FuelCost 1.0

A Tool for Evaluating the Costs of
Fuel Options for Transit Buses

User's Guide

ARCADIS Geraghty & Miller, Inc.

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FILES ON ACCOMPANYING DISKETTE

FILE NAME	DESCRIPTION
fc10.xls	FuelCost 1.0 in Microsoft Excel 5.0 Format
10buses.xls*	10-Bus Example in Microsoft Excel 5.0 Format
50buses.xls*	50-Bus Example in Microsoft Excel 5.0 Format
200buses.xls*	200-Bus Example in Microsoft Excel 5.0 Format
Usrguide.doc	FuelCost 1.0 User's Guide in Microsoft Word 6.0 Format

* Hard copy of these examples are also included in this User's Guide

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User's Guide

Contents

1 INTRODUCTION

1.1 What Is FuelCost 1.0?

FuelCost 1.0 is a Microsoft Excel 5.0 workbook file designed to help transit managers and other decision makers analyze the cost implications of various fuel options for full-sized transit buses. FuelCost 1.0 was developed by ARCADIS Geraghty & Miller, Inc. (formerly Acurex Environmental Corporation) under Transit Cooperative Research Program Project C-8, "A Framework for Evaluating Fuel Options for Transit Buses." Primary contributors were Daniel R. Luscher, Richard L. Remillard, and Elizabeth A. Devino.

FuelCost 1.0 uses data provided by the user (with default values if the user does not have fleet-specific data) and some pre-defined data to perform a lifecycle cost analysis of alternative fuels, as well as a cash-flow analysis that compares costs for different fuel options during each calendar year. This allows the user to see not only how fuel options compare over the long term, but also how they may affect the year-to-year operating cash flow for a transit agency. FuelCost 1.0 reflects uncertainty in calculating costs by including median, low, and high cost cases. FuelCost 1.0 can be used to analyze a single procurement, or a wholesale changeover to an alternative fuel over several years.

FuelCost 1.0 is intended to assist transit agencies with scoping-level planning. Any transit agency seriously considering a major purchase of alternative fuels should perform a detailed, site-specific analysis of fuel options before making a final decision.

1.2 About This User's Guide

This User's Guide will help you get the most out of the FuelCost 1.0 model. This first section provides basic information on the model.

Section 2 QUICK START gives you the information you need to start using FuelCost 1.0 immediately, with a minimum of reading.

Section 3 DETAILED USER INFORMATION provides more in-depth guidance in using FuelCost 1.0. It walks the user through each module of the model, explaining exactly where the user can input site-specific information, how FuelCost 1.0 calculates costs, and how to interpret results using both numbers and charts.

Section 4 EXAMPLE SCENARIOS illustrates the use of FuelCost 1.0 by presenting the results of three simple scenarios.

Section 5 LIST OF DEFAULT VALUES, PRE-DEFINED DATA, AND FORMULAS lists the specific information used by FuelCost 1.0.

Section 6 REFERENCES AND SOURCES lists sources of additional information on costs associated with alternative fuels for transit buses.

1.3 How Is FuelCost 1.0 Organized?

The heart of FuelCost 1.0 is a set of modules covering different cost and data elements. The six modules include:

- General Inputs
- Bus Data
- Fuel Price
- Facility Capital Costs
- Costs
- Yearly Cost Summary (Cash-Flow Analysis)

Each of these modules is represented by an individual spreadsheet within the Excel workbook (except for the Costs module, which consists of three spreadsheets representing median, low, and high cases). Additional spreadsheets display charts that visually present the results of the life-cycle cost analysis and the cash-flow analysis.

FuelCost 1.0 includes the following fuels: diesel, compressed natural gas (CNG), liquefied natural gas (LNG), methanol, ethanol, and liquefied petroleum gas (LPG).

1.4 How Do I Start Using FuelCost 1.0?

FuelCost 1.0 was designed for use on an IBM PC-compatible computer with Microsoft Excel 5.0 (for Windows 3.1 or newer) and a color monitor. However, it can also be used on an Apple Macintosh-compatible computer, also using Excel 5.0.

FuelCost 1.0 requires only that the user knows basic computer and spreadsheet skills, such as entering data into a spreadsheet cell, scrolling through spreadsheets, and switching between sheets within a workbook.

Before using your copy of FuelCost 1.0, it is important that you make a copy of the original workbook file (filename FC10.XLS) and keep it separate from the file you actually work with. This will allow you to keep a file with the original default values provided in FuelCost 1.0 (if you forget to do this, you can always manually reenter the default values, which are listed in Section 5).

1.5 Additional Sources of Information

In addition to FuelCost 1.0, various resources are available to help transit managers evaluate fuel options. The guidebook that accompanies FuelCost 1.0, entitled *Guidebook for Evaluating, Selecting, and Implementing Fuel Choices for Transit Bus Operations*, prepared by ARCADIS Geraghty & Miller under Transit Cooperative Research Program Project C-8, is intended to serve as an information reference for transit managers. It provides important basic information on transit bus fuel options, and discusses the ramifications of using various alternative fuels, including technical, safety, and cost issues. The references and sources listed in Section 6 of this User's Guide provide additional detail on various aspects of alternative fuels. In addition, various consulting firms have special expertise in evaluating alternative fuel options for individual transit agencies.

2 QUICK START

The basic operation of the FuelCost 1.0 model is quite simple. The model is pre-loaded with default values for all parameters used to calculate the costs of various fuel options. To perform a cost analysis, the user simply looks at the first five spreadsheets (i.e., those spreadsheets with the five left-most sheet tabs), which are entitled General Inputs, Bus Data, Fuel Price, Facilities, and Costs—Median. Within these five spreadsheets, the user performs two steps:

a. Look at each of the cells with blue text. These cells allow user input, and initially contain default values. The user should replace any of these values with values that are appropriate for the particular transit fleet.

b. Look at each of the cells with gray background. These cells are initially blank. The user can either leave these cells blank or enter a value appropriate for the particular transit fleet.

The following input parameters are the most likely ones the user will want to change in doing a cost analysis:

- In the General Inputs module (spreadsheet): scenario name, current year, sales tax rate, and alternative fuel to use for cash-flow analysis.

- In the Bus Data module (spreadsheet): bus procurement schedule.

Having completed steps a and b, the user can review the results of the cost analysis that the FuelCost 1.0 model has performed based on the input values. These results can be found in the following places:

- Summary spreadsheets, entitled Costs—Median, Costs—Low, Costs—High, and Cash Flow

- Cost charts, which comprise the next six spreadsheets in the workbook, entitled Ann. Cost Chart, Ann. Cost Breakdown Chart, Ann. Cost Chart—Local Share, Fuel Cost Chart, Cash Flow Chart, and Cash Flow Chart—Local Share

The user can print out any of the spreadsheets or the entire workbook to have a paper copy of the cost analysis.

The user can also save the spreadsheet with a special file name in order to save the user-defined inputs.

3 DETAILED USER INFORMATION

This section walks the user through the FuelCost 1.0 model, providing indepth guidance on the following topics:

1. How and where to input site-specific cost information and other data

2. How the FuelCost 1.0 model calculates fuel-related costs

3. How to view and interpret the results of the analysis

The FuelCost 1.0 workbook file consists of 15 spreadsheets, whose titles are indicated on sheet tabs at the bottom of the screen. The first eight spreadsheets (i.e., those with the left-most sheet tabs) contain the six modules that contain inputs and calculations for the life-cycle cost analysis and cash-flow analysis. The six modules are titled General Inputs, Bus Data, Fuel Price, Facility Capital Costs, Costs, and Yearly Cost Summary (Cash-Flow Analysis).

The cells in these modules can be divided into three categories for the purposes of user input. To allow the user to instantly identify the three types of cells, cells corresponding to each of these three categories have a different appearance in FuelCost 1.0:

1. Cells not allowing user input. Most cells in the FuelCost 1.0 modules contain either unchangeable input values (for example, fuel energy content) or formulas. These cells appear as **black print on a white background.** In addition, these cells are locked so that the user cannot change the cell value or formula.

2. Cells with a default value that allow a user-specified value. Those cells that contain a default value which can be changed by the user (such as diesel fuel price) appear on color monitors in **blue print on a white background.**

3. Cells allowing a user-specified value as an alternative to a fixed formula. Some values (such as alternative-fuel bus cost) are calculated by FuelCost 1.0 using formulas. In order to allow the user to input a fleet-specific value for certain of these parameters without erasing the formula, FuelCost 1.0 includes a separate cell (usually below the cell containing the formula) in which the user can enter a specific value if desired. These cells will appear with a **gray background.**

FuelCost 1.0 calculates all costs in 1997 U.S. dollars.

Sections 3.1 through 3.6 describe the use of the six modules. Section 3.7 describes the six charts that help the user interpret the results. Sample printouts of FuelCost 1.0 modules can be found in the Appendix.

3.1 General Inputs Module

The General Inputs module allows the user to specify certain basic data used throughout the analysis, as discussed below. Many of the default values provided in FuelCost 1.0 should be sufficient for many transit agencies. But the user is free to change any or all of the default values to reflect fleet-specific parameters or requirements.

Scenario name

The user can enter a scenario name in this cell (cell C4). The scenario name will appear at the top of each spreadsheet in the FuelCost 1.0 model, underneath the name of the module or chart. If the user chooses to run several analyses with different sets of assumptions, this scenario name allows the user to distinguish between the different runs. This cell can be left blank if the user wishes.

Current year

In this cell (C6), the user can enter the current year, or the first year for which the cost analysis is to be done. This value determines the range of years displayed in the Bus Data module and used in the cash-flow analysis. Regardless of the year specified in this cell, FuelCost 1.0 is designed to calculate costs in 1997 U.S. dollars.

Sales tax rate

In this cell (C8), the user should enter the local sales tax rate applicable to the transit agency. This rate is used in other modules to calculate the sales tax on fuel and bus purchase costs.

Amortization parameters

These two parameters are used in the life-cycle cost analysis to convert capital costs for buses and facilities into annualized costs. For the discount rate (cell C11), the user can enter an appropriate discount rate for the transit agency. The user can opt for the default value of 8%, or enter a value based on the transit agency's cost of money or some other criterion.

For the facility life (cell C12), the user can enter an appropriate lifespan for new fueling facilities and modified maintenance facilities. Note that this number should reflect the full physical life of the facility only if the transit agency

expects the facility to be used for that full life. If, for example, the user expects that the transit agency's alternative-fuel vehicle program will last for 12 years, then 12 years should be entered in this cell because this reflects the expected useful life for the new or modified alternative-fuel facilities. The default value of 20 years should be used if no site-specific information is known.

FuelCost 1.0 uses a bus life of 12 years, an assumption that cannot be changed by the user.

Annual miles per bus

This cell (C14) contains the average annual miles per bus in the fleet. The user should enter actual historical or expected annual miles per bus if known. The default of 41,667 miles is based on Federal Transit Administration (FTA) guidelines (500,000 total miles for a bus in a 12-year lifetime). FuelCost 1.0 uses annual bus miles in calculating annual operating costs, and in calculating required fueling facility fuel throughput.

Required vehicle range

This cell (C15) specifies the vehicle range between refueling required by the transit agency. This value only affects the purchase cost of CNG buses (since on-board fuel storage is relatively expensive for CNG buses). The default value is 400 miles, but the user can input 300 miles if the transit agency can tolerate lower range for CNG buses (in exchange for reduced capital costs for the buses).

Are buses parked indoors?

This cell (C18) indicates whether the buses are parked indoors or outdoors. This input determines whether FuelCost 1.0 adds costs for modifying bus parking facilities for alternative fuels. FuelCost 1.0 interprets anything other than "N" as a "yes" response.

Federal cost sharing of capital costs

These cells (C21 for the federal share of capital costs for diesel fleets, and C22 for alternative-fuel-related capital costs) can be used to specify federal cost sharing percentages for capital costs. These inputs are used to calculate the local share of capital costs. The default values are based on current FTA policy as of this writing.

Electricity costs (for CNG compressor station)

These cells (C25 and C26) are used to calculate the costs of compressing natural gas. The user should enter appropriate local costs for the unit electricity price and the demand charge. If CNG is not one of the options the transit agency is considering, the user can ignore these inputs.

Alternative fuel to use for cash-flow analysis

While the life-cycle cost analysis performed by FuelCost 1.0 includes six fuels, the cash-flow analysis only includes two fuels: diesel and one alternative fuel. In this cell (C28), the user can define which alternative fuel is to be included in the cash-flow analysis.

3.2 Bus Data Module

In the Bus Data module, the user inputs the number of buses in the current fleet, by year purchased, under the "Current bus fleet" heading (in cells B9 through B20). FuelCost 1.0 automatically calculates the total number of buses (shown in cell B22). Based on these data, the Bus Data module projects future bus replacement requirements (in cells E9 through E20, under "Bus procurement schedule: default"), assuming a standard 12-year bus life. Note that the first year of this procurement schedule corresponds to the year entered in the "Current year" field in the General Inputs module.

If the user wishes to enter a procurement schedule different from the default schedule calculated by FuelCost 1.0, the user can enter it in the gray cells underneath "Procurement schedule: user-specific" (cells F9 through F20). Later modules in FuelCost 1.0 will use the default bus procurement schedule if these cells are left blank, and will use the user-specified schedule if any of these cells are filled in.

The user has flexibility here in determining the scope of the cost analysis. For example, if the user only wants to consider replacing some of the fleet's buses with alternative-fuel buses, the user can only input the bus data for that portion of the fleet.

3.3 Fuel Price Module

The Fuel Price module calculates fuel prices for different fuel options based on user input and default values. Because the vast majority of transit fleets are exempt from most excise taxes, these excise taxes are not considered in calculating fuel price. Sales tax is added to all fuels except CNG, which is currently exempt from sales tax. The primary output of the Fuel Price module is fuel price per sales unit (therm for CNG, gallon for other fuels) for median, low, and high cases. The module also displays fuel prices per million Btu and per diesel-equivalent gallon, so that the user can see how fuel prices compare on an energy-equivalent basis.

In this module, the user can enter values for diesel fuel economy, unit fuel prices (for diesel, CNG, LNG, methanol, ethanol, and LPG), and delivery cost.

Diesel fuel economy

FuelCost 1.0 includes a default value for diesel fuel economy of 4.0 miles per gallon, which is typical for modern diesel transit buses. The user can enter a fleet-specific value (in cell B8) if the user's bus fleet experiences tougher or easier duty cycles than typical transit buses. Note that this value should reflect the fuel economy of new buses using modern four-stroke diesel engines, which may be higher than the fuel economy of a transit agency's existing fleet of buses.

The FuelCost 1.0 model uses this value to calculate the predicted fuel economy of alternative-fuel buses (in cells C8 through G8), accounting for differences in fuel energy content and energy efficiency.

Unit fuel prices

FuelCost 1.0 includes default unit fuel prices for each fuel (in $/therm for CNG, and $/gallon for other fuels). The user should enter a diesel fuel price (in cell B11) that reflects the actual diesel fuel price for the fleet under consideration (or expected future diesel fuel price). If the user knows what unit prices the transit agency would pay for particular alternative fuels of interest, the user should enter these prices (in cells C11 through G11). To reflect fuel price uncertainty, FuelCost 1.0 calculates low and high unit prices for the alternative fuels based on the median prices.

Delivery costs

If the user enters unit fuel prices that do not include delivery charges, the user should enter the estimated delivery cost for each fuel under consideration (in cells B12 through G12). The default unit fuel prices are delivered fuel prices, and therefore the default delivery cost for each fuel is $0.00.

3.4 Facility Capital Costs Module

This FuelCost 1.0 module calculates fueling facility and maintenance facility costs based on formulas relating fuel usage and fleet size to cost. (Note that the spreadsheet title on the sheet tab is abbreviated as "Facilities.") Alternatively, the user can input specific estimates of facility costs. To reflect uncertainty in facility costs, this module estimates low and high facility costs based on these median values and calculates total facility costs for the median, low, and high cases (in cells C18 through H18, C23 through H23, and C28 through H28, respectively).

The user can also input natural gas supply pressure for the CNG case.

For illustrative purposes, this module also displays daily fuel requirements (in cells C5 through H5), which FuelCost 1.0 calculates based on input from previous modules, specifically the number of buses, bus miles, and fuel economy. Also, the module displays the required fueling facility tank capacity (in cell C7 and cells E7 through H7) for the liquid alternative fuels and CNG fueling facility compressor capacity (in cell D8), which FuelCost 1.0 estimates based on the daily fuel throughput. The estimated fueling facility storage capacity is derived by estimating that fleets need usable storage capacity equivalent to nine days of fuel throughput for methanol, ethanol, and LPG, and four days of fuel throughput for LNG. FuelCost 1.0 estimates the required compressor capacity for a CNG fueling facility based on the required daily throughput and assuming an 8-hour window for refueling the buses.

Natural gas supply pressure

The supply pressure of natural gas affects the amount of energy required to compress the gas for on-board storage on a CNG bus. As the supply pressure increases, less compression energy is needed to fill a bus with CNG. FuelCost 1.0 calculates compression energy (and cost) using the Ideal Gas Law, with a default supply pressure of 65 psia. If CNG is one of the fuels of interest to the user, the user can input (in cell D9) the pressure that natural gas would be supplied to a CNG fueling facility from the utility gas line. This can usually be obtained from the gas utility company that supplies natural gas to the transit yard.

Fueling facility capital cost

FuelCost 1.0 calculates a default estimate for fueling facility cost for each of the alternative fuels (in cells D12 through H12), based on actual costs experienced for existing facilities.[1] This cost calculation is based on the amount of fuel required per day. However, if the user has site-specific cost estimates for any alternative fuels of interest, the user can enter these estimates in the gray cells below the default estimates (cells D13 through H13). In addition, if any new or modified diesel fueling facilities would be needed if the transit agency purchases diesel buses, an estimate of these costs can be entered (in cell C13).

Based on these estimates, which are considered median estimates, FuelCost 1.0 calculates low and high estimates of fueling facility costs (in cells C21 through H21 and C26 through H26, respectively). If the user accepts the default cost estimates (i.e., does not enter user-specified values), the model estimates the low and high costs using a range of plus or minus 40 percent for CNG and LNG (to reflect the large variations in actual constructed costs for

[1] The CNG fueling facility cost formula is based on ARCADIS Geraghty & Miller analysis of costs experienced at Pierce Transit, Los Angeles County MTA, Sacramento RT, Toronto Transit Commission, and Cleveland, as well as National Renewable Energy Laboratory (NREL) and Southern California Gas Company estimates. LNG costs are derived from experience at Houston Metro, Sun Metro, and Los Angeles International Airport, as well as previous analysis by ARCADIS Geraghty & Miller and NREL.

existing CNG and LNG fueling facilities), and plus or minus 20 percent for methanol, ethanol, and LPG. Where the user specifies the median cost estimate, the model estimates the low and high costs using a range of plus or minus 10 percent. This smaller range reflects potential differences between bid prices and actual constructed costs.

Maintenance facility capital cost

FuelCost 1.0 calculates a default estimate for the cost of maintenance garage modifications for each of the alternative fuels (in cells D16 through H16), based on actual costs for existing facilities for fleets of various sizes.[2] However, if any site-specific cost estimates are available, the user can enter these in the gray cells below the default estimates (cells D17 through H17), and costs for any maintenance garage modifications that would have to be done anyway even if new diesel buses are purchased can also be entered (in cell C17).

These estimates are considered median estimates, and FuelCost 1.0 calculates low and high estimates of maintenance garage modification costs (in cells C22 through H22 and C27 through H27, respectively) in a manner similar to the low and high fueling facility cost estimates.

3.5 Costs Module

The Costs module consists of 3 spreadsheets, titled "Costs—Median," "Costs—Low," and Costs—High." In the "Costs—Median" spreadsheet, the user can enter information on bus purchase prices, and FuelCost 1.0 calculates the total bus purchase costs, and incorporates data from other modules to summarize facility capital costs, fleet operating costs, and annualized life-cycle costs for various alternative fuel options. The Costs module also estimates the emissions impact of alternative fuel options. The following sections explain the various parts of the "Costs—Median" spreadsheet, followed by a description of the "Costs—Low" and "Costs—High" spreadsheets.

"Costs—Median" spreadsheet: Capital costs

FuelCost 1.0 provides a default value for the purchase cost of a baseline diesel bus, which is based on prices for well configured buses in recent transit bus procurements. The user can enter a fleet-specific value if desired (in cell D9 of the "Costs—Median" spreadsheet). Based on this value, FuelCost 1.0 calculates default estimates of alternative-fuel bus costs (in cells E9 through I9) by adding an

[2] The CNG and LNG maintenance facility modification cost formula is based on experience at Pierce Transit, Sacramento RT, and Maryland MTA, as well as previous analysis by ARCADIS Geraghty & Miller and Booz•Allen & Hamilton.

incremental cost for each alternative fuel (based on recent purchase prices of alternative-fuel buses) to the diesel bus cost.[3]

If the user has price quotes from vendors of alternative-fuel buses, the user can enter these in the gray cells below the default estimates (cells E10 through I10).

Using the bus cost input, this part of the Costs module calculates total bus purchase cost, including sales tax, for the fleet, and incorporates the median facility cost estimates from the Facility Capital Costs module to calculate total capital costs.

"Costs—Median" spreadsheet: Operating costs

Using input from previous modules, this part of the Costs module calculates fleet operating costs that relate to fuel options. The user need not enter anything in this section. However, FuelCost 1.0 provides default maintenance costs per bus-mile (in cells D24 through I24), and the user can enter a fleet-specific value if desired (in cells D25 through I25). In addition, the user can enter any other annual operating costs (in cells D29 through I29).

Note that operating costs that are unaffected by fuel choice, such as bus operator labor costs, are not included. FuelCost 1.0 calculates fuel cost per mile and per year (in cells D21 through I22) based on information from the Fuel Price, General Inputs, and Bus Data modules. The model then adds maintenance costs (in cells D24 through I26), fueling facility compression electricity cost (in cell E27) for CNG, fueling facility maintenance cost (in cells D28 through I28), and any "other" maintenance costs entered by the user (in cells D29 through I29) to derive total operating costs for each fuel option (in cells D31 through I31).

The default maintenance costs are based on existing experience with transit buses operating on various fuels. The fueling facility compression electricity cost represents the cost of electricity needed to power the compressors at the CNG fueling facility. This cost is derived from a formula that relates CNG fuel usage and gas input pressure to electricity use, and uses the electricity costs specified in the General Inputs module. The fueling facility maintenance cost represents typical costs for maintenance, inspection, and permitting of fueling facilities, and is related to facility size.

[3] The default incremental costs for CNG, LNG, and LPG buses are based on recent procurements and price quotes from several bus manufacturers. No methanol or ethanol engines are currently available for transit applications, so the incremental costs for these buses are based on older procurements when methanol buses were commercially available.

"Costs—Median" spreadsheet: Annualized costs

This part of the Costs module calculates the annualized life-cycle cost of the various fuel options (in cells D37 through I37) based on the capital and operating costs, combined with the amortization parameters (discount rate and facility life) defined in the General Inputs module, and a bus lifespan of 12 years. FuelCost 1.0 also calculates the local share of the annualized cost (in cells D43 through I43) using the federal cost sharing percentages specified in the General Inputs module.

"Costs—Median" spreadsheet: Emissions calculations

This part of the Costs module calculates the fleet emissions of oxides of nitrogen (NO_x) and particulate matter (PM) based on current certified emissions levels. FuelCost 1.0 derives the emissions reductions in tons per year for each alternative fuel options (in cells E50 through I50, for NO_x, and cells E56 through I56, for PM). These are provided for illustrative purposes, and are only meant to be a rough estimate of emissions impacts.

"Costs—Low" and "Costs—High" spreadsheets

To reflect uncertainty, FuelCost 1.0 calculates low and high cost estimates in addition to the median cost estimates discussed above. The user does not enter any values in either of these spreadsheets.

The low and high cases incorporate uncertainty in three of the major cost items related to fuel choice: bus cost, fuel price, and facility costs. If the user accepts the default estimates of incremental cost for alternative-fuel buses, the low and high estimates for bus cost reflect existing variability in bus purchase costs. If the user enters a fleet-specific bus cost for a given alternative fuel, FuelCost 1.0 eliminates bus cost variability, and uses the same user-specified bus cost for the median, low, and high cases.

Variability in fuel price and facility costs is discussed above in Sections 3.3 (Fuel Price module) and 3.4 (Facility Capital Costs module).

The "Costs—Low" and "Costs—High" spreadsheets are organized identically to the "Costs—Median" spreadsheet, except that the variances of the low and high cases compared to the median case are shown (in cells E38 through I38 for total annualized cost, and E45 through I45 for local share of annualized costs).

3.6 Yearly Cost Summary (Cash-Flow Analysis) Module

This FuelCost 1.0 module allocates capital and operating costs to specific calendar years over a 12-year period for the baseline diesel case and for one alternative fuel specified in the General Inputs module. (Note that the spreadsheet title on the sheet tab is abbreviated as "Cash Flow.") This module uses the bus purchase schedule specified in the Bus Data module, combined with the capital and operating costs summarized in the Costs module, to pinpoint the years in which capital and operating costs are incurred. The Yearly Cost Summary (Cash Flow) module requires no user input beyond that provided for the five life-cycle cost analysis modules discussed in Sections 3.1 through 3.5. By identifying costs in each year, rather than annualizing the costs, this module allows for a cash flow comparison of fuel options.

Diesel costs are totaled by year (in cells C11 through N12), as are median, low, and high costs for the selected alternative fuel (in cells C20 through N21, C28 through N29, C36 through N37, respectively). The cost differences in each year are also presented (in cells C40 through N45).

3.7 Charts

In addition to the above six modules, six spreadsheets contain charts that display the results of the life-cycle cost analysis and the cash-flow analysis. These charts, which FuelCost 1.0 generates automatically based on information from the six modules, allow the user to interpret the results simply and visually. If necessary for clear viewing, the user can change the display size of each chart using the "zoom control" box on the Standard toolbar in Excel, or by using the Zoom command under the View menu.

Each chart is discussed below.

Annualized Cost Chart

The Annualized Cost Chart spreadsheet shows total annualized costs for the fuel options. The solid bars represent the median costs calculated in the Costs module, and the error bars for each alternative fuel correspond to the low and high costs from the Costs module. Thus, the magnitude of the error bars give a sense of the level of uncertainty associated with each alternative fuel.

Annualized Cost Breakdown Chart

The Annualized Cost Breakdown Chart spreadsheet shows the total annualized cost for the median case broken down into vehicle capital costs, facility capital costs, and operating costs. These costs are taken from the Costs module. This chart does not include error bars reflecting low and high cases.

Annualized Cost Chart—Local Share

The Annualized Cost Chart—Local Share spreadsheet displays the local share of total annualized costs for the fuel options, calculated in the Costs module. Error bars are included to represent the low and high cost cases.

Fuel Cost Chart

The Fuel Cost Chart spreadsheet shows the fuel cost (in $ per million Btu) for each fuel option. The solid bars represent the median fuel costs calculated in the Fuel Price module, and the error bars for each alternative fuel correspond to the low and high fuel cost cases.

Cash Flow Chart

The Cash Flow Chart spreadsheet shows the difference in each calendar year between the cost of operating on diesel fuel and the cost of operating on the alternative fuel specified for use in the cash flow analysis in the General Inputs module. A positive value for a given year indicates that the alternative fuel would cost more in that year than diesel fuel operation would cost. Cost "spikes" represent years in which capital costs for vehicles and/or facilities are incurred.

The solid bars represent the difference between the median alternativefuel case and the baseline diesel case, calculated in the Yearly Cost Summary (Cash-Flow Analysis) module. The error bars represent the high alternative-fuel case compared to diesel, and the low alternative-fuel case compared to diesel.

Cash Flow Chart—Local Share

The Cash Flow Chart—Local Share spreadsheet illustrates the local share of the incremental cost of one alternative fuel (specified in the General Inputs module) compared to the diesel baseline, in each calendar year. Error bars correspond to the low and high alternative-fuel cases compared to the diesel baseline.

4 EXAMPLE SCENARIOS

To illustrate the use of FuelCost 1.0, this section presents simple runs of FuelCost 1.0 using three hypothetical transit bus fleets. These scenarios feature one small (10 buses), one medium (50 buses), and one large (200 buses) bus fleet, and the FuelCost 1.0 default values and formulas are used. Printouts of these three scenarios are in Appendix A. Key results are discussed below.

Small bus fleet scenario

This example scenario, titled "10-bus example case" in the printouts in Appendix A, is the default scenario in FuelCost 1.0. The bus procurement schedule for this fleet consists of 10 buses purchased in 1998. The Fuel Price module for this scenario indicates that CNG fuel costs are lower on a BTU-equivalent basis than diesel fuel. LNG is approximately the same cost, and LPG, methanol, and ethanol are all more expensive than diesel fuel.

The Facility Capital Costs Module indicates that CNG and LNG have median facility costs on the order of $400,000, and methanol, ethanol, and LPG entail facility costs of between $200,000 and $250,000.

The Costs Module calculates that CNG would require $754,250 more in bus replacement costs than diesel fuel (10 buses × $70,000/bus, plus sales tax), with the other alternative fuels requiring between $323,000 and $593,000 in incremental bus purchase costs.

The charts accompanying this scenario indicate higher costs for all alternative fuel options, with each alternative fuel except for ethanol entailing annualized costs of roughly $800,000. The baseline diesel annualized cost is approximately $620,000.

For more detailed results, refer to Appendix A.

Medium bus fleet scenario

This example scenario is titled "50-bus example case" in the printouts in Appendix A. The inputs to this scenario are identical to the 10-bus case except that the bus procurement schedule consists of 25 buses purchased in 1998 and 25 purchased in 2002.

Fuel prices are the same as in the 10-bus case. The Facility Capital Costs Module shows that CNG and LNG have median facility costs of approximately $800,000, and methanol, ethanol, and LPG entail facility costs significantly lower than that.

The Costs Module calculates that CNG would require $3,771,250 more in bus replacement costs than diesel fuel (50 buses × $70,000/bus, plus sales tax).

The charts accompanying the medium bus fleet scenario indicate higher costs for all alternative fuel options, with the alternative fuels having anywhere from $665,000 to $1,135,000 higher annualized costs than the diesel baseline. Facilities costs are a very small portion of total annualized costs, even for CNG and LNG. The primary source for the additional costs associated with the alternative fuels is vehicle procurement cost for CNG and LNG, and operating cost (primarily fuel cost) for methanol and ethanol.

For more detailed results, refer to Appendix A.

Large bus fleet scenario

The large bus fleet scenario is titled "200-bus example case" in the printouts in Appendix A. The procurement schedule for this scenario consists of 50 buses in 1998, 100 buses in 2002, and 50 buses in 2005.

The Facility Capital Costs Module shows that CNG and LNG have median facility costs of between $2.3 million and $2.4 million, with methanol and ethanol having facility costs of $782,000, and LPG $1,046,000.

The charts accompanying the large bus fleet scenario indicate higher costs for all alternative fuel options, with the alternative fuels having anywhere from $2.5 million to $4.5 million higher annualized costs than the diesel baseline.

For more detailed results, refer to Appendix A.

5 LIST OF DEFAULT VALUES, PRE-DEFINED DATA, AND FORMULAS

If the user replaces some default values with fleet-specific data, and then wishes to revert back to the default values, the user can either make another copy of the original FuelCost 1.0 workbook file and perform a new cost analysis, or the user can refer to the list of default values in this section and enter them into the appropriate cells. This section also contains the pre-defined (unchangeable) data in FuelCost 1.0. In addition, for users interested in the "inner workings" of FuelCost 1.0, the formulas used in FuelCost 1.0 are shown below as well.

General Inputs Module		
Scenario name	Default	10-bus example case
Current year	Default	1998
Sales tax rate	Default	7.75%
Discount rate	Default	8.00%
Fueling facility and maintenance facility life	Default	20 years
Annual miles per bus	Default	41,667
Required vehicle range	Default	400 miles
Are buses parked indoors?	Default	N
Federal share of diesel-related capital costs	Default	80%
Federal share of alternative-fuel-related capital costs	Default	90%
Unit electricity price	Default	$0.08/kWh
Demand charge	Default	$10.00/kW per month
Alternative fuel to use for cash-flow analysis	Default	1 (CNG)
Bus Data Module		
Current bus fleet	Default	10 buses 1986 and older
Fuel Price Module		
Energy content of diesel	Pre-defined	128,700 Btu/gal (LHV)
Energy content of CNG	Pre-defined	93,000 Btu/therm (LHV)
Energy content of LNG	Pre-defined	76,350 Btu/gal (LHV)
Energy content of methanol	Pre-defined	57,000 Btu/gal (LHV)
Energy content of ethanol	Pre-defined	76,400 Btu/gal (LHV)
Energy content of LPG	Pre-defined	83,500 Btu/gal (LHV)
Efficiency penalty for CNG	Pre-defined	-35%
Efficiency penalty for LNG	Pre-defined	-30%
Efficiency penalty for methanol	Pre-defined	-15%
Efficiency penalty for ethanol	Pre-defined	-15%

Efficiency penalty for LPG	Pre-defined	-35%
Fuel economy for diesel	Default	4.0 mpg
Fuel economy for alternative fuels	Formula	(Alt. fuel energy content / diesel energy content) × (diesel fuel economy / (1 - alt. fuel efficiency penalty))
Unit diesel price—median	Default	$0.80/gal
Unit CNG price—median	Default	$0.326/therm
Unit LNG price—median	Default	$0.45/gal
Unit methanol price—median	Default	$0.55/gal
Unit ethanol price—median	Default	$1.00/gal
Unit LPG price—median	Default	$0.60/gal
Delivery cost	Default	$0/gal (default fuel prices are delivered prices)
EPA Superfund excise tax	Pre-defined	$0.0023/gal for diesel $0/gal for alternative fuels
Unit CNG price—low	Default	Median CNG price - $0.05/therm
Unit LNG price—low	Default	Median LNG price - $0.05/gal
Unit methanol price—low	Default	Median methanol price - $0.10/gal
Unit ethanol price—low	Default	Median ethanol price - $0.10/gal
Unit LPG price—low	Default	Median LPG price - $0.10/gal
Unit CNG price—high	Default	Median CNG price + $0.08/therm
Unit LNG price—high	Default	Median LNG price + $0.15/gal
Unit methanol price—high	Default	Median methanol price + $0.15/gal
Unit ethanol price—high	Default	Median ethanol price + $0.10/gal
Unit LPG price—high	Default	Median LPG price + $0.10/gal
Facility Capital Costs Module		
Fuel required per weekday	Formula	(No. buses × annual miles per bus)/ (fuel economy × 312 days/yr)
Fueling facility tank capacity		
LNG	Formula	(Fuel required per weekday × 4) + 2,000 (rounded to nearest 1,000)
Methanol, ethanol, LPG	Formula	(Fuel required per weekday × 9) + 2,000 (rounded to nearest 1,000)
CNG fueling facility compressor capacity (cfm)	Formula	Fuel required per weekday / 4.8 (rounded to nearest 100)
Natural gas supply pressure	Default	65 psia
Fueling facility capital cost—median		
CNG	Formula	$200,000 + ($120 × Fuel required per weekday) (rounded to nearest 1,000)
LNG	Formula	$156,600 + ($113.20 × Fuel required per weekday) (rounded to nearest 1,000)
Methanol, ethanol	Formula	$57,600 + ($22 × Fuel required per weekday) (rounded to nearest 1,000)
LPG	Formula	$92,000 + ($44 × Fuel required per weekday) (rounded to nearest 1,000)

Maintenance facility capital cost—median		
CNG, LNG (outdoor parking)	Formula	$200,000 + ($1,500 × No. buses) (rounded to nearest 1,000)
CNG, LNG (indoor parking)	Formula	$200,000 + ($5,500 × No. buses) (rounded to nearest 1,000)
Methanol, ethanol, LPG (outdoor parking)	Formula	$115,000 + ($1,150 × No. buses) (rounded to nearest 1,000)
Methanol, ethanol (indoor parking)	Formula	$115,000 + ($2,150 × No. buses) (rounded to nearest 1,000)
LPG (indoor parking)	Formula	$115,000 + ($3,150 × No. buses) (rounded to nearest 1,000)
Fueling facility capital cost—low		
CNG, LNG	Formula	Default median facility cost × 0.6, or User-specified facility cost (if entered) × 0.9
Methanol, ethanol, LPG	Formula	Default median facility cost × 0.8, or User-specified facility cost (if entered) × 0.9
Maintenance facility capital cost—low		
CNG, LNG	Formula	Default median facility cost × 0.6, or User-specified facility cost (if entered) × 0.9
Methanol, ethanol, LPG	Formula	Default median facility cost × 0.8, or User-specified facility cost (if entered) × 0.9
Fueling facility capital cost—high		
CNG, LNG	Formula	Default median facility cost × 1.4 or User-specified facility cost (if entered) × 1.1
Methanol, ethanol, LPG	Formula	Default median facility cost × 1.2, or User-specified facility cost (if entered) × 1.1
Maintenance facility capital cost—high		
CNG, LNG	Formula	Default median facility cost × 1.4 or User-specified facility cost (if entered) × 1.1
Methanol, ethanol, LPG	Formula	Default median facility cost × 1.2, or User-specified facility cost (if entered) × 1.1

Costs Module

Incremental cost per bus		
CNG—median	Default	$62,500 if required vehicle range < 350 mi $70,000 if required vehicle range >= 350 mi
LNG—median	Default	$55,000
Methanol—median	Default	$30,000
Ethanol—median	Default	$30,000
LPG—median	Default	$40,000
CNG—low	Default	$60,000 if required vehicle range < 350 mi $65,000 if required vehicle range >= 350 mi
LNG—low	Default	$45,000
Methanol—low	Default	$25,000
Ethanol—low	Default	$25,000
LPG—low	Default	$35,000

CNG—high	Default	$65,000 if required vehicle range < 350 mi $75,000 if required vehicle range >= 350 mi
LNG—high	Default	$65,000
Methanol—high	Default	$35,000
Ethanol—high	Default	$35,000
LPG—high	Default	$45,000
Base diesel bus cost	Default	$250,000
Fuel cost per mile	Formula	Fuel price per gallon / fuel economy
Maintenance costs per mile		
Diesel	Pre-defined	$0.40
CNG, LNG, LPG	Pre-defined	$0.46
Methanol, ethanol	Pre-defined	$0.52
Annual fueling facility compression electricity cost	Formula	(Fuel required per weekday / 17.937) × ((4,500 / gas input pressure)$^{0.216}$ - 1) × ((8 × unit electricity price) + (demand charge / 30)) × 312 days/yr (rounded to nearest 100)
Annual fueling facility maintenance cost		
Diesel, methanol, ethanol, LPG	Formula	($5,800 + Fuel required per weekday × $0.30) (rounded to nearest 100)
CNG	Formula	(Fueling facility capital cost × 0.03) + $2,000 (rounded to nearest 100)
LNG	Formula	($11,500 + Fuel required per weekday × $2.60) (rounded to nearest 100)
Annualized vehicle replacement costs	Formula	Total vehicle replacement costs × (A/P, discount rate, 12 years)
Annualized facility modification costs	Formula	Total facility costs × (A/P, discount rate, facility life)

6 REFERENCES AND SOURCES

Acurex Environmental Corporation, *Alternative Fuels for Motor Vehicles: A Summary of Methanol, Ethanol, CNG, LNG, Propane, Hydrogen, and Electric Vehicle Technologies,* Report TR-95-103, prepared for California Energy Commission, August 1995.

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Chandler, K., et al, *Alternative Fuel Transit Bus Evaluation Program Results,* Report No. 961082, Society of Automotive Engineers, May 1996.

Gas Research Institute, *A Comparison of LNG, CNG, and Diesel Transit Bus Economics,* Report No. GRI-93/0421, prepared by Acurex Environmental Corporation, October 1993.

Motta, Robert, et al, *Alternative Fuel Transit Buses: Final Results from the National Renewable Energy Laboratory (NREL) Vehicle Evaluation Program.*

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APPENDIX EXAMPLE SCENARIO PRINTOUTS

GENERAL INPUTS
10-bus example case

Scenario name	10-bus example case
Current year	1998
Sales tax rate	7.75%
Amortization parameters	
Discount rate	8.00%
Fueling facility and maintenance facility life (years)	20
Annual miles per bus	41,667
Required vehicle range (miles) (Enter 300 or 400)	400
Are buses parked indoors? (Enter Y or N)	N
Cost sharing	
Federal share of diesel-related capital costs	80%
Federal share of alternative-fuel-related capital costs	90%
Electricity costs (for CNG compressor station)	
Unit electricity price ($/kWh)	$0.08
Demand charge ($/kW per month)	$10.00
Alternative fuel to use for cash-flow analysis (enter 1 for CNG, 2 for LNG, 3 for methanol, 4 for ethanol, 5 for LPG)	1

BUS DATA

10-bus example case

Current bus fleet

Model year	No. of buses: User-specific
1986 and older	10
1987	0
1988	0
1989	0
1990	0
1991	0
1992	0
1993	0
1994	0
1995	0
1996	0
1997	0
TOTAL	**10**

Bus procurement schedule

Model year	No. of buses: Default	No. of buses: User-specific
1998	10	
1999	0	
2000	0	
2001	0	
2002	0	
2003	0	
2004	0	
2005	0	
2006	0	
2007	0	
2008	0	
2009	0	
TOTAL	**10**	**0**

FUEL PRICE

10-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
Sales unit of fuel	gallon	therm (=100 scf)	gallon	gallon	gallon	gallon
Energy content of fuel (BTU/sales unit)	128,700	93,000	76,350	57,000	76,400	83,500
Efficiency penalty	0%	-35%	-30%	-15%	-15%	-35%
Fuel economy (mi/sales unit)	4.00	2.14	1.83	1.54	2.06	1.92
	mpg_{diesel}	mp $therm_{CNG}$	mpg_{LNG}	$mpg_{methanol}$	$mpg_{ethanol}$	mpg_{lpg}
Unit price--median ($/unit)	$ 0.8000	$ 0.3260	$ 0.4500	$ 0.5500	$ 1.0000	$ 0.6000
Delivery cost ($/unit)	$ -	$ -	$ -	$ -	$ -	$ -
EPA Superfund excise tax ($/unit)	$ 0.0023	$ -	$ -	$ -	$ -	$ -
Subtotal--median ($/unit)	$ 0.8023	$ 0.3260	$ 0.4500	$ 0.5500	$ 1.0000	$ 0.6000
State sales tax: 7.75%	$ 0.0622	$ -	$ 0.0349	$ 0.0426	$ 0.0775	$ 0.0465
Total fuel cost--median ($/unit)	**$ 0.8645**	**$ 0.3260**	**$ 0.4849**	**$ 0.5926**	**$ 1.0775**	**$ 0.6465**
Price of fuel/million BTU	$ 6.7170	$ 3.5054	$ 6.3507	$ 10.3969	$ 14.1034	$ 7.7425
Price of fuel/diesel-equivalent gallon	$ 0.8645	$ 0.4511	$ 0.8173	$ 1.3381	$ 1.8151	$ 0.9965
Unit price--low ($/unit)		$ 0.2760	$ 0.4000	$ 0.4500	$ 0.9000	$ 0.5000
Delivery cost ($/unit)		$ -	$ -	$ -	$ -	$ -
EPA Superfund excise tax ($/unit)		$ -	$ -	$ -	$ -	$ -
Subtotal--low ($/unit)		$ 0.2760	$ 0.4000	$ 0.4500	$ 0.9000	$ 0.5000
State sales tax: 7.75%		$ -	$ 0.0310	$ 0.0349	$ 0.0698	$ 0.0388
Total fuel cost--low ($/unit)	**$ 0.8645**	**$ 0.2760**	**$ 0.4310**	**$ 0.4849**	**$ 0.9698**	**$ 0.5388**
Price of fuel/million BTU	$ 6.7170	$ 2.9677	$ 5.6451	$ 8.5066	$ 12.6931	$ 6.4521
Price of fuel/diesel-equivalent gallon	$ 0.8645	$ 0.3819	$ 0.7265	$ 1.0948	$ 1.6336	$ 0.8304
Unit price--high ($/unit)		$ 0.4060	$ 0.6000	$ 0.7000	$ 1.1000	$ 0.7000
Delivery cost ($/unit)		$ -	$ -	$ -	$ -	$ -
EPA Superfund excise tax ($/unit)		$ -	$ -	$ -	$ -	$ -
Subtotal--high ($/unit)		$ 0.4060	$ 0.6000	$ 0.7000	$ 1.1000	$ 0.7000
State sales tax: 7.75%		$ -	$ 0.0465	$ 0.0543	$ 0.0853	$ 0.0543
Total fuel cost--high ($/unit)	**$ 0.8645**	**$ 0.4060**	**$ 0.6465**	**$ 0.7543**	**$ 1.1853**	**$ 0.7543**
Price of fuel/million BTU	$ 6.7170	$ 4.3656	$ 8.4676	$ 13.2325	$ 15.5137	$ 9.0329
Price of fuel/diesel-equivalent gallon	$ 0.8645	$ 0.5619	$ 1.0898	$ 1.7030	$ 1.9966	$ 1.1625

FACILITY CAPITAL COSTS
10-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
Fuel required per weekday	334 gal	624 therms	732 gal	867 gal	647 gal	695 gal
Fueling facility tank capacity (gal)			5,000	10,000	8,000	8,000
CNG fueling facility compressor capacity (cfm)		100				
Natural gas supply pressure (psia) (CNG only)		65				
Fueling facility capital cost						
Default estimate--median	$ -	$ 275,000	$ 239,000	$ 77,000	$ 77,000	$ 123,000
User-specific estimate						
Maintenance facility modification capital cost						
Default estimate--median	$ -	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000
User-specific estimate						
Total facility capital costs--median	**$ -**	**$ 400,000**	**$ 364,000**	**$ 202,000**	**$ 202,000**	**$ 248,000**
Fueling facility capital cost--low		$ 165,000	$ 143,000	$ 62,000	$ 62,000	$ 98,000
Maintenance facility modification capital cost--low		$ 75,000	$ 75,000	$ 100,000	$ 100,000	$ 100,000
Total facility capital costs--low		**$ 240,000**	**$ 218,000**	**$ 162,000**	**$ 162,000**	**$ 198,000**
Fueling facility capital cost--high		$ 385,000	$ 335,000	$ 92,000	$ 92,000	$ 148,000
Maintenance facility modification capital cost--high		$ 175,000	$ 175,000	$ 150,000	$ 150,000	$ 150,000
Total facility capital costs--high		**$ 560,000**	**$ 510,000**	**$ 242,000**	**$ 242,000**	**$ 298,000**

COSTS--MEDIAN
10-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
CAPITAL COSTS						
Vehicle replacement						
Incremental cost per bus--median		$ 70,000	$ 55,000	$ 30,000	$ 30,000	$ 40,000
Base cost per bus						
Default estimate	$ 250,000	$ 320,000	$ 305,000	$ 280,000	$ 280,000	$ 290,000
User-specific estimate						
State sales tax: 7.75%	$ 19,375	$ 24,800	$ 23,638	$ 21,700	$ 21,700	$ 22,475
Total cost per bus	$ 269,375	$ 344,800	$ 328,638	$ 301,700	$ 301,700	$ 312,475
Total vehicle replacement costs	**$ 2,693,750**	**$ 3,448,000**	**$ 3,286,375**	**$ 3,017,000**	**$ 3,017,000**	**$ 3,124,750**
Total facility costs	**$ -**	**$ 400,000**	**$ 364,000**	**$ 202,000**	**$ 202,000**	**$ 248,000**
Total capital costs--median	**$ 2,693,750**	**$ 3,848,000**	**$ 3,650,375**	**$ 3,219,000**	**$ 3,219,000**	**$ 3,372,750**
OPERATING COSTS						
Fuel economy (mi/sales unit)	4.00 mpg_{diesel}	2.14 $mp\ therm_{CNG}$	1.83 mpg_{LNG}	1.54 $mpg_{methanol}$	2.06 $mpg_{ethanol}$	1.92 mpg_{lpg}
Fuel price per gallon--median	$ 0.8645	$ 0.3260	$ 0.4849	$ 0.5926	$ 1.0775	$ 0.6465
Fuel cost per mile	$ 0.22	$ 0.15	$ 0.27	$ 0.38	$ 0.52	$ 0.34
Annual fleet fuel cost	$ 90,051	$ 63,442	$ 110,681	$ 160,293	$ 217,437	$ 140,129
Maintenance cost per mile						
Default estimate	$ 0.40	$ 0.46	$ 0.46	$ 0.52	$ 0.52	$ 0.46
User-specific estimate						
Annual fleet maintenance cost	$ 166,668	$ 191,668	$ 191,668	$ 216,668	$ 216,668	$ 191,668
Annual fueling facility compression electricity cost		$ 15,800				
Annual fueling facility maintenance cost	$ 5,900	$ 10,300	$ 13,400	$ 6,100	$ 6,000	$ 6,000
Other annual operating costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating cost per mile	$ 0.63	$ 0.67	$ 0.76	$ 0.92	$ 1.06	$ 0.81
Total annual operating costs--median	**$ 263,000**	**$ 281,000**	**$ 316,000**	**$ 383,000**	**$ 440,000**	**$ 338,000**
ANNUALIZED COSTS--TOTAL						
Vehicle replacement costs	$ 357,447	$ 457,532	$ 436,086	$ 400,341	$ 400,341	$ 414,639
Facility modification costs	$ -	$ 40,741	$ 37,074	$ 20,574	$ 20,574	$ 25,259
Operating costs	$ 263,000	$ 281,000	$ 316,000	$ 383,000	$ 440,000	$ 338,000
Total annualized cost--median	**$ 620,447**	**$ 779,273**	**$ 789,160**	**$ 803,915**	**$ 860,915**	**$ 777,898**
ANNUALIZED COSTS--LOCAL SHARE						
Vehicle replacement costs	$ 71,489	$81,497.96	$ 79,353	$ 75,779	$ 75,779	$ 77,209
Facility modification costs	$ -	$ 4,074	$ 3,707	$ 2,057	$ 2,057	$ 2,526
Operating costs	$ 263,000	$ 281,000	$ 316,000	$ 383,000	$ 440,000	$ 338,000
Local share of annualized cost--median	**$ 334,489**	**$ 366,572**	**$ 399,061**	**$ 460,836**	**$ 517,836**	**$ 417,735**
EMISSIONS CALCULATIONS						
Emissions rate (g NOx/bhp-hr)	4.0	2.5	2.5	2.0	3.0	2.5
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g NOx/mile)	17.2	10.8	10.8	8.6	12.9	10.8
Annual emissions (tons NOx/yr)	7.9	4.9	4.9	3.9	5.9	4.9
Fleet emissions reduced (tons NOx/year)		3.0	3.0	3.9	2.0	3.0
Emissions rate (g PM/bhp-hr)	0.05	0.03	0.03	0.05	0.05	0.03
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g PM/mile)	0.22	0.13	0.13	0.22	0.22	0.13
Annual emissions (tons PM/yr)	0.10	0.06	0.06	0.10	0.10	0.06
Fleet emissions reduced (tons PM/year)		0.04	0.04	0.00	0.00	0.04

COSTS—LOW
10-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
CAPITAL COSTS						
Vehicle replacement						
Incremental cost per bus–low		$ 65,000	$ 45,000	$ 25,000	$ 25,000	$ 35,000
Base cost per bus						
Default estimate	$ 250,000	$ 315,000	$ 295,000	$ 275,000	$ 275,000	$ 285,000
User-specific estimate		$ -	$ -	$ -	$ -	$ -
State sales tax: 7.75%	$ 19,375	$ 24,413	$ 22,863	$ 21,313	$ 21,313	$ 22,088
Total cost per bus	$ 269,375	$ 339,413	$ 317,863	$ 296,313	$ 296,313	$ 307,088
Total vehicle replacement costs	**$ 2,693,750**	**$ 3,394,125**	**$ 3,178,625**	**$ 2,963,125**	**$ 2,963,125**	**$ 3,070,875**
Total facility costs	**$ -**	**$ 240,000**	**$ 218,000**	**$ 162,000**	**$ 162,000**	**$ 198,000**
Total capital costs–low	**$ 2,693,750**	**$ 3,634,125**	**$ 3,396,625**	**$ 3,125,125**	**$ 3,125,125**	**$ 3,268,875**
OPERATING COSTS						
Fuel economy (mi/sales unit)	4.00 mpg_{diesel}	2.14 $mp\ therm_{CNG}$	1.83 mpg_{LNG}	1.54 $mpg_{methanol}$	2.06 $mpg_{ethanol}$	1.92 mpg_{lpg}
Fuel price per gallon–low	$ 0.8645	$ 0.2760	$ 0.4310	$ 0.4849	$ 0.9698	$ 0.5388
Fuel cost per mile	$ 0.22	$ 0.13	$ 0.24	$ 0.31	$ 0.47	$ 0.28
Annual fleet fuel cost	$ 90,051	$ 53,712	$ 98,384	$ 131,149	$ 195,693	$ 116,774
Maintenance cost per mile						
Default estimate	$ 0.40	$ 0.46	$ 0.46	$ 0.52	$ 0.52	$ 0.46
User-specific estimate	$ -	$ -	$ -	$ -	$ -	$ -
Annual fleet maintenance cost	$ 166,668	$ 191,668	$ 191,668	$ 216,668	$ 216,668	$ 191,668
Annual fueling facility compression electricity cost		$ 15,800				
Annual fueling facility maintenance cost	$ 5,900	$ 10,300	$ 13,400	$ 6,100	$ 6,000	$ 6,000
Other annual operating costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating cost per mile	$ 0.63	$ 0.65	$ 0.73	$ 0.85	$ 1.00	$ 0.75
Total annual operating costs–low	**$ 263,000**	**$ 271,000**	**$ 303,000**	**$ 354,000**	**$ 418,000**	**$ 314,000**
ANNUALIZED COSTS–TOTAL						
Vehicle replacement costs	$ 357,447	$ 450,383	$ 421,788	$ 393,192	$ 393,192	$ 407,490
Facility modification costs	$ -	$ 24,445	$ 22,204	$ 16,500	$ 16,500	$ 20,167
Operating costs	$ 263,000	$ 271,000	$ 303,000	$ 354,000	$ 418,000	$ 314,000
Total annualized cost–low	**$ 620,447**	**$ 745,828**	**$ 746,991**	**$ 763,692**	**$ 827,692**	**$ 741,657**
Amount less than median annualized cost	**$ -**	**$ 33,445**	**$ 42,168**	**$ 40,223**	**$ 33,223**	**$ 36,242**
ANNUALIZED COSTS–LOCAL SHARE						
Vehicle replacement costs	$ 71,489	$80,783.07	$77,923.49	$75,063.91	$75,063.91	$76,493.70
Facility modification costs	$ -	$ 2,444	$ 2,220	$ 1,650	$ 1,650	$ 2,017
Operating costs	$ 263,000	$ 271,000	$ 303,000	$ 354,000	$ 418,000	$ 314,000
Local share of annualized cost–low	**$ 334,489**	**$ 354,228**	**$ 383,144**	**$ 430,714**	**$ 494,714**	**$ 392,510**
Amount less than median annualized cost	**$ -**	**$ 12,345**	**$ 15,917**	**$ 30,122**	**$ 23,122**	**$ 25,234**
EMISSIONS CALCULATIONS						
Emissions rate (g NOx/bhp-hr)	4.0	2.5	2.5	2.0	3.0	2.5
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g NOx/mile)	17.2	10.8	10.8	8.6	12.9	10.8
Annual emissions (tons NOx/yr)	7.9	4.9	4.9	3.9	5.9	4.9
Fleet emissions reduced (tons NOx/year)		3.0	3.0	3.9	2.0	3.0
Emissions rate (g PM/bhp-hr)	0.05	0.03	0.03	0.05	0.05	0.03
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g PM/mile)	0.22	0.13	0.13	0.22	0.22	0.13
Annual emissions (tons PM/yr)	0.10	0.06	0.06	0.10	0.10	0.06
Fleet emissions reduced (tons PM/year)		0.04	0.04	0.00	0.00	0.04

COSTS—HIGH
10-bus example case

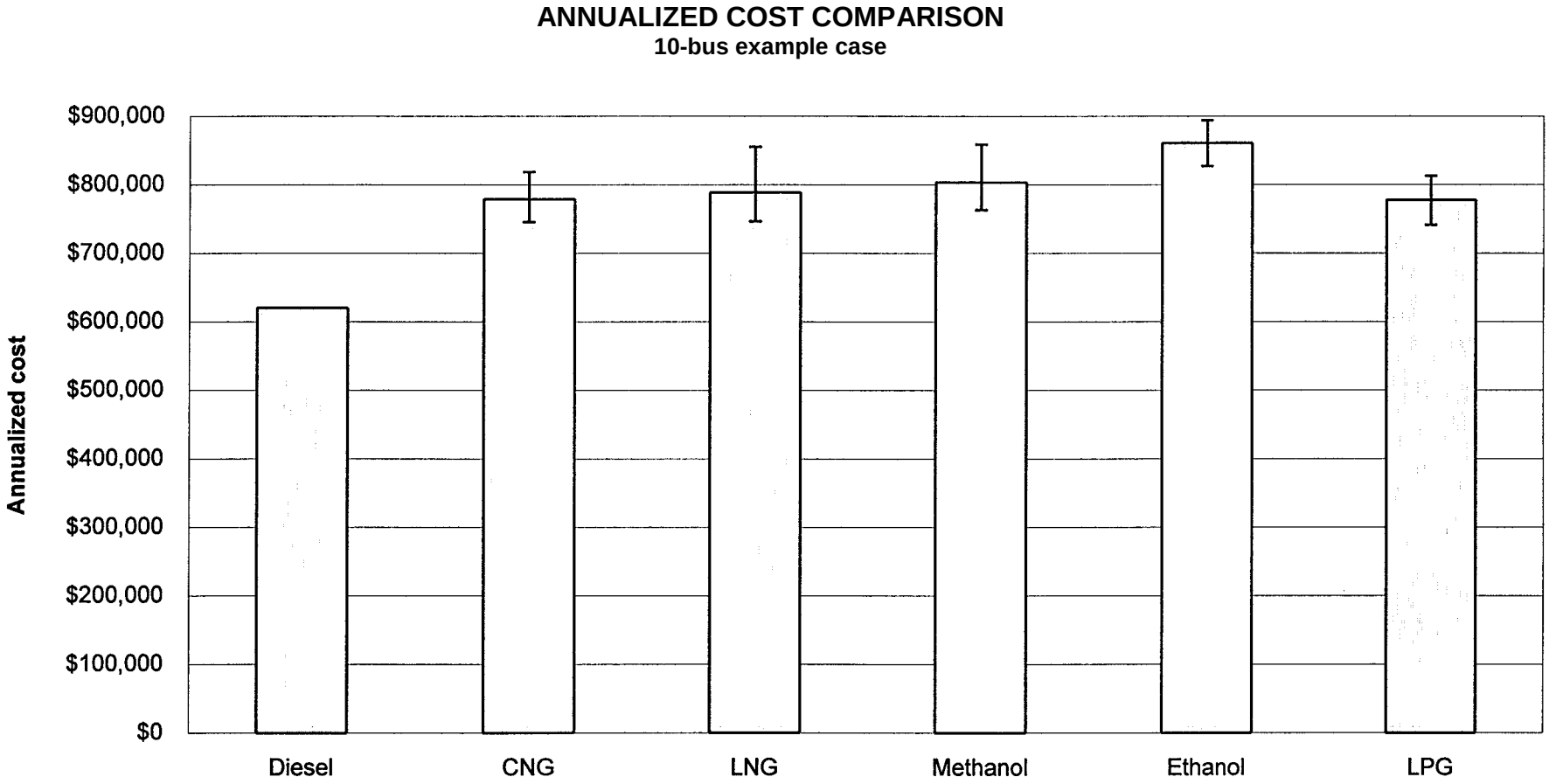
	Diesel	CNG	LNG	Methanol	Ethanol	LPG
CAPITAL COSTS						
Vehicle replacement						
Incremental cost per bus--high		$ 75,000	$ 65,000	$ 35,000	$ 35,000	$ 45,000
Base cost per bus						
Default estimate	$ 250,000	$ 325,000	$ 315,000	$ 285,000	$ 285,000	$ 295,000
User-specific estimate		$ -	$ -	$ -	$ -	$ -
State sales tax: 7.75%	$ 19,375	$ 25,188	$ 24,413	$ 22,088	$ 22,088	$ 22,863
Total cost per bus	$ 269,375	$ 350,188	$ 339,413	$ 307,088	$ 307,088	$ 317,863
Total vehicle replacement costs	$ 2,693,750	$ 3,501,875	$ 3,394,125	$ 3,070,875	$ 3,070,875	$ 3,178,625
Total facility costs	$ -	$ 560,000	$ 510,000	$ 242,000	$ 242,000	$ 298,000
Total capital costs--high	$ 2,693,750	$ 4,061,875	$ 3,904,125	$ 3,312,875	$ 3,312,875	$ 3,476,625
OPERATING COSTS						
Fuel economy (mi/sales unit)	4.00 mpg_{diesel}	2.14 $mp\ therm_{CNG}$	1.83 mpg_{LNG}	1.54 $mpg_{methanol}$	2.06 $mpg_{ethanol}$	1.92 mpg_{lpg}
Fuel price per gallon--high	$ 0.8645	$ 0.4060	$ 0.6465	$ 0.7543	$ 1.1853	$ 0.7543
Fuel cost per mile	$ 0.22	$ 0.19	$ 0.35	$ 0.49	$ 0.57	$ 0.39
Annual fleet fuel cost	$ 90,051	$ 79,011	$ 147,575	$ 204,009	$ 239,180	$ 163,483
Maintenance cost per mile						
Default estimate	$ 0.40	$ 0.46	$ 0.46	$ 0.52	$ 0.52	$ 0.46
User-specific estimate	$ -	$ -	$ -	$ -	$ -	$ -
Annual fleet maintenance cost	$ 166,668	$ 191,668	$ 191,668	$ 216,668	$ 216,668	$ 191,668
Annual fueling facility compression electricity cost		$ 15,800				
Annual fueling facility maintenance cost	$ 5,900	$ 10,300	$ 13,400	$ 6,100	$ 6,000	$ 6,000
Other annual operating costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating cost per mile	$ 0.63	$ 0.71	$ 0.85	$ 1.02	$ 1.11	$ 0.87
Total annual operating costs--high	$ 263,000	$ 297,000	$ 353,000	$ 427,000	$ 462,000	$ 361,000
ANNUALIZED COSTS--TOTAL						
Vehicle replacement costs	$ 357,447	$ 464,681	$ 450,363	$ 407,490	$ 407,490	$ 421,788
Facility modification costs	$ -	$ 57,037	$ 51,945	$ 24,648	$ 24,648	$ 30,352
Operating costs	$ 263,000	$ 297,000	$ 353,000	$ 427,000	$ 462,000	$ 361,000
Total annualized cost--high	$ 620,447	$ 818,719	$ 855,328	$ 859,138	$ 894,138	$ 813,140
Amount greater than median annualized cost	$ -	$ 39,445	$ 66,168	$ 55,223	$ 33,223	$ 35,242
ANNUALIZED COSTS--LOCAL SHARE						
Vehicle replacement costs	$ 71,489	$82,212.86	$80,783.07	$76,493.70	$76,493.70	$77,923.49
Facility modification costs	$ -	$ 5,704	$ 5,194	$ 2,465	$ 2,465	$ 3,035
Operating costs	$ 263,000	$ 297,000	$ 353,000	$ 427,000	$ 462,000	$ 361,000
Local share of annualized cost--high	$ 334,489	$ 384,917	$ 438,978	$ 505,959	$ 540,959	$ 441,959
Amount greater than median annualized cost	$ -	$ 18,345	$ 39,917	$ 45,122	$ 23,122	$ 24,224
EMISSIONS CALCULATIONS						
Emissions rate (g NOx/bhp-hr)	4.0	2.5	2.5	2.0	3.0	2.5
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g NOx/mile)	17.2	10.8	10.8	8.6	12.9	10.8
Annual emissions (tons NOx/yr)	7.9	4.9	4.9	3.9	5.9	4.9
Fleet emissions reduced (tons NOx/year)		3.0	3.0	3.9	2.0	3.0
Emissions rate (g PM/bhp-hr)	0.05	0.03	0.03	0.05	0.05	0.03
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g PM/mile)	0.22	0.13	0.13	0.22	0.22	0.13
Annual emissions (tons PM/yr)	0.10	0.06	0.06	0.10	0.10	0.06
Fleet emissions reduced (tons PM/year)		0.04	0.04	0.00	0.00	0.04

YEARLY COST SUMMARY (CASH-FLOW ANALYSIS)
10-bus example case

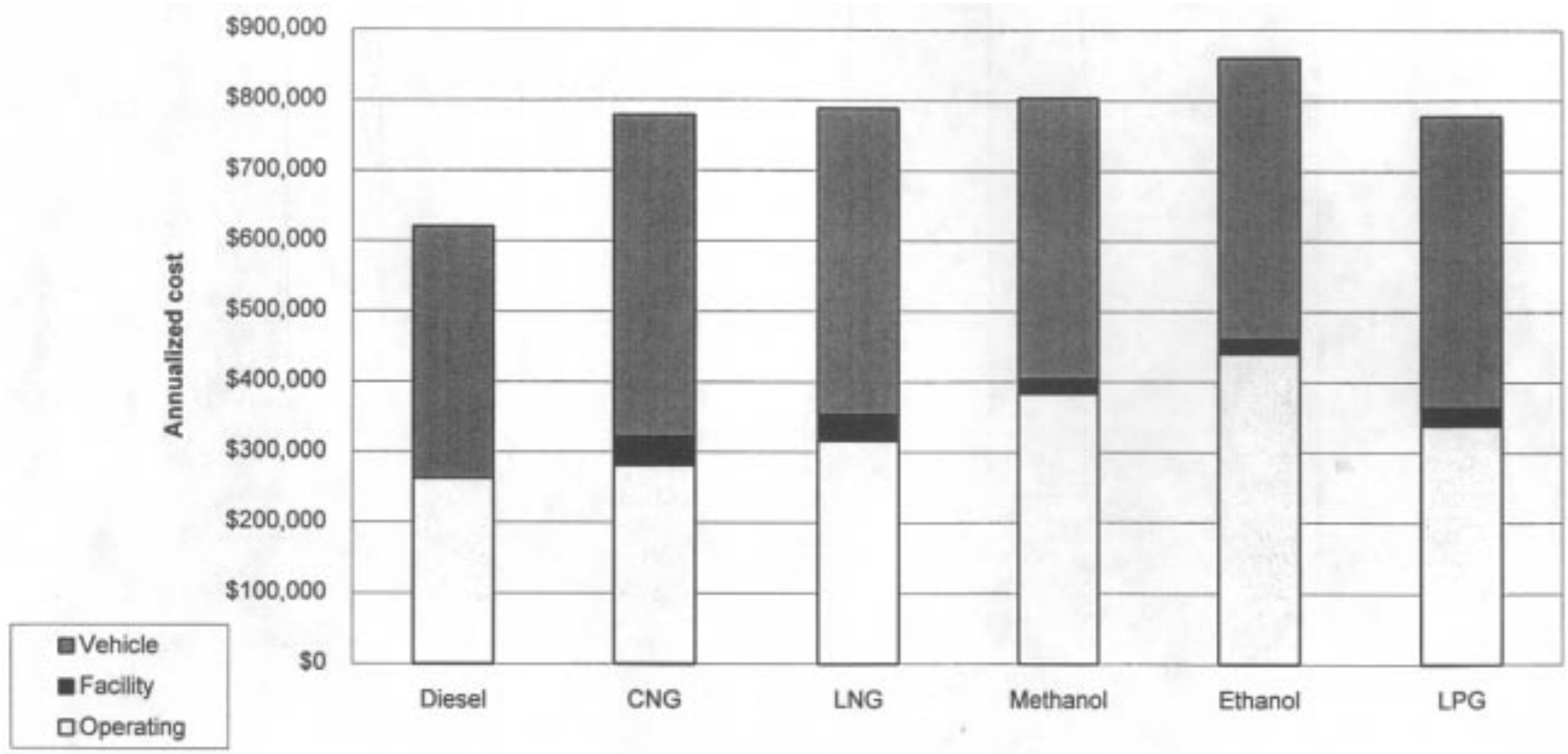
	1998	1999	2000	2001	2002	2003
DIESEL						
Total cost per bus	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375
Number of buses	10	0	0	0	0	0
Bus replacement costs	$ 2,693,750	$ -	$ -	$ -	$ -	$ -
Facilities costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs	$ 263,000	$ 263,000	$ 263,000	$ 263,000	$ 263,000	$ 263,000
Total costs	**$ 2,956,750**	**$ 263,000**	**$ 263,000**	**$ 263,000**	**$ 263,000**	**$ 263,000**
Local share	**$ 801,750**	**$ 263,000**	**$ 263,000**	**$ 263,000**	**$ 263,000**	**$ 263,000**
CNG						
Total cost per bus--median	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800
Number of buses	10	0	0	0	0	0
Bus replacement costs--median	$ 3,448,000	$ -	$ -	$ -	$ -	$ -
Facilities costs--median	$ 400,000	$ -	$ -	$ -	$ -	$ -
Operating costs--median	$ 281,000	$ 281,000	$ 281,000	$ 281,000	$ 281,000	$ 281,000
Total costs--median	**$ 4,129,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**
Local share	**$ 935,175**	**$ 281,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**
Total cost per bus--low	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413
Number of buses	10	0	0	0	0	0
Bus replacement costs--low	$ 3,394,125	$ -	$ -	$ -	$ -	$ -
Facilities costs--low	$ 240,000	$ -	$ -	$ -	$ -	$ -
Operating costs--low	$ 271,000	$ 271,000	$ 271,000	$ 271,000	$ 271,000	$ 271,000
Total costs--low	**$ 3,905,125**	**$ 271,000**	**$ 271,000**	**$ 271,000**	**$ 271,000**	**$ 271,000**
Local share	**$ 903,788**	**$ 271,000**	**$ 271,000**	**$ 271,000**	**$ 271,000**	**$ 271,000**
Total cost per bus--high	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188
Number of buses	10	0	0	0	0	0
Bus replacement costs--high	$ 3,501,875	$ -	$ -	$ -	$ -	$ -
Facilities costs--high	$ 560,000	$ -	$ -	$ -	$ -	$ -
Operating costs--high	$ 297,000	$ 297,000	$ 297,000	$ 297,000	$ 297,000	$ 297,000
Total costs--high	**$ 4,358,875**	**$ 297,000**	**$ 297,000**	**$ 297,000**	**$ 297,000**	**$ 297,000**
Local share	**$ 972,563**	**$ 297,000**	**$ 297,000**	**$ 297,000**	**$ 297,000**	**$ 297,000**
COST DIFFERENTIAL						
CNG--median vs. diesel	$ 1,172,250	$ 18,000	$ 18,000	$ 18,000	$ 18,000	$ 18,000
Local share	$ 133,425	$ 18,000	$ 18,000	$ 18,000	$ 18,000	$ 18,000
CNG--low vs. diesel	$ 948,375	$ 8,000	$ 8,000	$ 8,000	$ 8,000	$ 8,000
Local share	$ 102,038	$ 8,000	$ 8,000	$ 8,000	$ 8,000	$ 8,000
CNG--high vs. diesel	$ 1,402,125	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000
Local share	$ 170,813	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000

YEARLY COST SUMMARY (CASH-FLOW ANALYSIS) (CONCLUDED)
10-bus example case

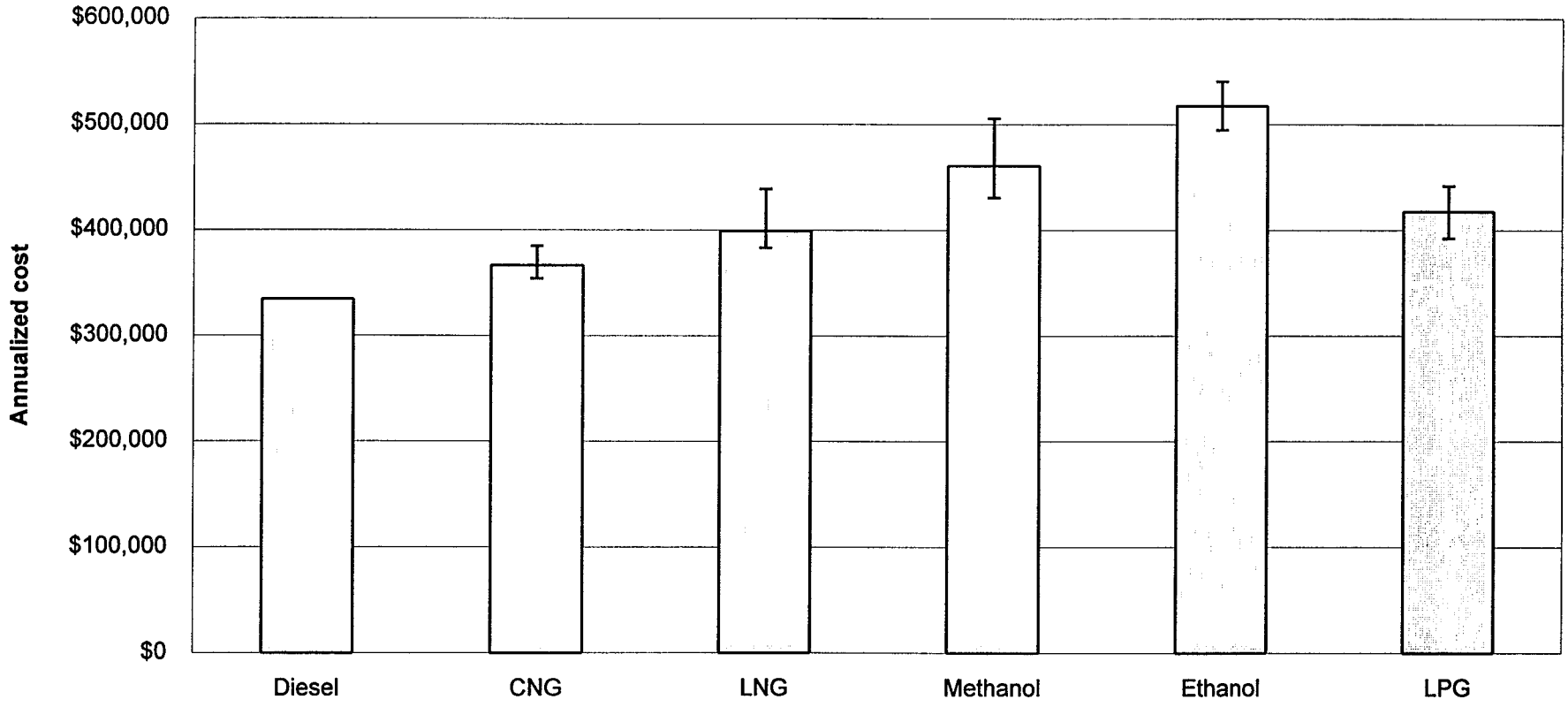
	2004	2005	2006	2007	2008	2009
DIESEL						
Total cost per bus	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375
Number of buses	0	0	0	0	0	0
Bus replacement costs	$ -	$ -	$ -	$ -	$ -	$ -
Facilities costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs	$ 263,000	$ 263,000	$ 263,000	$ 263,000	$ 263,000	$ 263,000
Total costs	**$ 263,000**	**$ 263,000**	**$ 263,000**	**$ 263,000**	**$ 263,000**	**$ 263,000**
Local share	**$ 263,000**	**$ 263,000**	**$ 263,000**	**$ 263,000**	**$ 263,000**	**$ 263,000**
CNG						
Total cost per bus--median	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800
Number of buses	0	0	0	0	0	0
Bus replacement costs--median	$ -	$ -	$ -	$ -	$ -	$ -
Facilities costs--median	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs--median	$ 281,000	$ 281,000	$ 281,000	$ 281,000	$ 281,000	$ 281,000
Total costs--median	**$ 281,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**
Local share	**$ 281,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**	**$ 281,000**
Total cost per bus--low	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413
Number of buses	0	0	0	0	0	0
Bus replacement costs--low	$ -	$ -	$ -	$ -	$ -	$ -
Facilities costs--low	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs--low	$ 271,000	$ 271,000	$ 271,000	$ 271,000	$ 271,000	$ 271,000
Total costs--low	**$ 271,000**	**$ 271,000**	**$ 271,000**	**$ 271,000**	**$ 271,000**	**$ 271,000**
Local share	**$ 271,000**	**$ 271,000**	**$ 271,000**	**$ 271,000**	**$ 271,000**	**$ 271,000**
Total cost per bus--high	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188
Number of buses	0	0	0	0	0	0
Bus replacement costs--high	$ -	$ -	$ -	$ -	$ -	$ -
Facilities costs--high	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs--high	$ 297,000	$ 297,000	$ 297,000	$ 297,000	$ 297,000	$ 297,000
Total costs--high	**$ 297,000**	**$ 297,000**	**$ 297,000**	**$ 297,000**	**$ 297,000**	**$ 297,000**
Local share	**$ 297,000**	**$ 297,000**	**$ 297,000**	**$ 297,000**	**$ 297,000**	**$ 297,000**
COST DIFFERENTIAL						
CNG--median vs. diesel	$ 18,000	$ 18,000	$ 18,000	$ 18,000	$ 18,000	$ 18,000
Local share	$ 18,000	$ 18,000	$ 18,000	$ 18,000	$ 18,000	$ 18,000
CNG--low vs diesel	$ 8,000	$ 8,000	$ 8,000	$ 8,000	$ 8,000	$ 8,000
Local share	$ 8,000	$ 8,000	$ 8,000	$ 8,000	$ 8,000	$ 8,000
CNG--high vs diesel	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000
Local share	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000


ANNUALIZED COST COMPARISON
10-bus example case
Annualized cost
$900,000
$800,000
$700,000
$600,000
$500,000
$400,000
$300,000
$200,000
$100,000
$0
Diesel
CNG
LNG
Methanol
Ethanol
LPG

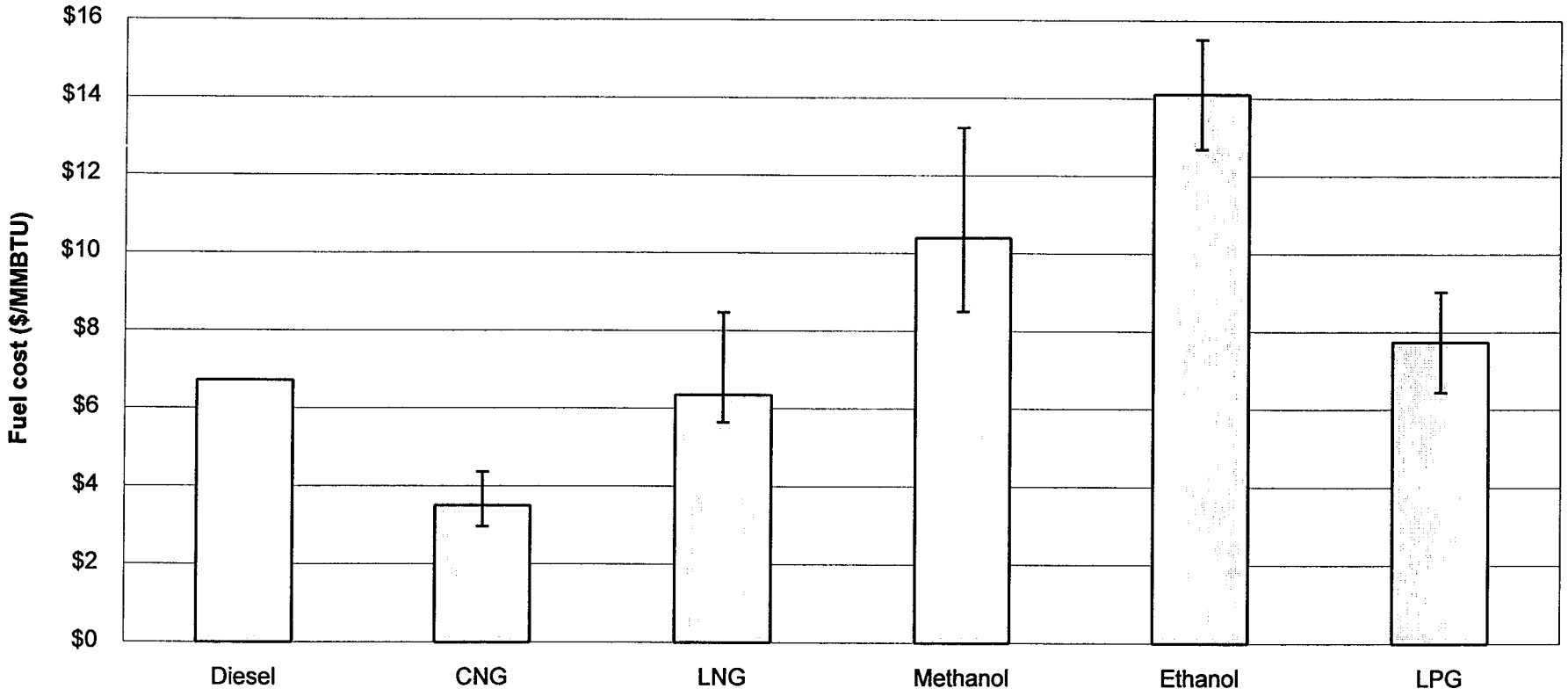
ANNUALIZED COST BREAKDOWN
10-bus example case

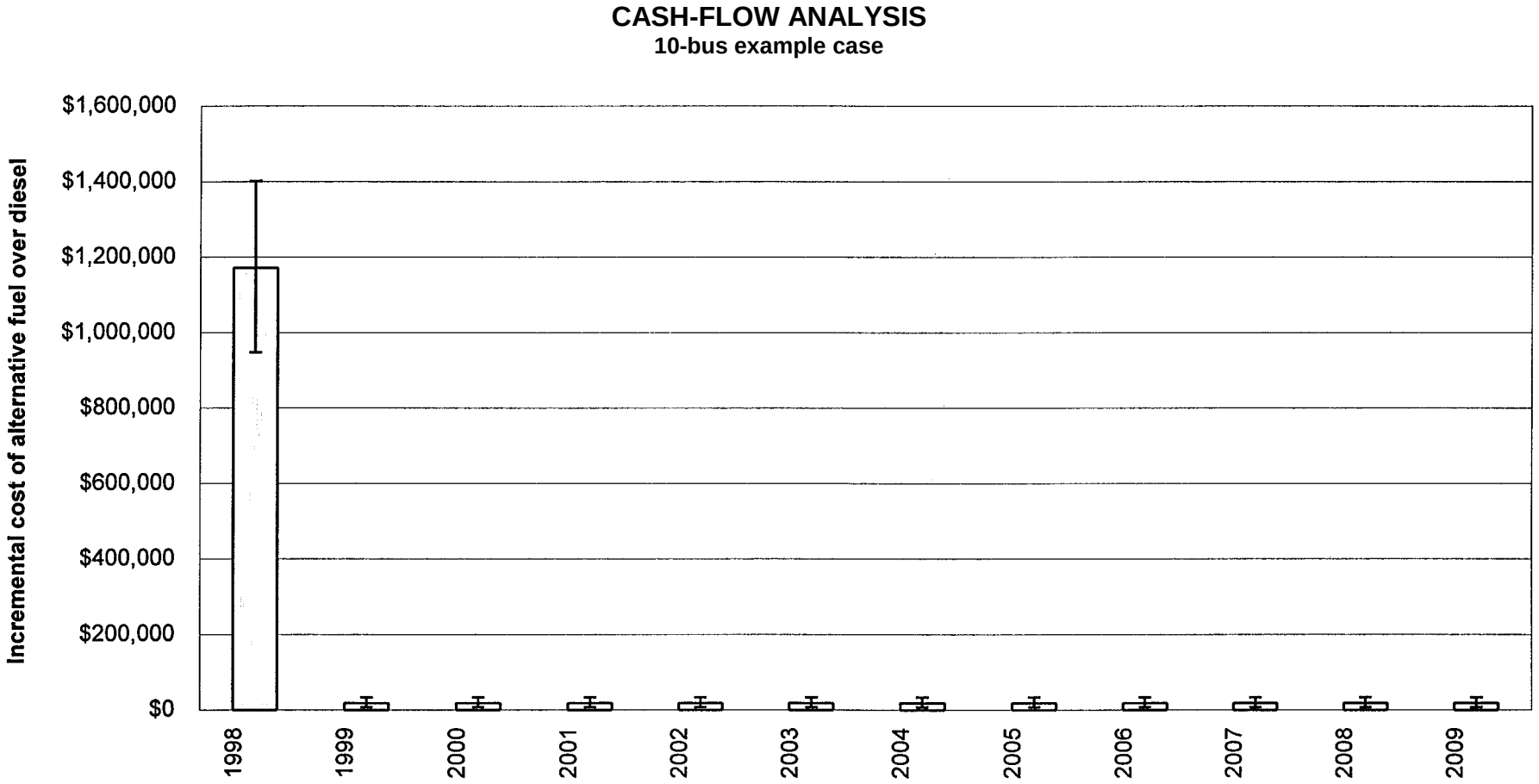


ANNUALIZED COST COMPARISON—LOCAL SHARE
10-bus example case



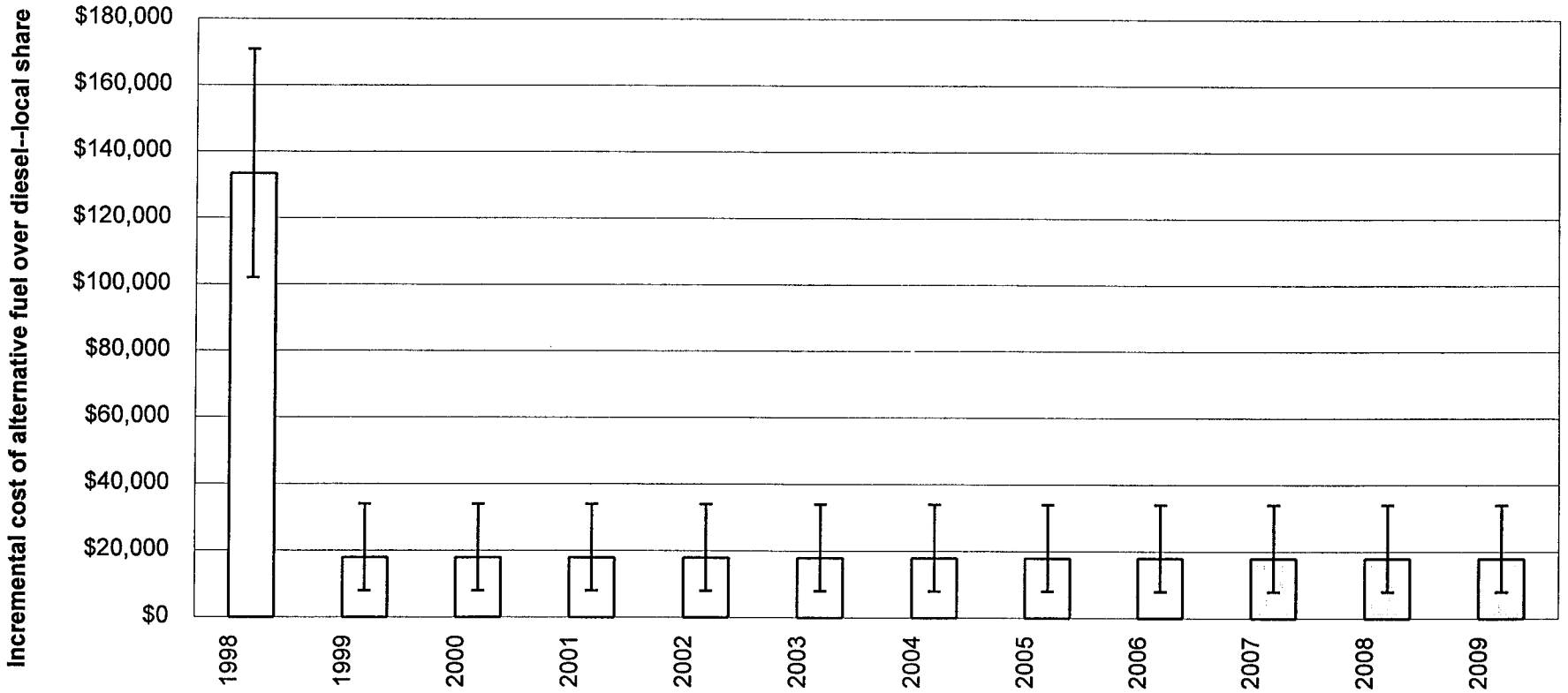
FUEL COST COMPARISON PER MILLION BTUs
10-bus example case




CASH-FLOW ANALYSIS
10-bus example case
Incremental cost of alternative fuel over diesel
$1,600,000
$1,400,000
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

CASH-FLOW ANALYSIS—LOCAL SHARE

10-bus example case



GENERAL INPUTS
50-bus example case

Scenario name	50-bus example case
Current year	1998
Sales tax rate	7.75%
Amortization parameters	
Discount rate	8.00%
Fueling facility and maintenance facility life (years)	20
Annual miles per bus	41,667
Required vehicle range (miles) (Enter 300 or 400)	400
Are buses parked indoors? (Enter Y or N)	N
Cost sharing	
Federal share of diesel-related capital costs	80%
Federal share of alternative-fuel-related capital costs	90%
Electricity costs (for CNG compressor station)	
Unit electricity price ($/kWh)	$0.08
Demand charge ($/kW per month)	$10.00
Alternative fuel to use for cash-flow analysis (enter 1 for CNG, 2 for LNG, 3 for methanol, 4 for ethanol, 5 for LPG)	1

BUS DATA

50-bus example case

Current bus fleet

Model year	No. of buses: User-specific
1986 and older	25
1987	0
1988	0
1989	0
1990	25
1991	0
1992	0
1993	0
1994	0
1995	0
1996	0
1997	0
TOTAL	50

Bus procurement schedule

Model year	No. of buses: Default	No. of buses: User-specific
1998	25	
1999	0	
2000	0	
2001	0	
2002	25	
2003	0	
2004	0	
2005	0	
2006	0	
2007	0	
2008	0	
2009	0	
TOTAL	50	0

FUEL PRICE

50-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
Sales unit of fuel	gallon	therm (=100 scf)	gallon	gallon	gallon	gallon
Energy content of fuel (BTU/sales unit)	128,700	93,000	76,350	57,000	76,400	83,500
Efficiency penalty	0%	-35%	-30%	-15%	-15%	-35%
Fuel economy (mi/sales unit)	4.00	2.14	1.83	1.54	2.06	1.92
	mpg_{diesel}	mp $therm_{CNG}$	mpg_{LNG}	$mpg_{methanol}$	$mpg_{ethanol}$	mpg_{lpg}
Unit price--median ($/unit)	$ 0.8000	$ 0.3260	$ 0.4500	$ 0.5500	$ 1.0000	$ 0.6000
Delivery cost ($/unit)	$ -	$ -	$ -	$ -	$ -	$ -
EPA Superfund excise tax ($/unit)	$ 0.0023	$ -	$ -	$ -	$ -	$ -
Subtotal--median ($/unit)	$ 0.8023	$ 0.3260	$ 0.4500	$ 0.5500	$ 1.0000	$ 0.6000
State sales tax: 7.75%	$ 0.0622	$ -	$ 0.0349	$ 0.0426	$ 0.0775	$ 0.0465
Total fuel cost--median ($/unit)	**$ 0.8645**	**$ 0.3260**	**$ 0.4849**	**$ 0.5926**	**$ 1.0775**	**$ 0.6465**
Price of fuel/million BTU	$ 6.7170	$ 3.5054	$ 6.3507	$ 10.3969	$ 14.1034	$ 7.7425
Price of fuel/diesel-equivalent gallon	$ 0.8645	$ 0.4511	$ 0.8173	$ 1.3381	$ 1.8151	$ 0.9965
Unit price--low ($/unit)		$ 0.2760	$ 0.4000	$ 0.4500	$ 0.9000	$ 0.5000
Delivery cost ($/unit)		$ -	$ -	$ -	$ -	$ -
EPA Superfund excise tax ($/unit)		$ -	$ -	$ -	$ -	$ -
Subtotal--low ($/unit)		$ 0.2760	$ 0.4000	$ 0.4500	$ 0.9000	$ 0.5000
State sales tax: 7.75%		$ -	$ 0.0310	$ 0.0349	$ 0.0698	$ 0.0388
Total fuel cost--low ($/unit)	**$ 0.8645**	**$ 0.2760**	**$ 0.4310**	**$ 0.4849**	**$ 0.9698**	**$ 0.5388**
Price of fuel/million BTU	$ 6.7170	$ 2.9677	$ 5.6451	$ 8.5066	$ 12.6931	$ 6.4521
Price of fuel/diesel-equivalent gallon	$ 0.8645	$ 0.3819	$ 0.7265	$ 1.0948	$ 1.6336	$ 0.8304
Unit price--high ($/unit)		$ 0.4060	$ 0.6000	$ 0.7000	$ 1.1000	$ 0.7000
Delivery cost ($/unit)		$ -	$ -	$ -	$ -	$ -
EPA Superfund excise tax ($/unit)		$ -	$ -	$ -	$ -	$ -
Subtotal--high ($/unit)		$ 0.4060	$ 0.6000	$ 0.7000	$ 1.1000	$ 0.7000
State sales tax: 7.75%		$ -	$ 0.0465	$ 0.0543	$ 0.0853	$ 0.0543
Total fuel cost--high ($/unit)	**$ 0.8645**	**$ 0.4060**	**$ 0.6465**	**$ 0.7543**	**$ 1.1853**	**$ 0.7543**
Price of fuel/million BTU	$ 6.7170	$ 4.3656	$ 8.4676	$ 13.2325	$ 15.5137	$ 9.0329
Price of fuel/diesel-equivalent gallon	$ 0.8645	$ 0.5619	$ 1.0898	$ 1.7030	$ 1.9966	$ 1.1625

FACILITY CAPITAL COSTS

50-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
Fuel required per weekday	1,669 gal	3,119 therms	3,658 gal	4,335 gal	3,234 gal	3,474 gal
Fueling facility tank capacity (gal)			17,000	41,000	31,000	33,000
CNG fueling facility compressor capacity (cfm)		600				
Natural gas supply pressure (psia) (CNG only)		65				
Fueling facility capital cost						
Default estimate--median	$ -	$ 574,000	$ 571,000	$ 153,000	$ 153,000	$ 245,000
User-specific estimate						
Maintenance facility modification capital cost						
Default estimate--median	$ -	$ 225,000	$ 225,000	$ 171,000	$ 171,000	$ 171,000
User-specific estimate						
Total facility capital costs--median	**$ -**	**$ 799,000**	**$ 796,000**	**$ 324,000**	**$ 324,000**	**$ 416,000**
Fueling facility capital cost--low		$ 344,000	$ 343,000	$ 122,000	$ 122,000	$ 196,000
Maintenance facility modification capital cost--low		$ 135,000	$ 135,000	$ 137,000	$ 137,000	$ 137,000
Total facility capital costs--low		**$ 479,000**	**$ 478,000**	**$ 259,000**	**$ 259,000**	**$ 333,000**
Fueling facility capital cost--high		$ 804,000	$ 799,000	$ 184,000	$ 184,000	$ 294,000
Maintenance facility modification capital cost--high		$ 315,000	$ 315,000	$ 205,000	$ 205,000	$ 205,000
Total facility capital costs--high		**$ 1,119,000**	**$ 1,114,000**	**$ 389,000**	**$ 389,000**	**$ 499,000**

COSTS—MEDIAN
50-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
CAPITAL COSTS						
Vehicle replacement						
Incremental cost per bus--median		$ 70,000	$ 55,000	$ 30,000	$ 30,000	$ 40,000
Base cost per bus						
Default estimate	$ 250,000	$ 320,000	$ 305,000	$ 280,000	$ 280,000	$ 290,000
User-specific estimate						
State sales tax: 7.75%	$ 19,375	$ 24,800	$ 23,638	$ 21,700	$ 21,700	$ 22,475
Total cost per bus	$ 269,375	$ 344,800	$ 328,638	$ 301,700	$ 301,700	$ 312,475
Total vehicle replacement costs	$ 13,468,750	$ 17,240,000	$ 16,431,875	$ 15,085,000	$ 15,085,000	$ 15,623,750
Total facility costs	$ -	$ 798,000	$ 796,000	$ 324,000	$ 324,000	$ 416,000
Total capital costs--median	$ 13,468,750	$ 18,039,000	$ 17,227,875	$ 15,409,000	$ 15,409,000	$ 16,039,750
OPERATING COSTS						
Fuel economy (mi/sales unit)	4.00 mpg_{diesel}	2.14 $mp\ therm_{CNG}$	1.83 mpg_{LNG}	1.54 $mpg_{methanol}$	2.06 $mpg_{ethanol}$	1.92 mpg_{lpg}
Fuel price per gallon--median	$ 0.8645	$ 0.3260	$ 0.4849	$ 0.5926	$ 1.0775	$ 0.6465
Fuel cost per mile	$ 0.22	$ 0.15	$ 0.27	$ 0.38	$ 0.52	$ 0.34
Annual fleet fuel cost	$ 450,253	$ 317,212	$ 553,407	$ 801,463	$ 1,087,183	$ 700,643
Maintenance cost per mile						
Default estimate	$ 0.40	$ 0.46	$ 0.46	$ 0.52	$ 0.52	$ 0.46
User-specific estimate						
Annual fleet maintenance cost	$ 833,340	$ 958,341	$ 958,341	$ 1,083,342	$ 1,083,342	$ 958,341
Annual fueling facility compression electricity cost		$ 79,100				
Annual fueling facility maintenance cost	$ 6,300	$ 19,200	$ 21,000	$ 7,100	$ 6,800	$ 6,800
Other annual operating costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating cost per mile	$ 0.62	$ 0.66	$ 0.74	$ 0.91	$ 1.05	$ 0.80
Total annual operating costs--median	$ 1,290,000	$ 1,374,000	$ 1,533,000	$ 1,892,000	$ 2,177,000	$ 1,666,000
ANNUALIZED COSTS--TOTAL						
Vehicle replacement costs	$ 1,787,236	$ 2,287,662	$ 2,180,428	$ 2,001,704	$ 2,001,704	$ 2,073,194
Facility modification costs	$ -	$ 81,380	$ 81,074	$ 33,000	$ 33,000	$ 42,371
Operating costs	$ 1,290,000	$ 1,374,000	$ 1,533,000	$ 1,892,000	$ 2,177,000	$ 1,666,000
Total annualized cost--median	$ 3,077,236	$ 3,743,042	$ 3,794,502	$ 3,926,704	$ 4,211,704	$ 3,781,564
ANNUALIZED COSTS--LOCAL SHARE						
Vehicle replacement costs	$ 357,447	$407,489.81	$ 396,766	$ 378,894	$ 378,894	$ 386,043
Facility modification costs	$ -	$ 8,138	$ 8,107	$ 3,300	$ 3,300	$ 4,237
Operating costs	$ 1,290,000	$ 1,374,000	$ 1,533,000	$ 1,892,000	$ 2,177,000	$ 1,666,000
Local share of annualized cost--median	$ 1,647,447	$ 1,789,628	$ 1,937,874	$ 2,274,194	$ 2,559,194	$ 2,056,280
EMISSIONS CALCULATIONS						
Emissions rate (g NOx/bhp-hr)	4.0	2.5	2.5	2.0	3.0	2.5
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g NOx/mile)	17.2	10.8	10.8	8.6	12.9	10.8
Annual emissions (tons NOx/yr)	39.5	24.7	24.7	19.7	29.6	24.7
Fleet emissions reduced (tons NOx/year)		14.8	14.8	19.7	9.9	14.8
Emissions rate (g PM/bhp-hr)	0.05	0.03	0.03	0.05	0.05	0.03
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g PM/mile)	0.22	0.13	0.13	0.22	0.22	0.13
Annual emissions (tons PM/yr)	0.49	0.30	0.30	0.49	0.49	0.30
Fleet emissions reduced (tons PM/year)		0.20	0.20	0.00	0.00	0.20

COSTS—LOW
50-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
CAPITAL COSTS						
Vehicle replacement						
Incremental cost per bus–low		$ 65,000	$ 45,000	$ 25,000	$ 25,000	$ 35,000
Base cost per bus						
Default estimate	$ 250,000	$ 315,000	$ 295,000	$ 275,000	$ 275,000	$ 285,000
User-specific estimate		$ -	$ -	$ -	$ -	$ -
State sales tax: 7.75%	$ 19,375	$ 24,413	$ 22,863	$ 21,313	$ 21,313	$ 22,088
Total cost per bus	$ 269,375	$ 339,413	$ 317,863	$ 296,313	$ 296,313	$ 307,088
Total vehicle replacement costs	$ 13,468,750	$ 16,970,625	$ 15,893,125	$ 14,815,625	$ 14,815,625	$ 15,354,375
Total facility costs	$ -	$ 479,000	$ 478,000	$ 259,000	$ 259,000	$ 333,000
Total capital costs–low	$ 13,468,750	$ 17,449,625	$ 16,371,125	$ 15,074,625	$ 15,074,625	$ 15,687,375
OPERATING COSTS						
Fuel economy (mi/sales unit)	4.00 mpg_{diesel}	2.14 $mp\ therm_{CNG}$	1.83 mpg_{LNG}	1.54 $mpg_{methanol}$	2.06 $mpg_{ethanol}$	1.92 mpg_{lpg}
Fuel price per gallon–low	$ 0.8645	$ 0.2760	$ 0.4310	$ 0.4849	$ 0.9698	$ 0.5388
Fuel cost per mile	$ 0.22	$ 0.13	$ 0.24	$ 0.31	$ 0.47	$ 0.28
Annual fleet fuel cost	$ 450,253	$ 268,560	$ 491,918	$ 655,743	$ 978,464	$ 583,869
Maintenance cost per mile						
Default estimate	$ 0.40	$ 0.46	$ 0.46	$ 0.52	$ 0.52	$ 0.46
User-specific estimate	$ -	$ -	$ -	$ -	$ -	$ -
Annual fleet maintenance cost	$ 833,340	$ 958,341	$ 958,341	$ 1,083,342	$ 1,083,342	$ 958,341
Annual fueling facility compression electricity cost		$ 79,100				
Annual fueling facility maintenance cost	$ 6,300	$ 19,200	$ 21,000	$ 7,100	$ 6,800	$ 6,800
Other annual operating costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating cost per mile	$ 0.62	$ 0.64	$ 0.71	$ 0.84	$ 0.99	$ 0.74
Total annual operating costs–low	$ 1,290,000	$ 1,325,000	$ 1,471,000	$ 1,746,000	$ 2,069,000	$ 1,549,000
ANNUALIZED COSTS–TOTAL						
Vehicle replacement costs	$ 1,787,236	$ 2,251,917	$ 2,108,938	$ 1,965,960	$ 1,965,960	$ 2,037,449
Facility modification costs	$ -	$ 48,787	$ 48,685	$ 26,380	$ 26,380	$ 33,917
Operating costs	$ 1,290,000	$ 1,325,000	$ 1,471,000	$ 1,746,000	$ 2,069,000	$ 1,549,000
Total annualized cost–low	$ 3,077,236	$ 3,625,705	$ 3,628,624	$ 3,738,339	$ 4,061,339	$ 3,620,366
Amount less than median annualized cost	$ -	$ 117,337	$ 165,878	$ 188,365	$ 150,365	$ 161,198
ANNUALIZED COSTS–LOCAL SHARE						
Vehicle replacement costs	$ 357,447	$403,915.34	$389,617.45	$375,319.56	$375,319.56	$382,468.51
Facility modification costs	$ -	$ 4,879	$ 4,869	$ 2,638	$ 2,638	$ 3,392
Operating costs	$ 1,290,000	$ 1,325,000	$ 1,471,000	$ 1,746,000	$ 2,069,000	$ 1,549,000
Local share of annualized cost–low	$ 1,647,447	$ 1,733,794	$ 1,865,486	$ 2,123,958	$ 2,446,958	$ 1,934,860
Amount less than median annualized cost	$ -	$ 55,834	$ 72,388	$ 150,237	$ 112,237	$ 121,420
EMISSIONS CALCULATIONS						
Emissions rate (g NOx/bhp-hr)	4.0	2.5	2.5	2.0	3.0	2.5
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g NOx/mile)	17.2	10.8	10.8	8.6	12.9	10.8
Annual emissions (tons NOx/yr)	39.5	24.7	24.7	19.7	29.6	24.7
Fleet emissions reduced (tons NOx/year)		14.8	14.8	19.7	9.9	14.8
Emissions rate (g PM/bhp-hr)	0.05	0.03	0.03	0.05	0.05	0.03
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g PM/mile)	0.22	0.13	0.13	0.22	0.22	0.13
Annual emissions (tons PM/yr)	0.49	0.30	0.30	0.49	0.49	0.30
Fleet emissions reduced (tons PM/year)		0.20	0.20	0.00	0.00	0.20

COSTS—HIGH
50-bus example case

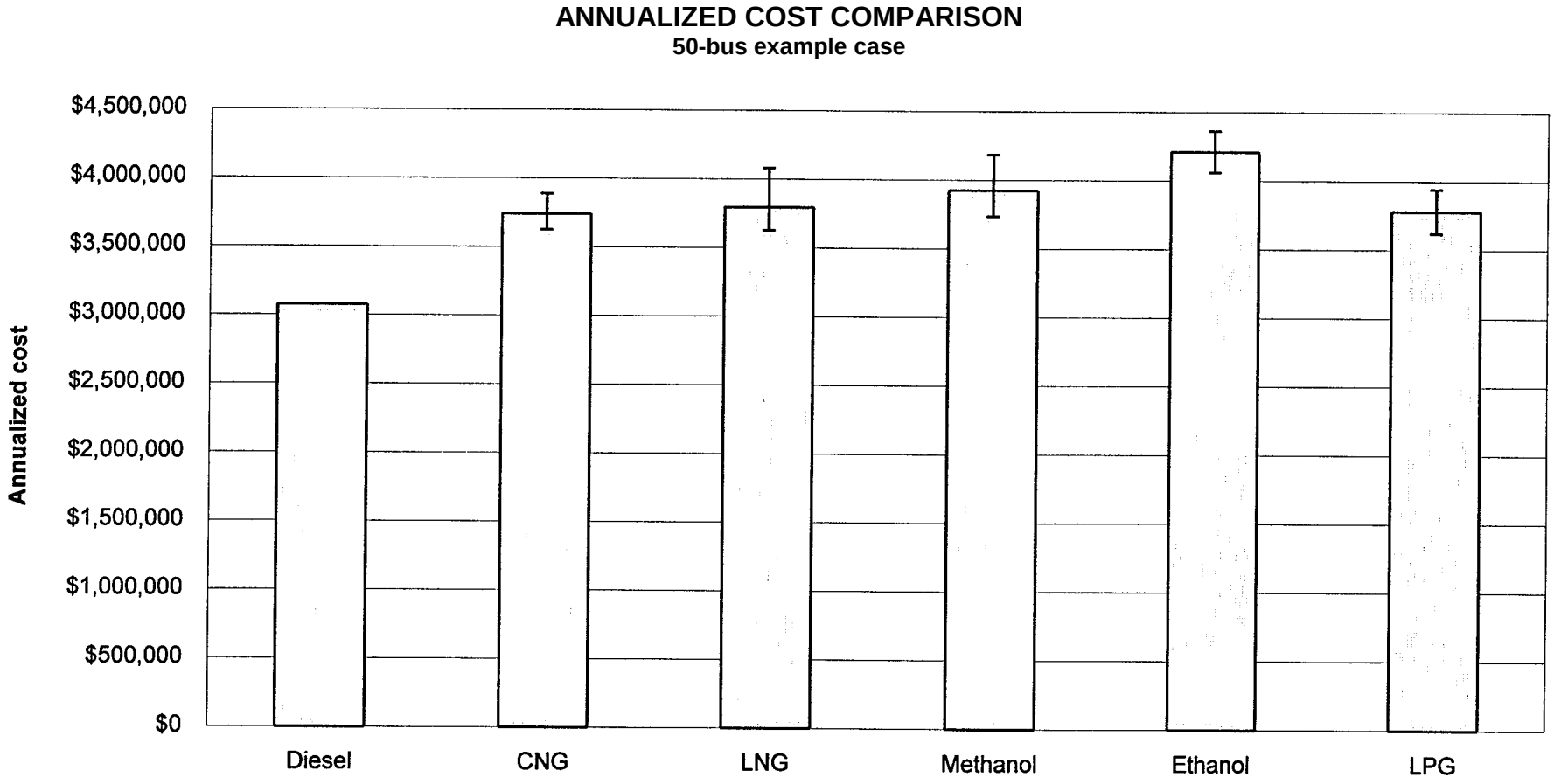
	Diesel	CNG	LNG	Methanol	Ethanol	LPG
CAPITAL COSTS						
Vehicle replacement						
Incremental cost per bus--high		$ 75,000	$ 65,000	$ 35,000	$ 35,000	$ 45,000
Base cost per bus						
Default estimate	$ 250,000	$ 325,000	$ 315,000	$ 285,000	$ 285,000	$ 295,000
User-specific estimate		$ -	$ -	$ -	$ -	$ -
State sales tax: 7.75%	$ 19,375	$ 25,188	$ 24,413	$ 22,088	$ 22,088	$ 22,863
Total cost per bus	$ 269,375	$ 350,188	$ 339,413	$ 307,088	$ 307,088	$ 317,863
Total vehicle replacement costs	**$ 13,468,750**	**$ 17,509,375**	**$ 16,970,625**	**$ 15,354,375**	**$ 15,354,375**	**$ 15,893,125**
Total facility costs	**$ -**	**$ 1,119,000**	**$ 1,114,000**	**$ 389,000**	**$ 389,000**	**$ 499,000**
Total capital costs--high	**$ 13,468,750**	**$ 18,628,375**	**$ 18,084,625**	**$ 15,743,375**	**$ 15,743,375**	**$ 16,392,125**
OPERATING COSTS						
Fuel economy (mi/sales unit)	4.00 mpg_{diesel}	2.14 $mp\ therm_{CNG}$	1.83 mpg_{LNG}	1.54 $mpg_{methanol}$	2.06 $mpg_{ethanol}$	1.92 mpg_{lpg}
Fuel price per gallon--high	$ 0.8645	$ 0.4060	$ 0.6465	$ 0.7543	$ 1.1853	$ 0.7543
Fuel cost per mile	$ 0.22	$ 0.19	$ 0.35	$ 0.49	$ 0.57	$ 0.39
Annual fleet fuel cost	$ 450,253	$ 395,055	$ 737,876	$ 1,020,044	$ 1,196,901	$ 817,417
Maintenance cost per mile						
Default estimate	$ 0.40	$ 0.46	$ 0.46	$ 0.52	$ 0.52	$ 0.46
User-specific estimate	$ -	$ -	$ -	$ -	$ -	$ -
Annual fleet maintenance cost	$ 833,340	$ 958,341	$ 958,341	$ 1,083,342	$ 1,083,342	$ 958,341
Annual fueling facility compression electricity cost		$ 79,100				
Annual fueling facility maintenance cost	$ 6,300	$ 19,200	$ 21,000	$ 7,100	$ 6,800	$ 6,800
Other annual operating costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating cost per mile	$ 0.62	$ 0.70	$ 0.82	$ 1.01	$ 1.10	$ 0.86
Total annual operating costs--high	**$ 1,290,000**	**$ 1,452,000**	**$ 1,717,000**	**$ 2,110,000**	**$ 2,286,000**	**$ 1,783,000**
ANNUALIZED COSTS--TOTAL						
Vehicle replacement costs	$ 1,787,236	$ 2,323,407	$ 2,251,917	$ 2,037,449	$ 2,037,449	$ 2,108,938
Facility modification costs	$ -	$ 113,973	$ 113,463	$ 39,621	$ 39,621	$ 50,824
Operating costs	$ 1,290,000	$ 1,452,000	$ 1,717,000	$ 2,110,000	$ 2,286,000	$ 1,783,000
Total annualized cost--high	**$ 3,077,236**	**$ 3,889,379**	**$ 4,082,381**	**$ 4,187,070**	**$ 4,363,070**	**$ 3,942,763**
Amount greater than median annualized cost	**$ -**	**$ 146,337**	**$ 287,878**	**$ 260,365**	**$ 151,365**	**$ 181,198**
ANNUALIZED COSTS--LOCAL SHARE						
Vehicle replacement costs	$ 357,447	$411,064.28	$403,915.34	$382,468.51	$382,468.51	$389,617.45
Facility modification costs	$ -	$ 11,397	$ 11,346	$ 3,962	$ 3,962	$ 5,082
Operating costs	$ 1,290,000	$ 1,452,000	$ 1,717,000	$ 2,110,000	$ 2,286,000	$ 1,783,000
Local share of annualized cost--high	**$ 1,647,447**	**$ 1,874,462**	**$ 2,132,262**	**$ 2,496,431**	**$ 2,672,431**	**$ 2,177,700**
Amount greater than median annualized cost	**$ -**	**$ 84,834**	**$ 194,388**	**$ 222,237**	**$ 113,237**	**$ 121,420**
EMISSIONS CALCULATIONS						
Emissions rate (g NOx/bhp-hr)	4.0	2.5	2.5	2.0	3.0	2.5
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g NOx/mile)	17.2	10.8	10.8	8.6	12.9	10.8
Annual emissions (tons NOx/yr)	39.5	24.7	24.7	19.7	29.6	24.7
Fleet emissions reduced (tons NOx/year)		14.8	14.8	19.7	9.9	14.8
Emissions rate (g PM/bhp-hr)	0.05	0.03	0.03	0.05	0.05	0.03
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g PM/mile)	0.22	0.13	0.13	0.22	0.22	0.13
Annual emissions (tons PM/yr)	0.49	0.30	0.30	0.49	0.49	0.30
Fleet emissions reduced (tons PM/year)		0.20	0.20	0.00	0.00	0.20

YEARLY COST SUMMARY (CASH-FLOW ANALYSIS)
50-bus example case

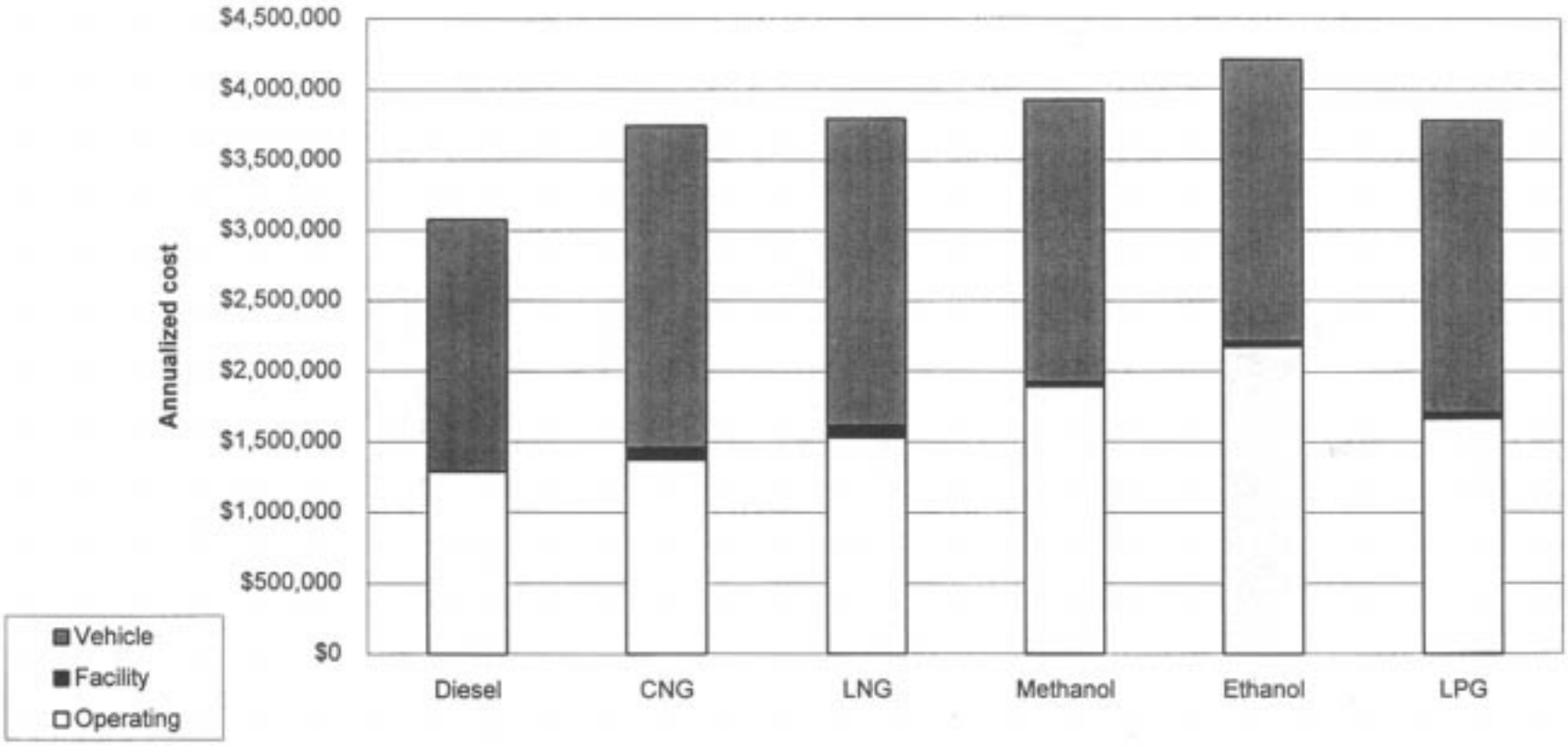
	1998	1999	2000	2001	2002	2003
DIESEL						
Total cost per bus	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375
Number of buses	25	0	0	0	25	0
Bus replacement costs	$ 6,734,375	$ -	$ -	$ -	$ 6,734,375	$ -
Facilities costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs	$ 648,000	$ 648,000	$ 648,000	$ 648,000	$ 1,290,000	$ 1,290,000
Total costs	**$ 7,382,375**	**$ 648,000**	**$ 648,000**	**$ 648,000**	**$ 8,024,375**	**$ 1,290,000**
Local share	**$ 1,994,875**	**$ 648,000**	**$ 648,000**	**$ 648,000**	**$ 2,636,875**	**$ 1,290,000**
CNG						
Total cost per bus--median	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800
Number of buses	25	0	0	0	25	0
Bus replacement costs--median	$ 8,620,000	$ -	$ -	$ -	$ 8,620,000	$ -
Facilities costs--median	$ 799,000	$ -	$ -	$ -	$ -	$ -
Operating costs--median	$ 697,000	$ 697,000	$ 697,000	$ 697,000	$ 1,374,000	$ 1,374,000
Total costs--median	**$ 10,116,000**	**$ 697,000**	**$ 697,000**	**$ 697,000**	**$ 9,994,000**	**$ 1,374,000**
Local share	**$ 2,312,338**	**$ 697,000**	**$ 697,000**	**$ 697,000**	**$ 2,909,438**	**$ 1,374,000**
Total cost per bus--low	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413
Number of buses	25	0	0	0	25	0
Bus replacement costs--low	$ 8,485,313	$ -	$ -	$ -	$ 8,485,313	$ -
Facilities costs--low	$ 479,000	$ -	$ -	$ -	$ -	$ -
Operating costs--low	$ 672,000	$ 672,000	$ 672,000	$ 672,000	$ 1,325,000	$ 1,325,000
Total costs--low	**$ 9,636,313**	**$ 672,000**	**$ 672,000**	**$ 672,000**	**$ 9,810,313**	**$ 1,325,000**
Local share	**$ 2,241,869**	**$ 672,000**	**$ 672,000**	**$ 672,000**	**$ 2,846,969**	**$ 1,325,000**
Total cost per bus--high	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188
Number of buses	25	0	0	0	25	0
Bus replacement costs--high	$ 8,754,688	$ -	$ -	$ -	$ 8,754,688	$ -
Facilities costs--high	$ 1,119,000	$ -	$ -	$ -	$ -	$ -
Operating costs--high	$ 735,000	$ 735,000	$ 735,000	$ 735,000	$ 1,452,000	$ 1,452,000
Total costs--high	**$ 10,608,688**	**$ 735,000**	**$ 735,000**	**$ 735,000**	**$ 10,206,688**	**$ 1,452,000**
Local share	**$ 2,395,806**	**$ 735,000**	**$ 735,000**	**$ 735,000**	**$ 3,000,906**	**$ 1,452,000**
COST DIFFERENTIAL						
CNG--median vs. diesel	$ 2,733,625	$ 49,000	$ 49,000	$ 49,000	$ 1,969,625	$ 84,000
Local share	$ 317,463	$ 49,000	$ 49,000	$ 49,000	$ 272,563	$ 84,000
CNG--low vs. diesel	$ 2,253,938	$ 24,000	$ 24,000	$ 24,000	$ 1,785,938	$ 35,000
Local share	$ 246,994	$ 24,000	$ 24,000	$ 24,000	$ 210,094	$ 35,000
CNG--high vs. diesel	$ 3,226,313	$ 87,000	$ 87,000	$ 87,000	$ 2,182,313	$ 162,000
Local share	$ 400,931	$ 87,000	$ 87,000	$ 87,000	$ 364,031	$ 162,000

YEARLY COST SUMMARY (CASH-FLOW ANALYSIS) (CONCLUDED)
50-bus example case

	2004	2005	2006	2007	2008	2009
DIESEL						
Total cost per bus	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375
Number of buses	0	0	0	0	0	0
Bus replacement costs	$ -	$ -	$ -	$ -	$ -	$ -
Facilities costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs	$ 1,290,000	$ 1,290,000	$ 1,290,000	$ 1,290,000	$ 1,290,000	$ 1,290,000
Total costs	**$ 1,290,000**	**$ 1,290,000**	**$ 1,290,000**	**$ 1,290,000**	**$ 1,290,000**	**$ 1,290,000**
Local share	**$ 1,290,000**	**$ 1,290,000**	**$ 1,290,000**	**$ 1,290,000**	**$ 1,290,000**	**$ 1,290,000**
CNG						
Total cost per bus--median	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800
Number of buses	0	0	0	0	0	0
Bus replacement costs--median	$ -	$ -	$ -	$ -	$ -	$ -
Facilities costs--median	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs--median	$ 1,374,000	$ 1,374,000	$ 1,374,000	$ 1,374,000	$ 1,374,000	$ 1,374,000
Total costs--median	**$ 1,374,000**	**$ 1,374,000**	**$ 1,374,000**	**$ 1,374,000**	**$ 1,374,000**	**$ 1,374,000**
Local share	**$ 1,374,000**	**$ 1,374,000**	**$ 1,374,000**	**$ 1,374,000**	**$ 1,374,000**	**$ 1,374,000**
Total cost per bus--low	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413
Number of buses	0	0	0	0	0	0
Bus replacement costs--low	$ -	$ -	$ -	$ -	$ -	$ -
Facilities costs--low	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs--low	$ 1,325,000	$ 1,325,000	$ 1,325,000	$ 1,325,000	$ 1,325,000	$ 1,325,000
Total costs--low	**$ 1,325,000**	**$ 1,325,000**	**$ 1,325,000**	**$ 1,325,000**	**$ 1,325,000**	**$ 1,325,000**
Local share	**$ 1,325,000**	**$ 1,325,000**	**$ 1,325,000**	**$ 1,325,000**	**$ 1,325,000**	**$ 1,325,000**
Total cost per bus--high	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188
Number of buses	0	0	0	0	0	0
Bus replacement costs--high	$ -	$ -	$ -	$ -	$ -	$ -
Facilities costs--high	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs--high	$ 1,452,000	$ 1,452,000	$ 1,452,000	$ 1,452,000	$ 1,452,000	$ 1,452,000
Total costs--high	**$ 1,452,000**	**$ 1,452,000**	**$ 1,452,000**	**$ 1,452,000**	**$ 1,452,000**	**$ 1,452,000**
Local share	**$ 1,452,000**	**$ 1,452,000**	**$ 1,452,000**	**$ 1,452,000**	**$ 1,452,000**	**$ 1,452,000**
COST DIFFERENTIAL						
CNG--median vs. diesel	$ 84,000	$ 84,000	$ 84,000	$ 84,000	$ 84,000	$ 84,000
Local share	$ 84,000	$ 84,000	$ 84,000	$ 84,000	$ 84,000	$ 84,000
CNG--low vs diesel	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000
Local share	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000
CNG--high vs diesel	$ 162,000	$ 162,000	$ 162,000	$ 162,000	$ 162,000	$ 162,000
Local share	$ 162,000	$ 162,000	$ 162,000	$ 162,000	$ 162,000	$ 162,000

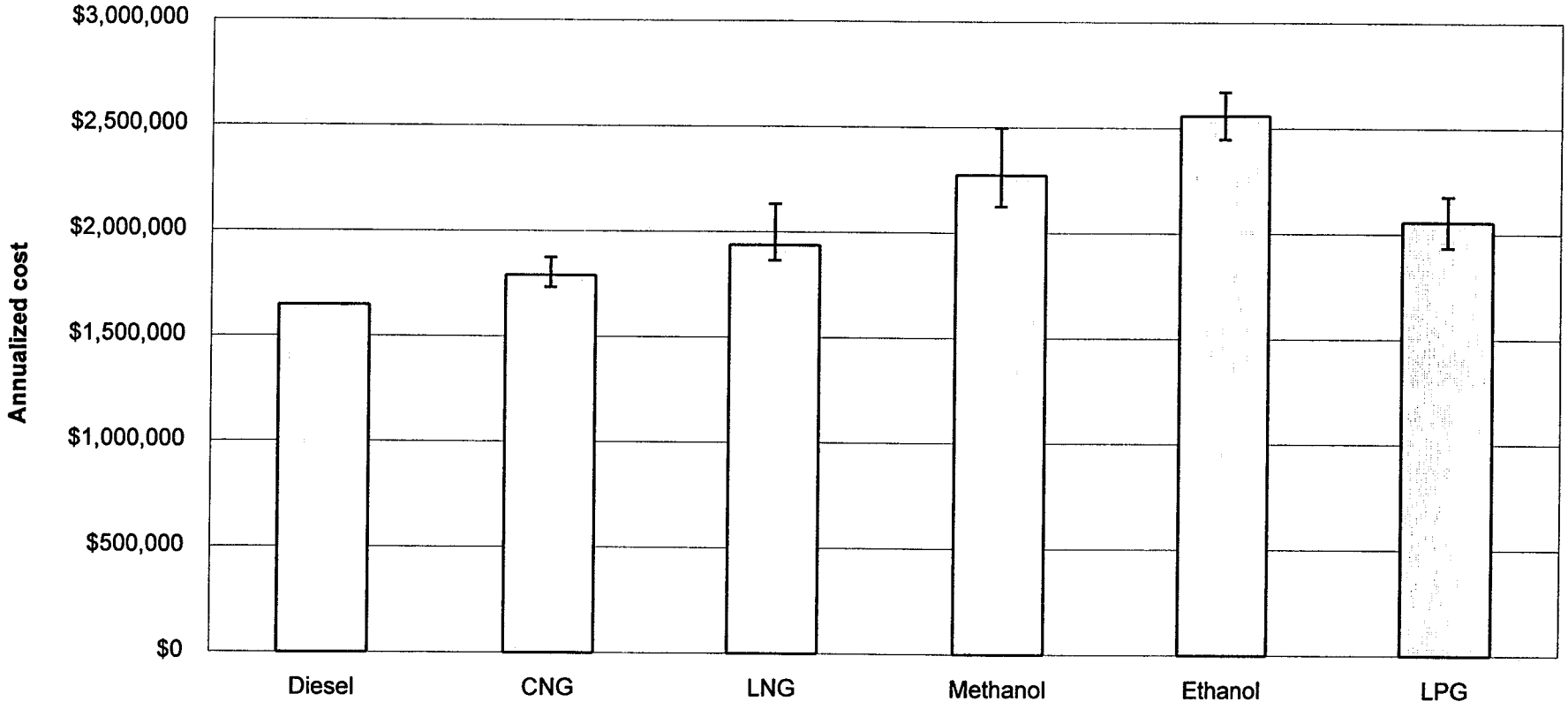

ANNUALIZED COST COMPARISON
50-bus example case
Annualized cost
$4,500,000
$4,000,000
$3,500,000
$3,000,000
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$0
Diesel
CNG
LNG
Methanol
Ethanol
LPG

ANNUALIZED COST BREAKDOWN
50-bus example case

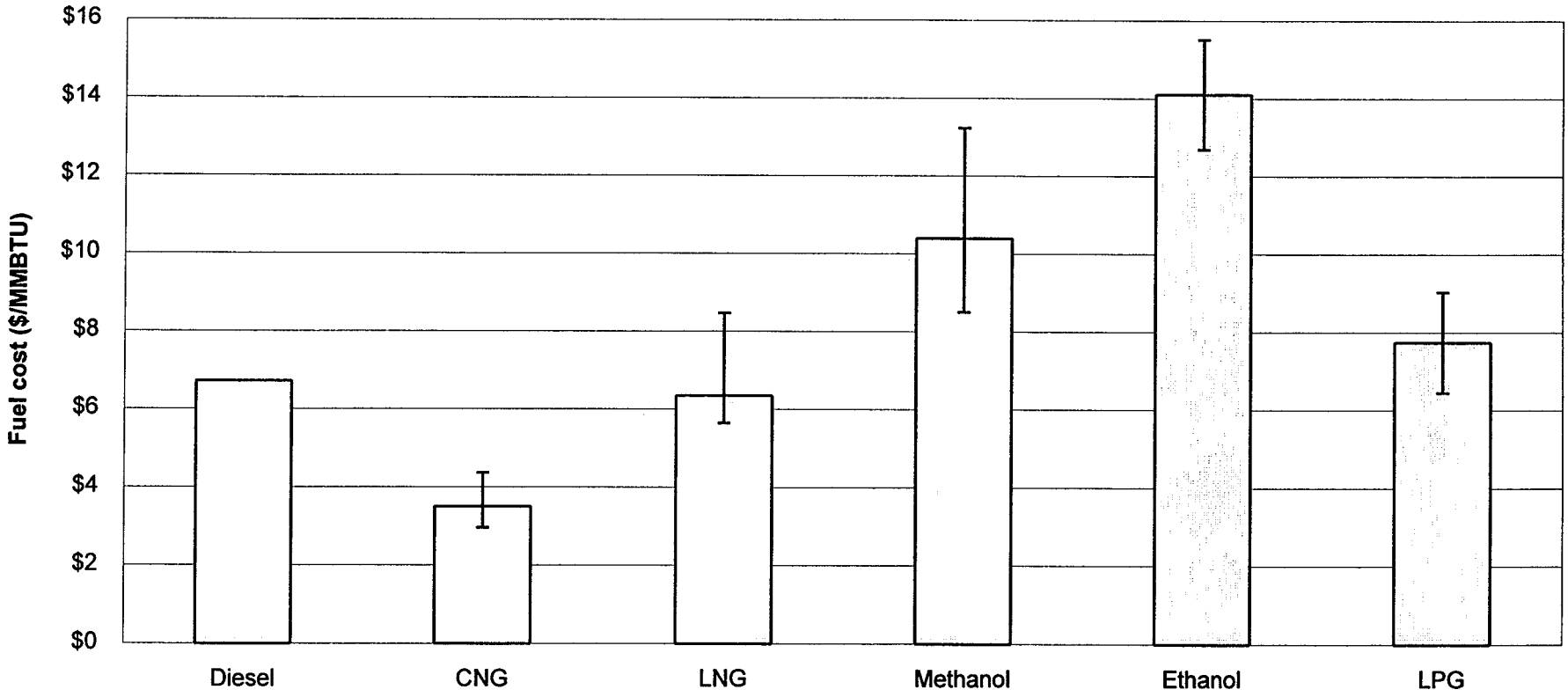


ANNUALIZED COST COMPARISON—LOCAL SHARE

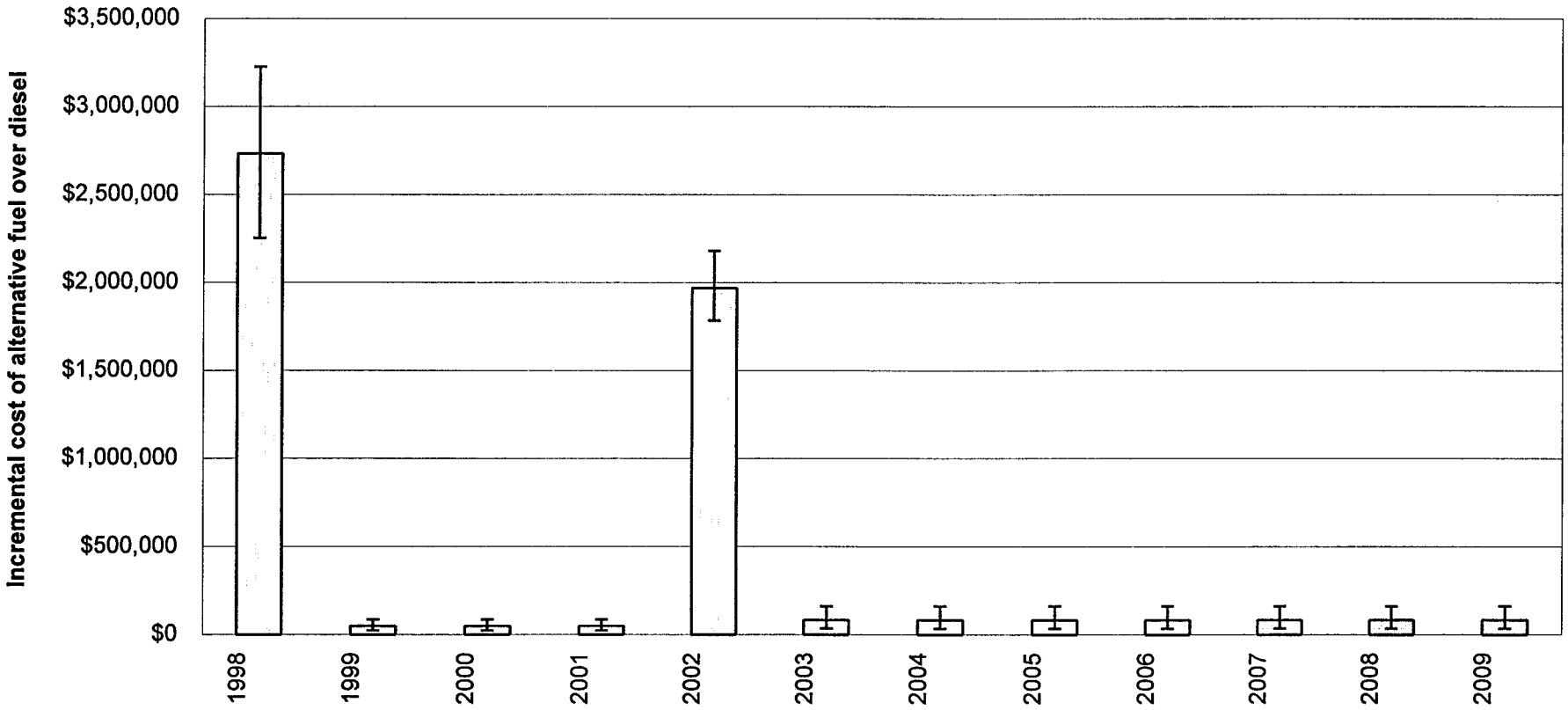
50-bus example case



FUEL COST COMPARISON PER MILLION BTUs
50-bus example case

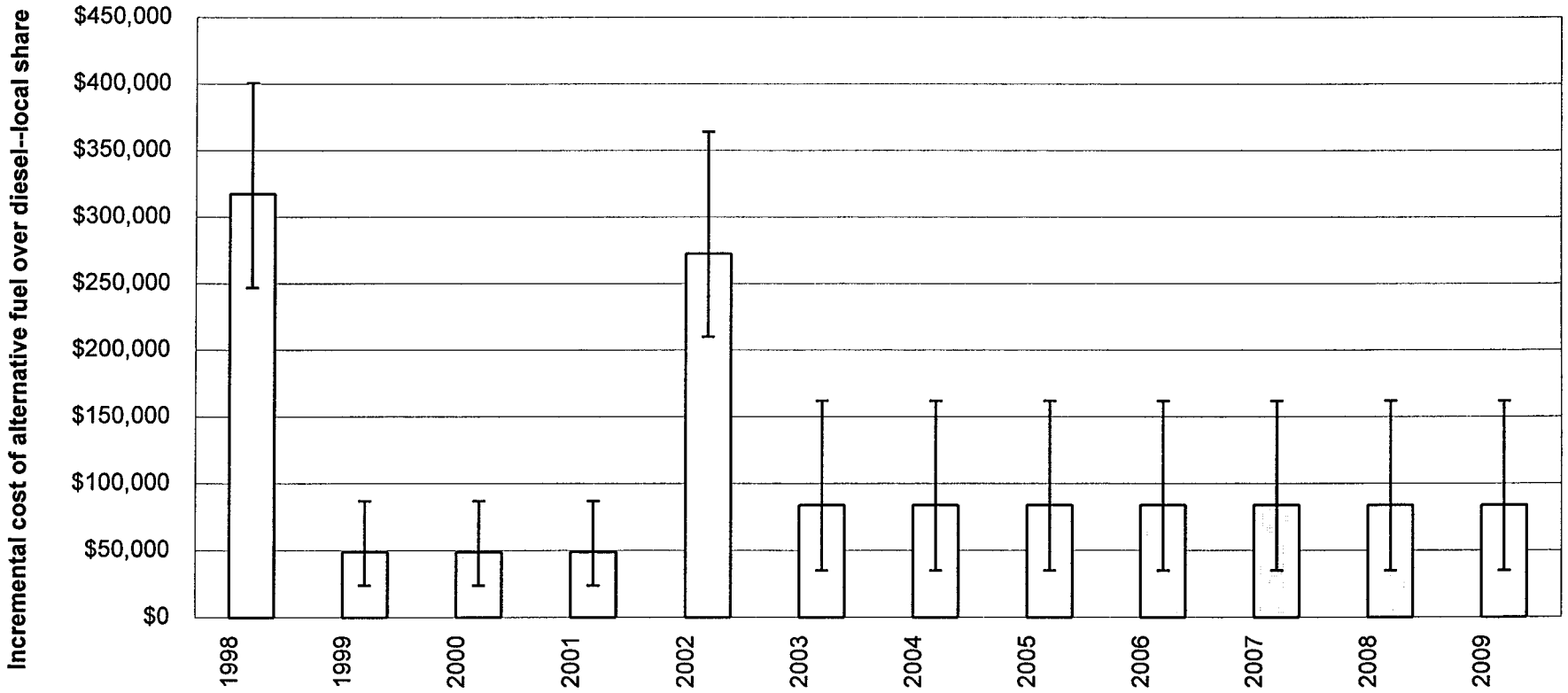


CASH-FLOW ANALYSIS
50-bus example case



CASH-FLOW ANALYSIS—LOCAL SHARE

50-bus example case



GENERAL INPUTS
200-bus example case

Scenario name	200-bus example case
Current year	1998
Sales tax rate	7.75%
Amortization parameters	
Discount rate	8.00%
Fueling facility and maintenance facility life (years)	20
Annual miles per bus	41,667
Required vehicle range (miles) (Enter 300 or 400)	400
Are buses parked indoors? (Enter Y or N)	N
Cost sharing	
Federal share of diesel-related capital costs	80%
Federal share of alternative-fuel-related capital costs	90%
Electricity costs (for CNG compressor station)	
Unit electricity price ($/kWh)	$0.08
Demand charge ($/kW per month)	$10.00
Alternative fuel to use for cash-flow analysis (enter 1 for CNG, 2 for LNG, 3 for methanol, 4 for ethanol, 5 for LPG)	1

BUS DATA

200-bus example case

Current bus fleet

Model year	No. of buses: User-specific
1986 and older	50
1987	0
1988	0
1989	0
1990	100
1991	0
1992	0
1993	50
1994	0
1995	0
1996	0
1997	0
TOTAL	**200**

Bus procurement schedule

Model year	No. of buses: Default	No. of buses: User-specific
1998	50	
1999	0	
2000	0	
2001	0	
2002	100	
2003	0	
2004	0	
2005	50	
2006	0	
2007	0	
2008	0	
2009	0	
TOTAL	**200**	**0**

FUEL PRICE

200-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
Sales unit of fuel	gallon	therm (=100 scf)	gallon	gallon	gallon	gallon
Energy content of fuel (BTU/sales unit)	128,700	93,000	76,350	57,000	76,400	83,500
Efficiency penalty	0%	-35%	-30%	-15%	-15%	-35%
Fuel economy (mi/sales unit)	4.00	2.14	1.83	1.54	2.06	1.92
	mpg_{diesel}	mp $therm_{CNG}$	mpg_{LNG}	$mpg_{methanol}$	$mpg_{ethanol}$	mpg_{lpg}
Unit price--median ($/unit)	$ 0.8000	$ 0.3260	$ 0.4500	$ 0.5500	$ 1.0000	$ 0.6000
Delivery cost ($/unit)	$ -	$ -	$ -	$ -	$ -	$ -
EPA Superfund excise tax ($/unit)	$ 0.0023	$ -	$ -	$ -	$ -	$ -
Subtotal--median ($/unit)	$ 0.8023	$ 0.3260	$ 0.4500	$ 0.5500	$ 1.0000	$ 0.6000
State sales tax: 7.75%	$ 0.0622	$ -	$ 0.0349	$ 0.0426	$ 0.0775	$ 0.0465
Total fuel cost--median ($/unit)	**$ 0.8645**	**$ 0.3260**	**$ 0.4849**	**$ 0.5926**	**$ 1.0775**	**$ 0.6465**
Price of fuel/million BTU	$ 6.7170	$ 3.5054	$ 6.3507	$ 10.3969	$ 14.1034	$ 7.7425
Price of fuel/diesel-equivalent gallon	$ 0.8645	$ 0.4511	$ 0.8173	$ 1.3381	$ 1.8151	$ 0.9965
Unit price--low ($/unit)		$ 0.2760	$ 0.4000	$ 0.4500	$ 0.9000	$ 0.5000
Delivery cost ($/unit)		$ -	$ -	$ -	$ -	$ -
EPA Superfund excise tax ($/unit)		$ -	$ -	$ -	$ -	$ -
Subtotal--low ($/unit)		$ 0.2760	$ 0.4000	$ 0.4500	$ 0.9000	$ 0.5000
State sales tax: 7.75%		$ -	$ 0.0310	$ 0.0349	$ 0.0698	$ 0.0388
Total fuel cost--low ($/unit)	**$ 0.8645**	**$ 0.2760**	**$ 0.4310**	**$ 0.4849**	**$ 0.9698**	**$ 0.5388**
Price of fuel/million BTU	$ 6.7170	$ 2.9677	$ 5.6451	$ 8.5066	$ 12.6931	$ 6.4521
Price of fuel/diesel-equivalent gallon	$ 0.8645	$ 0.3819	$ 0.7265	$ 1.0948	$ 1.6336	$ 0.8304
Unit price--high ($/unit)		$ 0.4060	$ 0.6000	$ 0.7000	$ 1.1000	$ 0.7000
Delivery cost ($/unit)		$ -	$ -	$ -	$ -	$ -
EPA Superfund excise tax ($/unit)		$ -	$ -	$ -	$ -	$ -
Subtotal--high ($/unit)		$ 0.4060	$ 0.6000	$ 0.7000	$ 1.1000	$ 0.7000
State sales tax: 7.75%		$ -	$ 0.0465	$ 0.0543	$ 0.0853	$ 0.0543
Total fuel cost--high ($/unit)	**$ 0.8645**	**$ 0.4060**	**$ 0.6465**	**$ 0.7543**	**$ 1.1853**	**$ 0.7543**
Price of fuel/million BTU	$ 6.7170	$ 4.3656	$ 8.4676	$ 13.2325	$ 15.5137	$ 9.0329
Price of fuel/diesel-equivalent gallon	$ 0.8645	$ 0.5619	$ 1.0898	$ 1.7030	$ 1.9966	$ 1.1625

FACILITY CAPITAL COSTS

200-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
Fuel required per weekday	6,677 gal	12,475 therms	14,633 gal	17,338 gal	12,936 gal	13,894 gal
Fueling facility tank capacity (gal)			61,000	158,000	118,000	127,000
CNG fueling facility compressor capacity (cfm)		2,600				
Natural gas supply pressure (psia) (CNG only)		65				
Fueling facility capital cost						
Default estimate--median	$ -	$ 1,697,000	$ 1,813,000	$ 439,000	$ 439,000	$ 703,000
User-specific estimate						
Maintenance facility modification capital cost						
Default estimate--median	$ -	$ 600,000	$ 600,000	$ 343,000	$ 343,000	$ 343,000
User-specific estimate						
Total facility capital costs--median	**$ -**	**$ 2,297,000**	**$ 2,413,000**	**$ 782,000**	**$ 782,000**	**$ 1,046,000**
Fueling facility capital cost--low		$ 1,018,000	$ 1,088,000	$ 351,000	$ 351,000	$ 562,000
Maintenance facility modification capital cost--low		$ 360,000	$ 360,000	$ 274,000	$ 274,000	$ 274,000
Total facility capital costs--low		**$ 1,378,000**	**$ 1,448,000**	**$ 625,000**	**$ 625,000**	**$ 836,000**
Fueling facility capital cost--high		$ 2,376,000	$ 2,538,000	$ 527,000	$ 527,000	$ 844,000
Maintenance facility modification capital cost--high		$ 840,000	$ 840,000	$ 412,000	$ 412,000	$ 412,000
Total facility capital costs--high		**$ 3,216,000**	**$ 3,378,000**	**$ 939,000**	**$ 939,000**	**$ 1,256,000**

COSTS—MEDIAN
200-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
CAPITAL COSTS						
Vehicle replacement						
Incremental cost per bus--median		$ 70,000	$ 55,000	$ 30,000	$ 30,000	$ 40,000
Base cost per bus						
Default estimate	$ 250,000	$ 320,000	$ 305,000	$ 280,000	$ 280,000	$ 290,000
User-specific estimate						
State sales tax: 7.75%	$ 19,375	$ 24,800	$ 23,638	$ 21,700	$ 21,700	$ 22,475
Total cost per bus	$ 269,375	$ 344,800	$ 328,638	$ 301,700	$ 301,700	$ 312,475
Total vehicle replacement costs	$ 53,875,000	$ 68,960,000	$ 65,727,500	$ 60,340,000	$ 60,340,000	$ 62,495,000
Total facility costs	$ -	$ 2,297,000	$ 2,413,000	$ 782,000	$ 782,000	$ 1,046,000
Total capital costs--median	$ 53,875,000	$ 71,257,000	$ 68,140,500	$ 61,122,000	$ 61,122,000	$ 63,541,000
OPERATING COSTS						
Fuel economy (mi/sales unit)	4.00	2.14	1.83	1.54	2.06	1.92
	mpg_{diesel}	$mp\ therm_{CNG}$	mpg_{LNG}	$mpg_{methanol}$	$mpg_{ethanol}$	mpg_{lpg}
Fuel price per gallon--median	$ 0.8645	$ 0.3260	$ 0.4849	$ 0.5926	$ 1.0775	$ 0.6465
Fuel cost per mile	$ 0.22	$ 0.15	$ 0.27	$ 0.38	$ 0.52	$ 0.34
Annual fleet fuel cost	$ 1,801,011	$ 1,268,847	$ 2,213,629	$ 3,205,854	$ 4,348,731	$ 2,802,571
Maintenance cost per mile						
Default estimate	$ 0.40	$ 0.46	$ 0.46	$ 0.52	$ 0.52	$ 0.46
User-specific estimate						
Annual fleet maintenance cost	$ 3,333,360	$ 3,833,364	$ 3,833,364	$ 4,333,368	$ 4,333,368	$ 3,833,364
Annual fueling facility compression electricity cost		$ 316,300				
Annual fueling facility maintenance cost	$ 7,800	$ 52,900	$ 49,500	$ 11,000	$ 9,700	$ 10,000
Other annual operating costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating cost per mile	$ 0.62	$ 0.66	$ 0.73	$ 0.91	$ 1.04	$ 0.80
Total annual operating costs--median	$ 5,142,000	$ 5,471,000	$ 6,096,000	$ 7,550,000	$ 8,692,000	$ 6,646,000
ANNUALIZED COSTS--TOTAL						
Vehicle replacement costs	$ 7,148,944	$ 9,150,648	$ 8,721,712	$ 8,006,817	$ 8,006,817	$ 8,292,775
Facility modification costs	$ -	$ 233,955	$ 245,769	$ 79,648	$ 79,648	$ 106,537
Operating costs	$ 5,142,000	$ 5,471,000	$ 6,096,000	$ 7,550,000	$ 8,692,000	$ 6,646,000
Total annualized cost--median	$ 12,290,944	$ 14,855,603	$ 15,063,481	$ 15,636,466	$ 16,778,466	$ 15,045,312
ANNUALIZED COSTS--LOCAL SHARE						
Vehicle replacement costs	$ 1,429,789	$1,829,959.24	$ 1,587,066	$ 1,515,576	$ 1,515,576	$ 1,544,172
Facility modification costs	$ -	$ 23,395	$ 24,577	$ 7,965	$ 7,965	$ 10,654
Operating costs	$ 5,142,000	$ 5,471,000	$ 6,096,000	$ 7,550,000	$ 8,692,000	$ 6,646,000
Local share of annualized cost--median	$ 6,571,789	$ 7,124,355	$ 7,707,643	$ 9,073,541	$ 10,215,541	$ 8,200,826
EMISSIONS CALCULATIONS						
Emissions rate (g NOx/bhp-hr)	4.0	2.5	2.5	2.0	3.0	2.5
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g NOx/mile)	17.2	10.8	10.8	8.6	12.9	10.8
Annual emissions (tons NOx/yr)	158.0	98.7	98.7	79.0	118.5	98.7
Fleet emissions reduced (tons NOx/year)		59.2	59.2	79.0	39.5	59.2
Emissions rate (g PM/bhp-hr)	0.05	0.03	0.03	0.05	0.05	0.03
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g PM/mile)	0.22	0.13	0.13	0.22	0.22	0.13
Annual emissions (tons PM/yr)	1.97	1.18	1.18	1.97	1.97	1.18
Fleet emissions reduced (tons PM/year)		0.79	0.79	0.00	0.00	0.79

COSTS—LOW
200-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
CAPITAL COSTS						
Vehicle replacement						
Incremental cost per bus--low		$ 65,000	$ 45,000	$ 25,000	$ 25,000	$ 35,000
Base cost per bus						
Default estimate	$ 250,000	$ 315,000	$ 295,000	$ 275,000	$ 275,000	$ 285,000
User-specific estimate		$ -	$ -	$ -	$ -	$ -
State sales tax: 7.75%	$ 19,375	$ 24,413	$ 22,863	$ 21,313	$ 21,313	$ 22,088
Total cost per bus	$ 269,375	$ 339,413	$ 317,863	$ 296,313	$ 296,313	$ 307,088
Total vehicle replacement costs	**$ 53,875,000**	**$ 67,882,500**	**$ 63,572,500**	**$ 59,262,500**	**$ 59,262,500**	**$ 61,417,500**
Total facility costs	**$ -**	**$ 1,378,000**	**$ 1,448,000**	**$ 625,000**	**$ 625,000**	**$ 836,000**
Total capital costs--low	**$ 53,875,000**	**$ 69,260,500**	**$ 65,020,500**	**$ 59,887,500**	**$ 59,887,500**	**$ 62,253,500**
OPERATING COSTS						
Fuel economy (mi/sales unit)	4.00 mpg_{diesel}	2.14 $mp\ therm_{CNG}$	1.83 mpg_{LNG}	1.54 $mpg_{methanol}$	2.06 $mpg_{ethanol}$	1.92 mpg_{lpg}
Fuel price per gallon--low	$ 0.8645	$ 0.2760	$ 0.4310	$ 0.4849	$ 0.9698	$ 0.5388
Fuel cost per mile	$ 0.22	$ 0.13	$ 0.24	$ 0.31	$ 0.47	$ 0.28
Annual fleet fuel cost	$ 1,801,011	$ 1,074,238	$ 1,967,670	$ 2,622,971	$ 3,913,858	$ 2,335,476
Maintenance cost per mile						
Default estimate	$ 0.40	$ 0.46	$ 0.46	$ 0.52	$ 0.52	$ 0.46
User-specific estimate	$ -	$ -	$ -	$ -	$ -	$ -
Annual fleet maintenance cost	$ 3,333,360	$ 3,833,364	$ 3,833,364	$ 4,333,368	$ 4,333,368	$ 3,833,364
Annual fueling facility compression electricity cost		$ 316,300				
Annual fueling facility maintenance cost	$ 7,800	$ 52,900	$ 49,500	$ 11,000	$ 9,700	$ 10,000
Other annual operating costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating cost per mile	$ 0.62	$ 0.63	$ 0.70	$ 0.84	$ 0.99	$ 0.74
Total annual operating costs--low	**$ 5,142,000**	**$ 5,277,000**	**$ 5,851,000**	**$ 6,967,000**	**$ 8,257,000**	**$ 6,179,000**
ANNUALIZED COSTS--TOTAL						
Vehicle replacement costs	$ 7,148,944	$ 9,007,669	$ 8,435,754	$ 7,863,838	$ 7,863,838	$ 8,149,796
Facility modification costs	$ -	$ 140,352	$ 147,482	$ 63,658	$ 63,658	$ 85,148
Operating costs	$ 5,142,000	$ 5,277,000	$ 5,851,000	$ 6,967,000	$ 8,257,000	$ 6,179,000
Total annualized cost--low	**$ 12,290,944**	**$ 14,425,022**	**$ 14,434,236**	**$ 14,894,496**	**$ 16,184,496**	**$ 14,413,945**
Amount less than median annualized cost	**$ -**	**$ 430,581**	**$ 629,245**	**$ 741,970**	**$ 593,970**	**$ 631,368**
ANNUALIZED COSTS--LOCAL SHARE						
Vehicle replacement costs	$ 1,429,789	$1,615,661.35	$1,558,469.80	$1,501,278.25	$1,501,278.25	$1,529,874.02
Facility modification costs	$ -	$ 14,035	$ 14,748	$ 6,366	$ 6,366	$ 8,515
Operating costs	$ 5,142,000	$ 5,277,000	$ 5,851,000	$ 6,967,000	$ 8,257,000	$ 6,179,000
Local share of annualized cost--low	**$ 6,571,789**	**$ 6,906,697**	**$ 7,424,218**	**$ 8,474,644**	**$ 9,764,644**	**$ 7,717,389**
Amount less than median annualized cost	**$ -**	**$ 217,658**	**$ 283,425**	**$ 596,897**	**$ 450,897**	**$ 483,437**
EMISSIONS CALCULATIONS						
Emissions rate (g NOx/bhp-hr)	4.0	2.5	2.5	2.0	3.0	2.5
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g NOx/mile)	17.2	10.8	10.8	8.6	12.9	10.8
Annual emissions (tons NOx/yr)	158.0	98.7	98.7	79.0	118.5	98.7
Fleet emissions reduced (tons NOx/year)		59.2	59.2	79.0	39.5	59.2
Emissions rate (g PM/bhp-hr)	0.05	0.03	0.03	0.05	0.05	0.03
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g PM/mile)	0.22	0.13	0.13	0.22	0.22	0.13
Annual emissions (tons PM/yr)	1.97	1.18	1.18	1.97	1.97	1.18
Fleet emissions reduced (tons PM/year)		0.79	0.79	0.00	0.00	0.79

COSTS—HIGH
200-bus example case

	Diesel	CNG	LNG	Methanol	Ethanol	LPG
CAPITAL COSTS						
Vehicle replacement						
Incremental cost per bus--high		$ 75,000	$ 65,000	$ 35,000	$ 35,000	$ 45,000
Base cost per bus						
Default estimate	$ 250,000	$ 325,000	$ 315,000	$ 285,000	$ 285,000	$ 295,000
User-specific estimate		$ -	$ -	$ -	$ -	$ -
State sales tax: 7.75%	$ 19,375	$ 25,188	$ 24,413	$ 22,088	$ 22,088	$ 22,863
Total cost per bus	$ 269,375	$ 350,188	$ 339,413	$ 307,088	$ 307,088	$ 317,863
Total vehicle replacement costs	**$ 53,875,000**	**$ 70,037,500**	**$ 67,882,500**	**$ 61,417,500**	**$ 61,417,500**	**$ 63,572,500**
Total facility costs	**$ -**	**$ 3,216,000**	**$ 3,378,000**	**$ 939,000**	**$ 939,000**	**$ 1,256,000**
Total capital costs--high	**$ 53,875,000**	**$ 73,253,500**	**$ 71,260,500**	**$ 62,356,500**	**$ 62,356,500**	**$ 64,828,500**
OPERATING COSTS						
Fuel economy (mi/sales unit)	4.00 mpg_{diesel}	2.14 $mp\ therm_{CNG}$	1.83 mpg_{LNG}	1.54 $mpg_{methanol}$	2.06 $mpg_{ethanol}$	1.92 mpg_{lpg}
Fuel price per gallon--high	$ 0.8645	$ 0.4060	$ 0.6465	$ 0.7543	$ 1.1853	$ 0.7543
Fuel cost per mile	$ 0.22	$ 0.19	$ 0.35	$ 0.49	$ 0.57	$ 0.39
Annual fleet fuel cost	$ 1,801,011	$ 1,580,220	$ 2,951,506	$ 4,080,178	$ 4,783,604	$ 3,269,666
Maintenance cost per mile						
Default estimate	$ 0.40	$ 0.46	$ 0.46	$ 0.52	$ 0.52	$ 0.46
User-specific estimate	$ -	$ -	$ -	$ -	$ -	$ -
Annual fleet maintenance cost	$ 3,333,360	$ 3,833,364	$ 3,833,364	$ 4,333,368	$ 4,333,368	$ 3,833,364
Annual fueling facility compression electricity cost		$ 316,300				
Annual fueling facility maintenance cost	$ 7,800	$ 52,900	$ 49,500	$ 11,000	$ 9,700	$ 10,000
Other annual operating costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating cost per mile	$ 0.62	$ 0.69	$ 0.82	$ 1.01	$ 1.10	$ 0.85
Total annual operating costs--high	**$ 5,142,000**	**$ 5,783,000**	**$ 6,834,000**	**$ 8,425,000**	**$ 9,127,000**	**$ 7,113,000**
ANNUALIZED COSTS--TOTAL						
Vehicle replacement costs	$ 7,148,944	$ 9,293,627	$ 9,007,669	$ 8,149,796	$ 8,149,796	$ 8,435,754
Facility modification costs	$ -	$ 327,557	$ 344,057	$ 95,639	$ 95,639	$ 127,926
Operating costs	$ 5,142,000	$ 5,783,000	$ 6,834,000	$ 8,425,000	$ 9,127,000	$ 7,113,000
Total annualized cost--high	**$ 12,290,944**	**$ 15,404,184**	**$ 16,185,726**	**$ 16,670,435**	**$ 17,372,435**	**$ 15,676,680**
Amount greater than median annualized cost	**$ -**	**$ 548,581**	**$ 1,122,245**	**$ 1,033,970**	**$ 593,970**	**$ 631,368**
ANNUALIZED COSTS--LOCAL SHARE						
Vehicle replacement costs	$ 1,429,789	$1,644,257.13	$1,615,661.35	$1,529,874.02	$1,529,874.02	$1,558,469.80
Facility modification costs	$ -	$ 32,756	$ 34,406	$ 9,564	$ 9,564	$ 12,793
Operating costs	$ 5,142,000	$ 5,783,000	$ 6,834,000	$ 8,425,000	$ 9,127,000	$ 7,113,000
Local share of annualized cost--high	**$ 6,571,789**	**$ 7,460,013**	**$ 8,484,067**	**$ 9,964,438**	**$ 10,666,438**	**$ 8,684,262**
Amount greater than median annualized cost	**$ -**	**$ 335,658**	**$ 776,425**	**$ 890,897**	**$ 450,897**	**$ 483,437**
EMISSIONS CALCULATIONS						
Emissions rate (g NOx/bhp-hr)	4.0	2.5	2.5	2.0	3.0	2.5
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g NOx/mile)	17.2	10.8	10.8	8.6	12.9	10.8
Annual emissions (tons NOx/yr)	158.0	98.7	98.7	79.0	118.5	98.7
Fleet emissions reduced (tons NOx/year)		59.2	59.2	79.0	39.5	59.2
Emissions rate (g PM/bhp-hr)	0.05	0.03	0.03	0.05	0.05	0.03
Conversion factor (bhp-hr/mile)	4.3	4.3	4.3	4.3	4.3	4.3
Emissions rate (g PM/mile)	0.22	0.13	0.13	0.22	0.22	0.13
Annual emissions (tons PM/yr)	1.97	1.18	1.18	1.97	1.97	1.18
Fleet emissions reduced (tons PM/year)		0.79	0.79	0.00	0.00	0.79

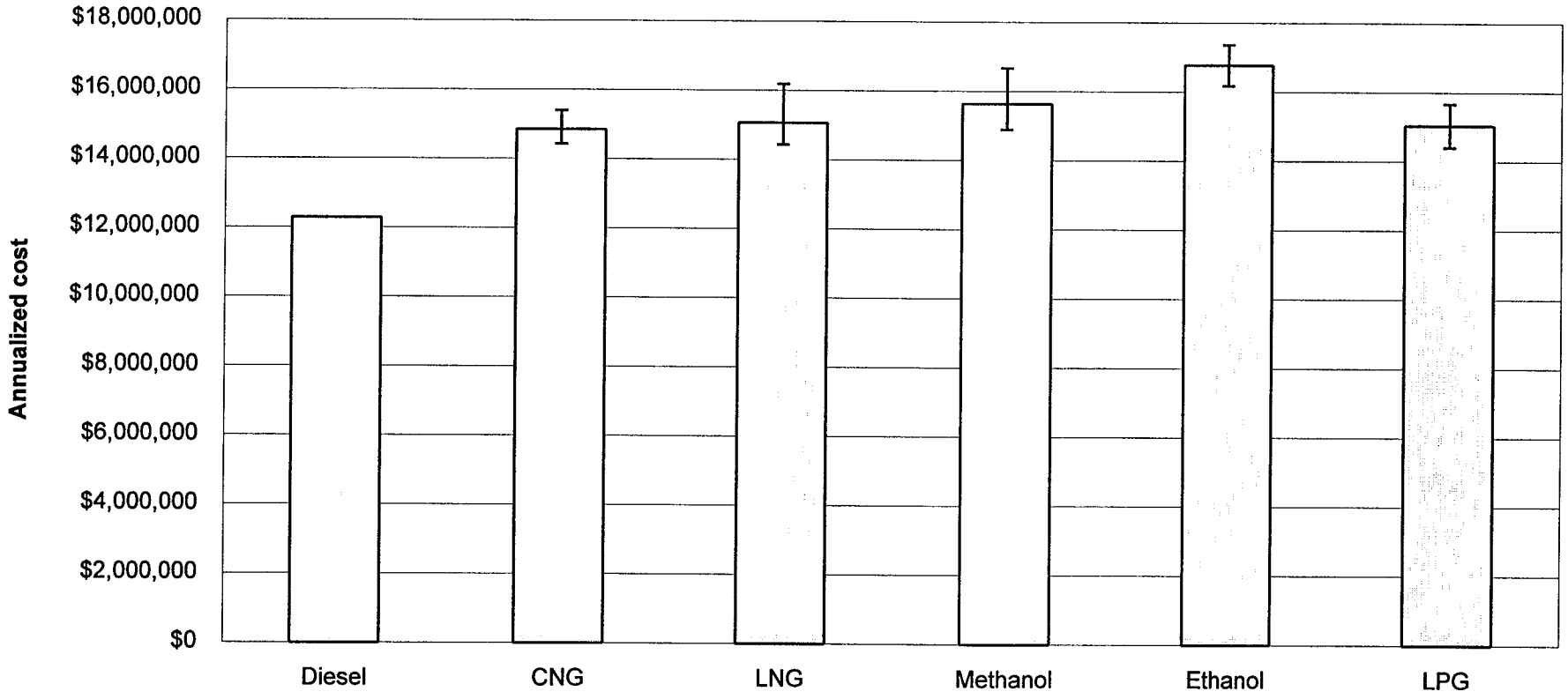
YEARLY COST SUMMARY (CASH-FLOW ANALYSIS)
200-bus example case

	1998	1999	2000	2001	2002	2003
DIESEL						
Total cost per bus	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375
Number of buses	50	0	0	0	100	0
Bus replacement costs	$ 13,468,750	$ -	$ -	$ -	$ 26,937,500	$ -
Facilities costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs	$ 1,291,000	$ 1,291,000	$ 1,291,000	$ 1,291,000	$ 3,859,000	$ 3,859,000
Total costs	**$ 14,759,750**	**$ 1,291,000**	**$ 1,291,000**	**$ 1,291,000**	**$ 30,796,500**	**$ 3,859,000**
Local share	**$ 3,984,750**	**$ 1,291,000**	**$ 1,291,000**	**$ 1,291,000**	**$ 9,246,500**	**$ 3,859,000**
CNG						
Total cost per bus--median	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800
Number of buses	50	0	0	0	100	0
Bus replacement costs--median	$ 17,240,000	$ -	$ -	$ -	$ 34,480,000	$ -
Facilities costs--median	$ 2,297,000	$ -	$ -	$ -	$ -	$ -
Operating costs--median	$ 1,408,000	$ 1,408,000	$ 1,408,000	$ 1,408,000	$ 4,117,000	$ 4,117,000
Total costs--median	**$ 20,945,000**	**$ 1,408,000**	**$ 1,408,000**	**$ 1,408,000**	**$ 38,597,000**	**$ 4,117,000**
Local share	**$ 4,708,575**	**$ 1,408,000**	**$ 1,408,000**	**$ 1,408,000**	**$ 10,258,750**	**$ 4,117,000**
Total cost per bus--low	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413
Number of buses	50	0	0	0	100	0
Bus replacement costs--low	$ 16,970,625	$ -	$ -	$ -	$ 33,941,250	$ -
Facilities costs--low	$ 1,378,000	$ -	$ -	$ -	$ -	$ -
Operating costs--low	$ 1,359,000	$ 1,359,000	$ 1,359,000	$ 1,359,000	$ 3,971,000	$ 3,971,000
Total costs--low	**$ 19,707,625**	**$ 1,359,000**	**$ 1,359,000**	**$ 1,359,000**	**$ 37,912,250**	**$ 3,971,000**
Local share	**$ 4,540,738**	**$ 1,359,000**	**$ 1,359,000**	**$ 1,359,000**	**$ 10,058,875**	**$ 3,971,000**
Total cost per bus--high	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188
Number of buses	50	0	0	0	100	0
Bus replacement costs--high	$ 17,509,375	$ -	$ -	$ -	$ 35,018,750	$ -
Facilities costs--high	$ 3,216,000	$ -	$ -	$ -	$ -	$ -
Operating costs--high	$ 1,485,000	$ 1,485,000	$ 1,485,000	$ 1,485,000	$ 4,350,000	$ 4,350,000
Total costs--high	**$ 22,210,375**	**$ 1,485,000**	**$ 1,485,000**	**$ 1,485,000**	**$ 39,368,750**	**$ 4,350,000**
Local share	**$ 4,904,413**	**$ 1,485,000**	**$ 1,485,000**	**$ 1,485,000**	**$ 10,545,625**	**$ 4,350,000**
COST DIFFERENTIAL						
CNG--median vs. diesel	$ 6,185,250	$ 117,000	$ 117,000	$ 117,000	$ 7,800,500	$ 258,000
Local share	$ 723,825	$ 117,000	$ 117,000	$ 117,000	$ 1,012,250	$ 258,000
CNG--low vs. diesel	$ 4,947,875	$ 68,000	$ 68,000	$ 68,000	$ 7,115,750	$ 112,000
Local share	$ 555,988	$ 68,000	$ 68,000	$ 68,000	$ 812,375	$ 112,000
CNG--high vs. diesel	$ 7,450,625	$ 194,000	$ 194,000	$ 194,000	$ 8,572,250	$ 491,000
Local share	$ 919,663	$ 194,000	$ 194,000	$ 194,000	$ 1,299,125	$ 491,000

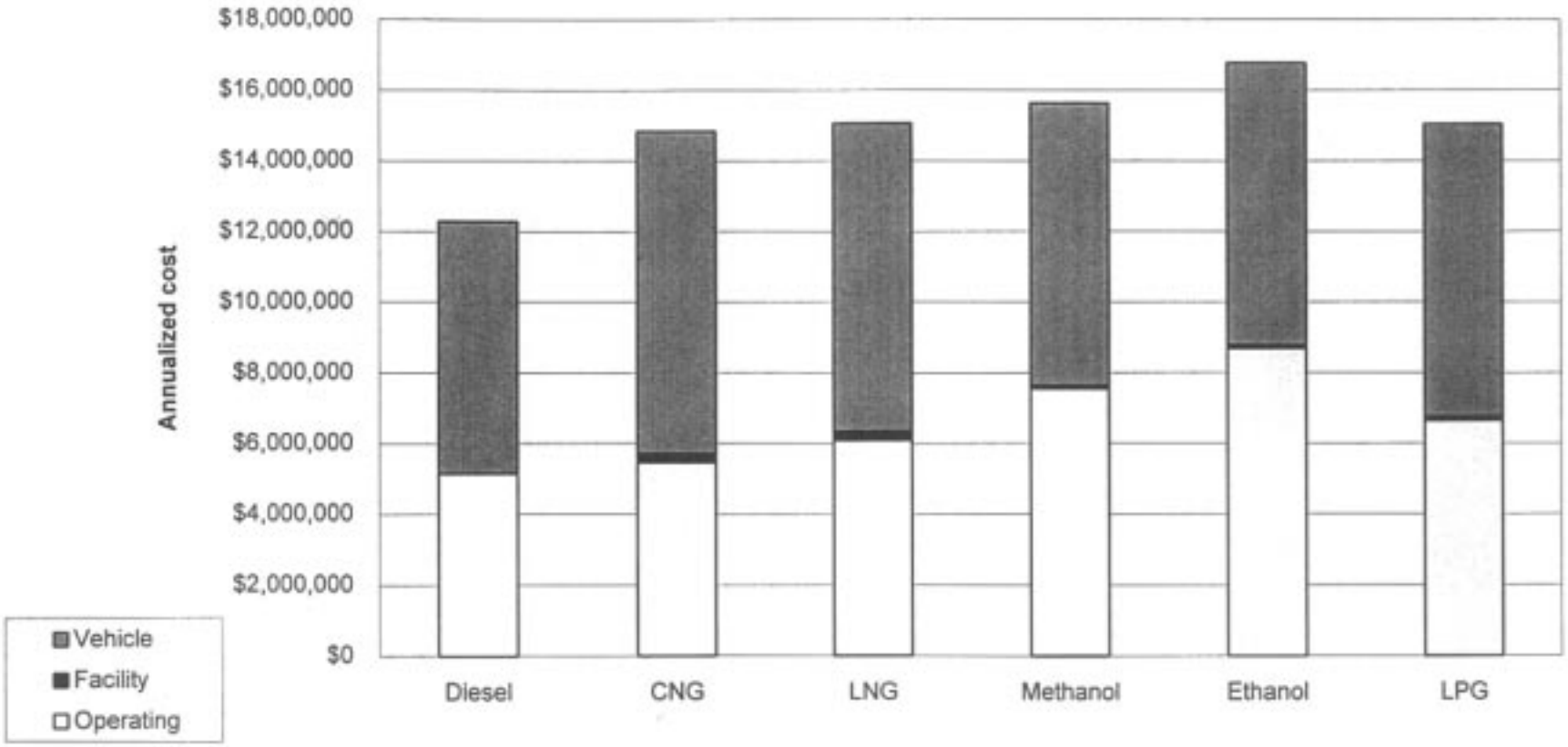
YEARLY COST SUMMARY (CASH-FLOW ANALYSIS) (CONCLUDED)
200-bus example case

	2004	2005	2006	2007	2008	2009
DIESEL						
Total cost per bus	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375	$ 269,375
Number of buses	0	50	0	0	0	0
Bus replacement costs	$ -	$ 13,468,750	$ -	$ -	$ -	$ -
Facilities costs	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs	$ 3,859,000	$ 5,142,000	$ 5,142,000	$ 5,142,000	$ 5,142,000	$ 5,142,000
Total costs	**$ 3,859,000**	**$ 18,610,750**	**$ 5,142,000**	**$ 5,142,000**	**$ 5,142,000**	**$ 5,142,000**
Local share	**$ 3,859,000**	**$ 7,835,750**	**$ 5,142,000**	**$ 5,142,000**	**$ 5,142,000**	**$ 5,142,000**
CNG						
Total cost per bus--median	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800	$ 344,800
Number of buses	0	50	0	0	0	0
Bus replacement costs--median	$ -	$ 17,240,000	$ -	$ -	$ -	$ -
Facilities costs--median	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs--median	$ 4,117,000	$ 5,471,000	$ 5,471,000	$ 5,471,000	$ 5,471,000	$ 5,471,000
Total costs--median	**$ 4,117,000**	**$ 22,711,000**	**$ 5,471,000**	**$ 5,471,000**	**$ 5,471,000**	**$ 5,471,000**
Local share	**$ 4,117,000**	**$ 8,541,875**	**$ 5,471,000**	**$ 5,471,000**	**$ 5,471,000**	**$ 5,471,000**
Total cost per bus--low	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413	$ 339,413
Number of buses	0	50	0	0	0	0
Bus replacement costs--low	$ -	$ 16,970,625	$ -	$ -	$ -	$ -
Facilities costs--low	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs--low	$ 3,971,000	$ 5,277,000	$ 5,277,000	$ 5,277,000	$ 5,277,000	$ 5,277,000
Total costs--low	**$ 3,971,000**	**$ 22,247,625**	**$ 5,277,000**	**$ 5,277,000**	**$ 5,277,000**	**$ 5,277,000**
Local share	**$ 3,971,000**	**$ 8,320,938**	**$ 5,277,000**	**$ 5,277,000**	**$ 5,277,000**	**$ 5,277,000**
Total cost per bus--high	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188	$ 350,188
Number of buses	0	50	0	0	0	0
Bus replacement costs--high	$ -	$ 17,509,375	$ -	$ -	$ -	$ -
Facilities costs--high	$ -	$ -	$ -	$ -	$ -	$ -
Operating costs--high	$ 4,350,000	$ 5,783,000	$ 5,783,000	$ 5,783,000	$ 5,783,000	$ 5,783,000
Total costs--high	**$ 4,350,000**	**$ 23,292,375**	**$ 5,783,000**	**$ 5,783,000**	**$ 5,783,000**	**$ 5,783,000**
Local share	**$ 4,350,000**	**$ 8,880,813**	**$ 5,783,000**	**$ 5,783,000**	**$ 5,783,000**	**$ 5,783,000**
COST DIFFERENTIAL						
CNG--median vs. diesel	$ 258,000	$ 4,100,250	$ 329,000	$ 329,000	$ 329,000	$ 329,000
Local share	$ 258,000	$ 706,125	$ 329,000	$ 329,000	$ 329,000	$ 329,000
CNG--low vs diesel	$ 112,000	$ 3,636,875	$ 135,000	$ 135,000	$ 135,000	$ 135,000
Local share	$ 112,000	$ 485,188	$ 135,000	$ 135,000	$ 135,000	$ 135,000
CNG--high vs diesel	$ 491,000	$ 4,681,625	$ 641,000	$ 641,000	$ 641,000	$ 641,000
Local share	$ 491,000	$ 1,045,063	$ 641,000	$ 641,000	$ 641,000	$ 641,000

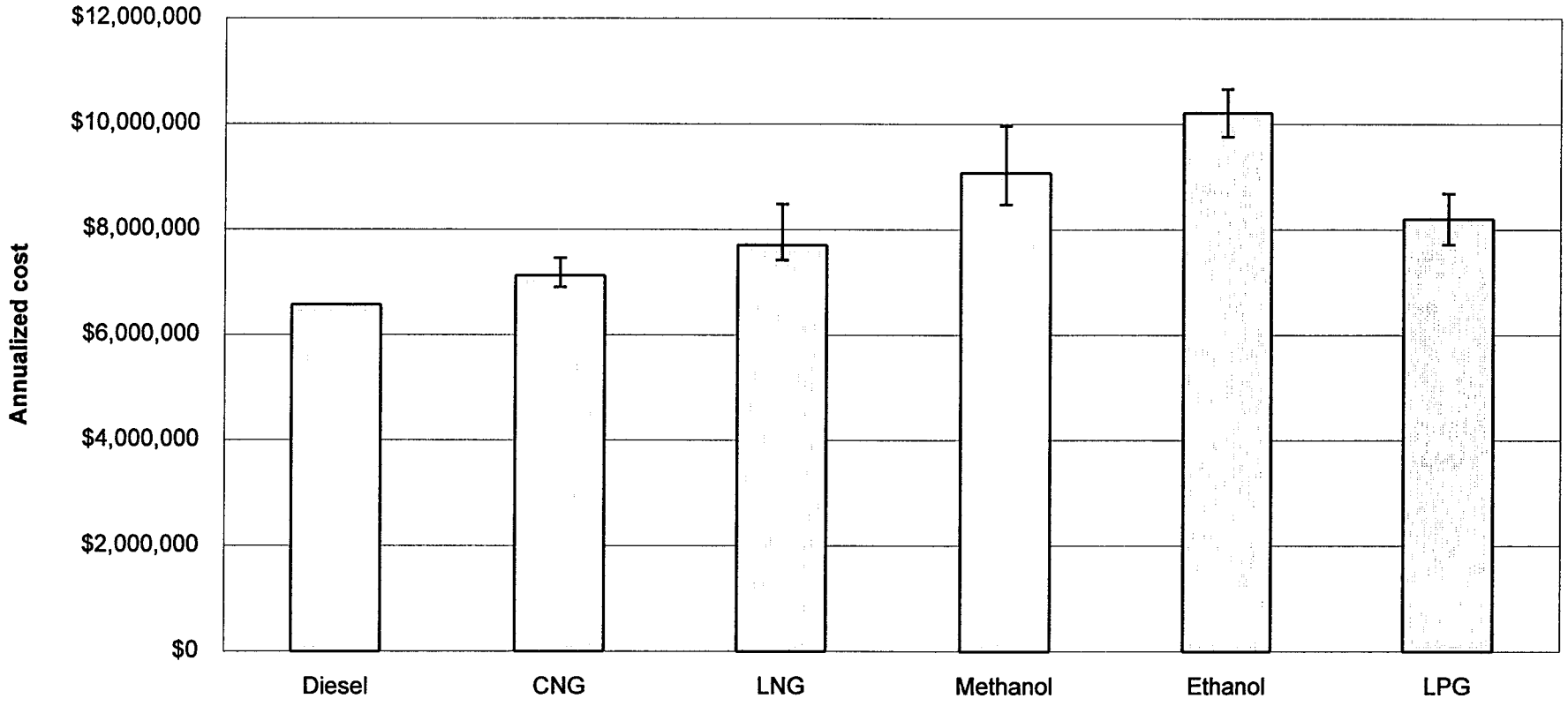
ANNUALIZED COST COMPARISON
200-bus example case



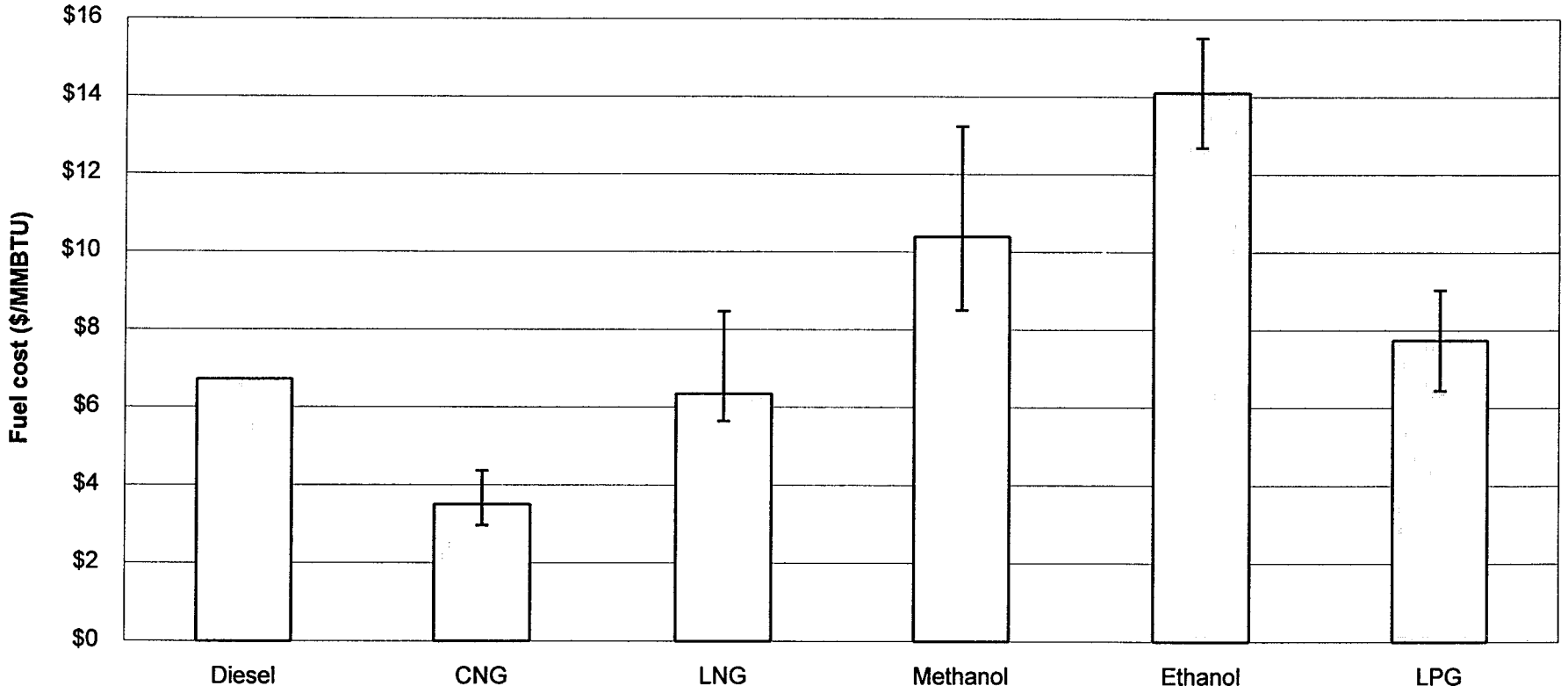
ANNUALIZED COST BREAKDOWN
200-bus example case

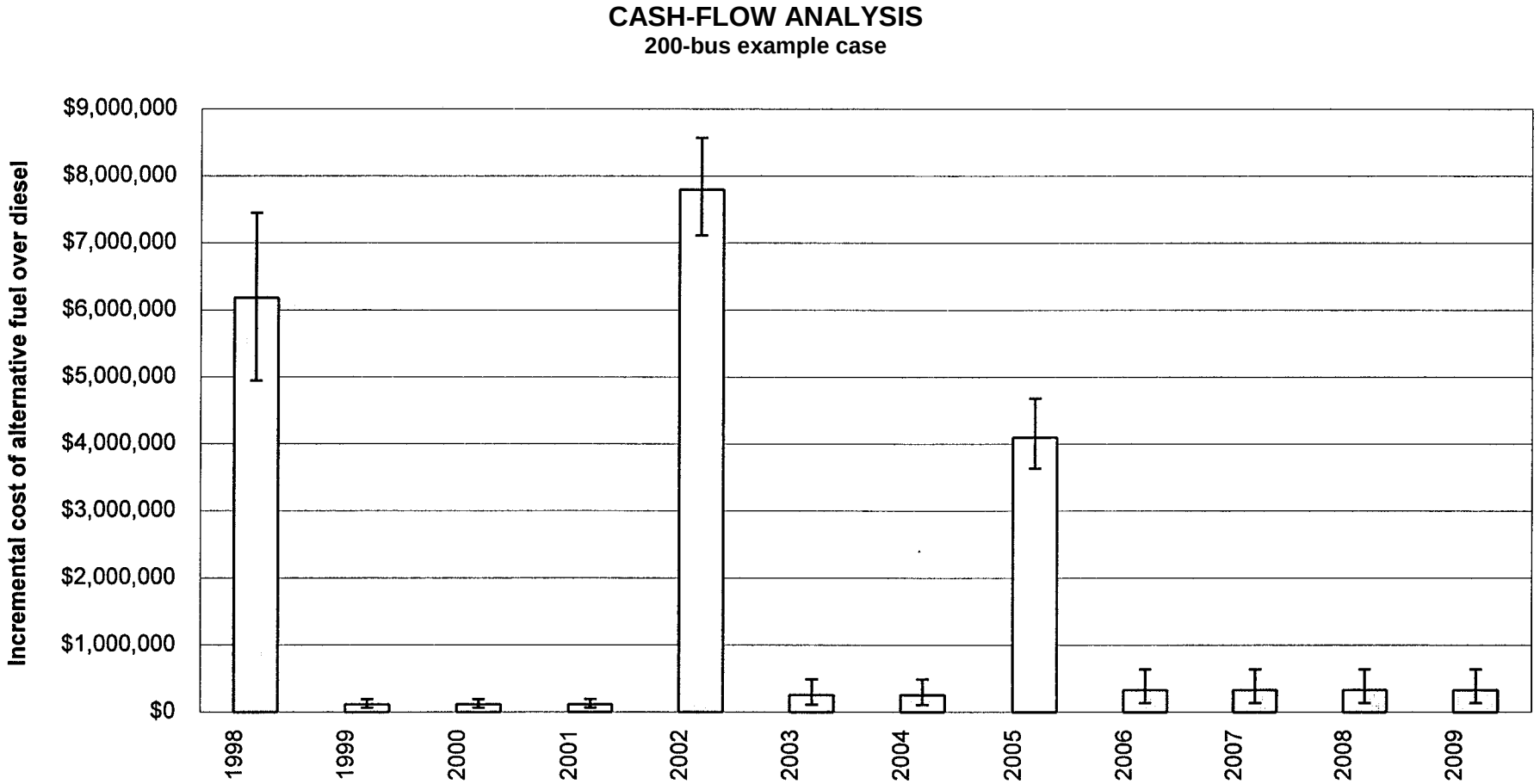


ANNUALIZED COST COMPARISON—LOCAL SHARE
200-bus example case



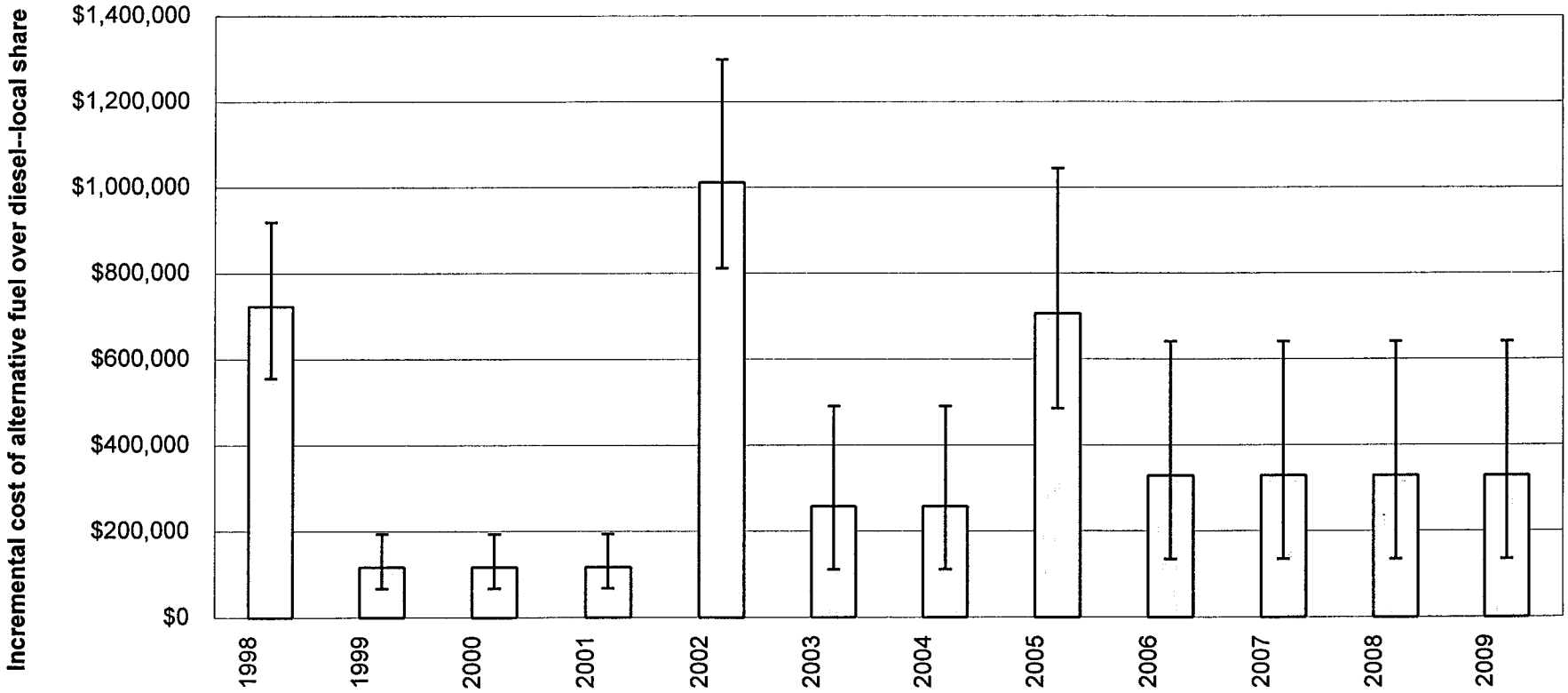
FUEL COST COMPARISON PER MILLION BTUs
200-bus example case




CASH-FLOW ANALYSIS
200-bus example case
Incremental cost of alternative fuel over diesel
$9,000,000
$8,000,000
$7,000,000
$6,000,000
$5,000,000
$4,000,000
$3,000,000
$2,000,000
$1,000,000
$0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

CASH-FLOW ANALYSIS—LOCAL SHARE

200-bus example case



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The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the Institute of Medicine.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purpose of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. William A. Wulf are chairman and vice chairman, respectively, of the National Research Council.

Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation