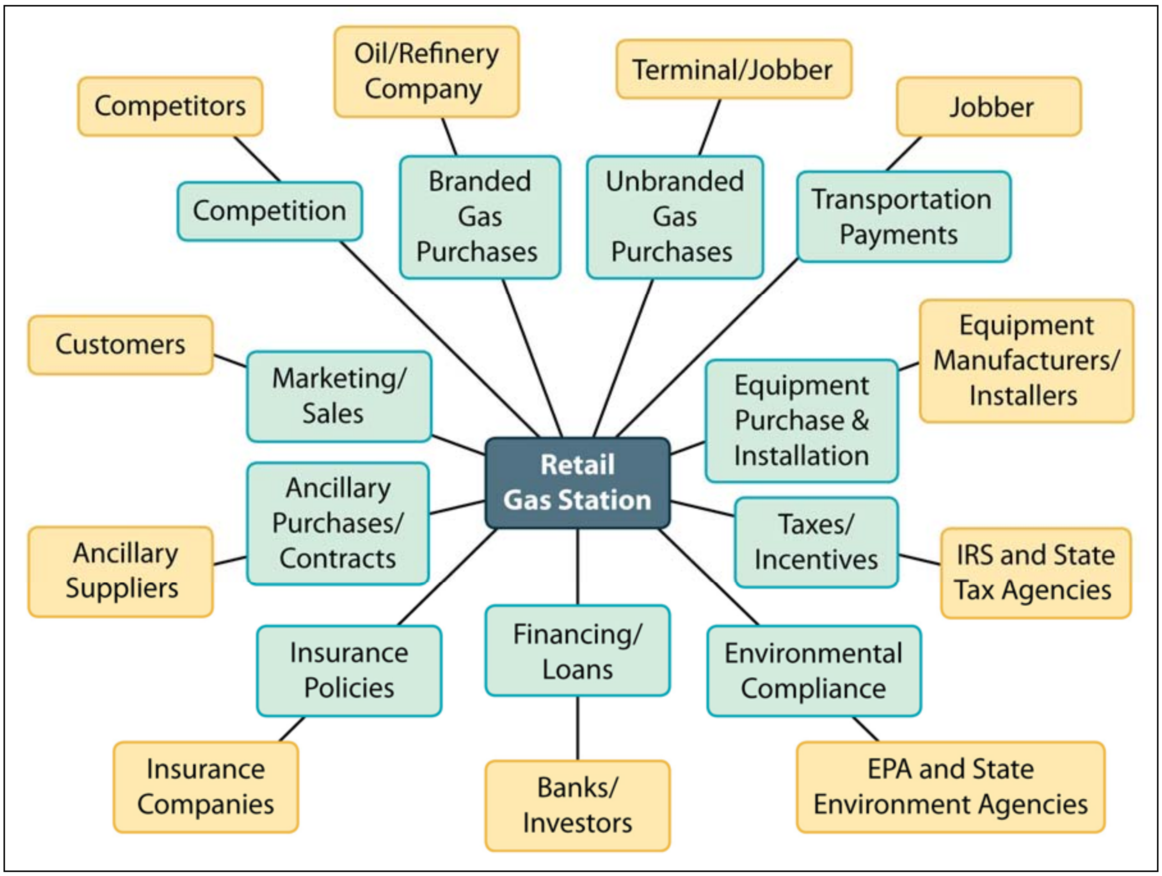

Figure 14. Retail station relationships. The boxes on the perimeter are the organizations that a retailer must interact with. The inner boxes are the mechanisms that constitute the relationships between the retailer and other entities.

Branded Gasoline Purchases

Many of the refining companies that own the major gasoline brands do not allow E85 to be sold under the same canopy (protective roof) as their branded gasoline products. As a result, many gas stations have added a separate canopy under which to dispense E85. This configuration can increase the cost of an E85 project.

Unbranded Gasoline Purchases

Taking on E85 can influence a retailer's decision about where to purchase unbranded gasoline. Purchasing E85 and gasoline from the same jobber/blender might be preferable, as the advantages of bulk purchasing, including fuel discounts and greater shares of fuel during proration (see box), can be retained.

> **Proration** is the allocation of gasoline during a shortage, which results in a temporary limit on the amount of gasoline customers can purchase at the terminal. Priority during proration is established by contract ahead of time, and generally goes to those who regularly purchase larger quantities of gasoline.

Transportation Payments

Jobbers typically double as the "blenders" when dealing E85. As such, they combine ethanol and gasoline to make E85. This distinction is needed because IRS-registered blenders are the organizations that receive the $0.51/gal tax credit from selling ethanol (or up to $0.43/gal E85). Usually, the ethanol and gasoline are at the terminal, where the blender easily combines them at the rack as they flow into his truck.

Most jobbers are not registered blenders, so retailing E85 can complicate a station's fuel purchases. If the blender is far away, it might be cheapest to purchase only E85 from it while purchasing gasoline from a local jobber. Under this condition, the E85 should be bought one entire truckload at a time to avoid a partial-load surcharge. If the blender is nearby, then purchasing E85, multiple grades of gasoline, and even diesel fuel from it is economical. Tanker trucks are divided into three, four, or five compartments, so the station can purchase fewer than 2,000 gallons of E85 without incurring a partial-load surcharge.

Equipment Purchases and Installation

Gasoline retailers require a set of expensive equipment to sell fuel safely and legally. Most installations and upgrades are made by contractors who design a system, coordinate the purchase of all components, and install the "turnkey" (complete) system. Contractors typically offer a limited guarantee of their work in addition to the warranties offered by the component manufacturers.

Many contractors who are competent with gasoline systems do not know the requirements for an E85 system. This has resulted in a situation where most E85 dispensers in a recent survey had not been retrofitted according to manufacturer recommendations (UL 2007). Therefore, a station needs to find a contractor who specializes in E85. Contact your local Clean Cities coordinator for recommendations.

Once installed, both gasoline and E85 systems need to meet specific state and local regulations and may also need to be approved by a local fire marshal. This approval is generally easiest to obtain if you are using Underwriters Laboratories (UL) certified equipment. However, at publication time, there were no UL listed E85 dispensers. UL started accepting dispensing products for evaluation and certification in October 2007 and expects listings sometime in 2008. Prior to the testing being completed and a dispenser being listed, most jurisdictions will allow alternate equivalent dispenser designs to be submitted for approval. Each jurisdiction has its own process and discretion in granting variances or waivers to approve uncertified designs. To date, numerous states and organizations have chosen to grant variances or waivers or have produced written positions on measures related to uncertified products.

Taxes and Incentives

Gasoline retailers paid an average of $0.468/gal of gasoline in 2006 (API 2006). These include gallon-based taxes (not income or property taxes) that break down as follows:

- $0.184/gal in federal excise taxes.
- $0.182/gal in state excise taxes (weighted by volume sold).
- $0.102/gal in sales taxes, gross receipts taxes, and miscellaneous inspection and environmental fees.

The above tax structure is changed by E85 in the following ways:

- Federal excise taxes are paid by the blender. They also receive a tax credit of $0.36 (in the northern winter, when E85 is actually only 70% ethanol) to $0.43 (in the summer or in warm climates, when it is 85% ethanol) per gallon of E85.
- State excise taxes apply to E85 in most states. However, these are reduced and tax credits are offered by many state governments. The AFDC Laws and Incentives Web site has a list of states that tax E85 differently than gasoline.
- The $0.102 that goes to miscellaneous taxes and fees are not changed by E85 in any consistent way.

Regardless of the different tax structure E85 faces, the most important tax-related action an E85 retailer can take is to capture the 30% (up to $30,000) federal tax credit for purchasing the E85 fueling equipment.

Environmental and Safety Compliance

Neither EPA's Office of Underground Storage Tanks nor State-delegated UST programs (except Iowa) have set any regulations aimed at E85 specifically, so these programs currently treat these tanks as if they held gasoline (Patton 2006). Therefore, station owners should treat E85 as if it were gasoline when considering environmental compliance for storage and spillage.

The safety standards for handling and storing E85 are also the same as for gasoline. They are both subject to the National Fire Protection Agency standards 30 and 30A. However, local fire marshals usually differentiate between the two fuels and have different storage requirements. E85 needs to be properly labeled since firefighters must use different chemicals and fire fighting techniques when suppressing E85 fires. A fire marshal needs to approve the system before it can be operational, so the retailer should ask the local fire marshal about specific requirements before installing the equipment.

ASTM has a fuel quality specification (D5798) that covers E85. Complying with this standard is the blender's responsibility, unless the E85 is stored at the retailers for long periods. Duration of storage is an issue because D5798 specifies seasonally adjusted mixtures of ethanol and gasoline. Therefore, E85 purchased in the summer will be out of compliance if stored until the winter

(DOE and Clean Cities 2006). If this occurs, the retailer should contact its blender or fuel supplier for suggestions on how to adjust the fuel mixture.

Another area where environmental regulation may differ for E85 is vapor recovery at the dispenser (Stage II). Vapor recovery equipment is required at gasoline dispensers in Clean Air Act non-attainment zones. However, EPA (2006) has deemed these requirements as no longer applicable to E85 dispensers because most FFVs have onboard vapor recovery systems that negate the need for Stage II vapor recovery systems.

Financing/Loans

Loans for E85 equipment differ in one major way from those targeting gasoline equipment. Multiple state governments offer low-cost loans to station owners that install E85 equipment. These loan programs can be found on the AFDC Laws and Incentives Web site.

Insurance Policies

As a market with high physical risks, gasoline retailers incur high insurance costs—almost 1% of a retailer's gross income in 2002 (NACS 2003). A retailer needs multiple kinds of insurance to cover property damage, worker and customer injuries, theft, and environmental impairment caused by leaks and spills.

E85 can deviate from gasoline in its effect on property damage insurance because insurance companies generally require that E85 equipment be listed by UL as a precondition for coverage (Green Car Congress 2007). Now that UL has suspended its listing, insurance companies may deny or postpone coverage of the equipment. This situation will be improved when UL-certified dispensers become available in 2008.

Ancillary Purchases/Contracts

Ancillary items are the goods such as snacks, cigarettes, and alcohol that are sold inside the convenience store. As mentioned in the main body of this report, these sales are expected to increase when the station starts selling E85.

Sales and Marketing

As discussed in the main section of this business case, offering E85 could be a major marketing strategy for a retail station that frames it as green, cutting-edge, farmer-friendly, and patriotic.

Competition

Retailers compete with each other mainly on pricing and location. This paradigm can be shifted by differentiating the station through the selling of E85, as discussed extensively in the main section.

Appendix C: Cost of E85 Equipment

The default cost used in the model for a *new E85 installation* at an existing gasoline station is $60,000. A new installation in this case includes a UST because liability issues generally prevent aboveground tanks from being used in public fueling stations (Doenges 2007). This $60,000 value was derived by combining estimates represented in Table 7. The four estimates for a new installation (above the double line) overlap between $50,000 and $62,000. The upper end of this range was chosen because this overlap was at the lower end of three of the four estimates.

The default cost for *converting an existing tank* and system is $20,000. This value is included in the top three existing tank estimates (below the double line) for converting a tank and system. These estimates are used because the UL 2007 survey of 45 stations found that none of the stations that simply cleaned the existing system took manufacturer-recommended retrofits into account. It is unlikely that these simplified cases will meet the upcoming UL standards for E85 dispensers. Subsequent interviews with E85 project coordinators agreed with the higher rate of equipment changeout.

Table 7. Generalized Cost Projections for E85 Equipment

Scenario	Cost	Source	Description	Major Variables Affecting Cost
New tank, new or retrofit dispenser(s)	$50K-$200K	NACS	Includes new underground storage tank (UST), pump, dispenser(s), piping, electric, excavation, and concrete work	Dispenser needs, concrete work, excavation, sell-backs, canopy, tank size, location, labor cost, permitting requirements
	$50K-$70K	DOT, EPA, DOE		
	>$50K	NEVC		
	<$62,407	DAI		
Convert existing tank, new or retrofit dispenser(s)	$19K-$30K	DAI	Tank cleaning, replace non-compatible components in piping and dispensers	Dispenser needs, # of non-compatible components, location, labor cost, permitting requirements
	$5K-$30K	DOT, EPA, DOE		
	$2.5-25K	NEVC		

NREL is currently conducting a survey of E85 equipment costs and will publish findings in an upcoming report. Preliminary findings support the default costs used in this business case.

Appendix D: Reasons Wholesale E85 Prices Must Be Ascertained from Local Blender/Dealer

- Spot market prices of ethanol are not reliable. They represent only the most volatile 5% to 15% of sales. (RFA 2006)
- Even contract-based prices such as the OPIS ethanol fixed/contract price is not a reliable representation because the prices from different ethanol plants vary greatly.
- Contract prices with a single ethanol producer can vary greatly according to timing. The blender/dealer will already have contracts set up and therefore be able to quote the most reliable price.
- E85 prices cannot simply be calculated as 85% retail ethanol and 15% retail gasoline. This composition is adjusted depending on the time of year.
- Transportation costs vary greatly according to distance from production plant and distance from terminal. The dealer has the information to take these costs into account.

Appendix E: E85's Reduced Fuel Economy

One gallon of E85 contains 23% to 28% less energy than a gallon of gasoline,[8] which reduces the fuel economy of E85-powered vehicles. This reduction in energy content is often overstated for two reasons:

- Most estimates do not take the seasonal changes of E85 into account. ASTM D5798 mandates that the ethanol content of E85 is reduced to 70% in the winter to ensure proper starting and performance. This higher content of gasoline means that the energy content, and therefore the fuel economy, will be higher than if calculated as 85% ethanol.
- Most estimates do not take the hydrocarbon (usually gasoline) used as denaturant into account when calculating energy content. Ethanol must be denatured by 2% to 5% hydrocarbon (required by ASTM D4806).

In addition to overstating the energy content reduction of E85, the impacts on fuel economy are commonly overstated. This is because vehicles that burn E85 have slightly better efficiency in terms of miles per energy unit (NREL 1998). Anecdotal evidence shows this improvement to vary depending on a variety of conditions including altitude and age of car (Mills and Gentry 2007). Furthermore, E85 vehicles have the potential to trade off their superior acceleration for a greater fuel economy (on an MPGE basis) over gasoline vehicles. One engine that was optimized to E85 properties yielded up to 24% (MPGE) fuel economy improvements over baseline gasoline engines (Gardiner et al. 1999). If such engine optimization were widespread in the future, the overall energy penalty would be smaller.

[8] Calculated using lower heating values from the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model (GREET 2006).

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13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 Words)*
The National Renewable Energy Laboratory (NREL) developed a model to test the influence on investment profitability on adding E85 to retail stations. When investigating equipment scenarios, the model found that E85 projects meet investment goals most easily when the gas station can convert its mid-grade gasoline tank to hold E85. The next most profitable scenario is adding a new tank, followed by converting the premium tank to hold E85.

15. SUBJECT TERMS
E85; ethanol; alternative fueling infrastructure; business case; flexible fuel vehicles; National Renewable Energy Laboratory; profitability; influence on investment

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
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