



## Lake Country Transit Energy Use Reduction Plan

**Energy Use Reduction, Capital Expenditure,  
Funding and Management/Training Plan**

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## Table of Contents

<b>Executive Summary .....</b>	<b>1</b>
<b>1 Energy Use Reduction Plan .....</b>	<b>4</b>
1.1 Introduction .....	4
1.2 Facility .....	6
1.2.1 <i>Review of Existing Facility and Operations</i> .....	6
1.2.2 <i>Facility, Operations and Maintenance Strategies</i> .....	7
1.3 Vehicle Fleet and Alternative Fuels .....	16
1.3.1 <i>Review of Fleet Operations</i> .....	16
1.3.2 <i>Alternative Fuel Options</i> .....	16
1.3.3 <i>SWOT Analysis</i> .....	24
1.3.4 <i>Fleet Analysis</i> .....	27
1.3.5 <i>Fleet Alternatives Cost Analysis</i> .....	28
1.4 Recommendations .....	39
1.5 Electric Bus Case Study – Foothill Transit .....	41
<b>2 Recommended Capital Expenditure Plan .....</b>	<b>44</b>
2.1 Facility Improvements .....	44
2.2 Electric Bus and Charging Infrastructure .....	44
2.3 Propane Bus and Refueling Infrastructure .....	44
2.4 Solar .....	45
<b>3 Funding Plan .....</b>	<b>47</b>
3.1 Potential Funding Programs .....	47
3.1.1 <i>Federal Programs</i> .....	47
3.1.2 <i>State Programs</i> .....	48
3.1.3 <i>Regional Programs</i> .....	51
3.2 Fuel Funding Plans .....	52
3.2.1 <i>Electricity</i> .....	52
3.2.2 <i>Propane</i> .....	54
3.2.3 <i>Natural Gas</i> .....	54
<b>4 Management and Training Plan .....</b>	<b>55</b>
<b>Appendix A – Mendocino-Lake Energy Watch Energy Audit .....</b>	<b>57</b>

## List of Tables

Table ES-1. Summary of Plan Recommendations, Capital Costs and Operating Cost Savings .....	3
Table 1-1. Lake Transit Fleet Vehicles .....	4
Table 1-2. Opportunities for Lighting Replacement or Retrofit.....	7
Table 1-3. Indoor Bulb Replacement Cost Analysis .....	8
Table 1-4. Outdoor Bulb Replacement Cost Analysis .....	9
Table 1-5. Electricity by Rate Period and Peak Demand for Each Month.....	10
Table 1-6. PG&E Electricity Rate Schedules Available to Lake Transit.....	10
Table 1-7. Projected Electricity Generated from a 27 kW System.....	11
Table 1-8. Solar Cost Analysis .....	12
Table 1-9. Bus Canopy Cost Analysis.....	13
Table 1-10. UV Film Cost Analysis .....	14
Table 1-11. Driver Training Cost Analysis.....	15
Table 1-12. Light-Duty Plug-in Electric Vehicles Offered in the United States .....	23
Table 1-13. Medium and Heavy-Duty Electric Vehicles Currently Commercialized .....	24
Table 1-14. SWOT Analysis.....	26
Table 1-15. Lake Transit Fleet Replacement Years by Vehicle Class by Fuel .....	27
Table 1-16. CalACT Vehicle Cost .....	30
Table 1-17. Electric Bus Options and Costs.....	30
Table 1-18. Vehicle Fuel Economy by Fuel/Technology .....	31
Table 1-19. Conventional and Alternative Fuel O&M Cost Analysis Assumptions .....	31
Table 1-20. Fueling Infrastructure and O&M Costs .....	32
Table 1-21. GHG Emission Intensity by Fuel and Technology.....	35
Table 1-22. Relative Criteria Pollutant Emissions to Diesel .....	36
Table 2-1. Capital Expenditure Plan .....	46
Table 3-1. HVIP Zero-Emission Truck and Bus Voucher Amounts .....	50
Table 3-2. Estimated ZETB Project Cost .....	52
Table 3-3. Match Funding Descriptions .....	53
Table 4-1. Driver Training Cost Analysis.....	56

## List of Figures

Figure 1-1. Projected Electricity Generated from a 27 kW System .....	11
Figure 1-2. Monthly Electric Vehicle Sales in the United States (November 2010 – October 2015).....	22
Figure 1-3. Cutaway Bus.....	27
Figure 1-4. Transit Bus .....	27
Figure 1-5. Cost Analysis Fuel Price Projections .....	29
Figure 1-6. 10 Year Fleet Cost Analysis for New Vehicles .....	33
Figure 1-7. 10 Year Cost Comparison for Replacing Four (4) 32' Diesel Buses .....	34
Figure 1-8. 10 Year Cost Comparison for Replacing Four (4) 32' Diesel Buses with Electric Buses & Solar.....	37
Figure 1-9. 10 Year Cost Analysis for Replacing 10 Class C Buses.....	38
Figure 1-10. Proterra electric buses operated by Foothill Transit .....	41

## Abbreviations and Acronyms

<b>AB32</b>	Global Warming Solutions Act
<b>ACT</b>	Advanced Clean Transit Rule
<b>AEO</b>	Annual Energy Outlook
<b>AQIP</b>	ARB Air Quality Improvement Program
<b>ARB</b>	California Air Resources Board
<b>ARFVTP</b>	Alternative and Renewable Fuel and Vehicle Technology Program
<b>B5</b>	Diesel blend with 5% by volume biodiesel
<b>B20</b>	Diesel blend with 20% by volume biodiesel
<b>B50</b>	Diesel blend with 50% by volume biodiesel
<b>B100</b>	100% Biodiesel
<b>BD</b>	Biodiesel
<b>BEV</b>	Battery Electric Vehicle
<b>BTU</b>	British Thermal Unit
<b>CalACT</b>	California Association for Coordinated Transportation
<b>CARB</b>	California Air Resources Board
<b>CDC</b>	Community Development Commission of Mendocino County
<b>CEC</b>	California Energy Commission
<b>CH4</b>	Methane
<b>CMAQ</b>	Congestion Mitigation and Air Quality
<b>CNG</b>	Compressed Natural Gas
<b>CO2</b>	Carbon Dioxide
<b>CO2E</b>	Carbon Dioxide Equivalent
<b>CPUC</b>	California Public Utilities Commission
<b>CUTA</b>	Canadian Urban Transit Association
<b>DGE</b>	Diesel Gallon Equivalent
<b>DOT</b>	Department of Transportation
<b>ECM</b>	Electronic Control Module
<b>EER</b>	Energy Equivalency Ratio
<b>EIA</b>	United States Energy Information Administration
<b>EPA</b>	US Environmental Protection Agency
<b>EV</b>	Electric Vehicle
<b>EVSE</b>	Electric Vehicle Supply Equipment
<b>FCV</b>	Fuel Cell Vehicle
<b>FTA</b>	Federal Transit Administration
<b>Gal</b>	Gallon
<b>GGE</b>	Gasoline Gallon Equivalent
<b>GHG</b>	Greenhouse Gas
<b>GVRW</b>	Gross Vehicle Weight Rating

<b>HDVs</b>	Heavy-Duty Vehicles
<b>HVIP</b>	Hybrid Vehicle Incentive Program
<b>ICE</b>	Internal Combustion Engine
<b>IEPR</b>	Integrated Energy Policy Report
<b>kW</b>	Kilowatt
<b>kWh</b>	Kilowatt-hour
<b>Lake APC</b>	Lake County/City Area Planning Council
<b>LCFS</b>	Low Carbon Fuel Standard
<b>LCNG</b>	Liquefied Compressed Natural Gas
<b>LCTOP</b>	Low Carbon Transit Operations Program
<b>LDV</b>	Light-Duty Vehicle
<b>LED</b>	Light Emitting Diode
<b>LNG</b>	Liquefied Natural Gas
<b>LPG</b>	Liquefied Petroleum Gas
<b>MDV</b>	Medium Duty Vehicle
<b>MPO</b>	Metropolitan Planning Organization
<b>NGV</b>	Natural Gas Vehicle
<b>NMOC</b>	Non-Methane Organic Carbon
<b>NOx</b>	Oxides of Nitrogen
<b>NREL</b>	National Renewable Energy Laboratory
<b>OEM</b>	Original Engine Manufacturer
<b>O&amp;M</b>	Operational and Maintenance
<b>PERC</b>	Propane Education & Research Council
<b>PEV</b>	Plug-In Electric Vehicles
<b>PG&amp;E</b>	Pacific Gas and Electric
<b>PHEV</b>	Plug-In Hybrid Electric Vehicles
<b>PM</b>	Particulate Matter
<b>PPA</b>	Public Purchase Agreement
<b>PV</b>	Photovoltaic
<b>RD</b>	Renewable Diesel
<b>RFP</b>	Request for Proposals
<b>RNG</b>	Renewable Natural Gas
<b>SACOG</b>	Sacramento Area Council of Governments
<b>SCO</b>	State Controller's Office
<b>SWOT</b>	Strengths, Weaknesses, Opportunities, and Threats
<b>TIGER</b>	Transportation Investment Generating Economic Recovery
<b>TIGGER</b>	Transit Investments for Greenhouse Gas and Energy Reduction
<b>TOU</b>	Time of Use
<b>ULSD</b>	Ultra-Low Sulfur Diesel
<b>UV</b>	Ultraviolet

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<b>VAC</b>	Alternating Current Volts
<b>VMT</b>	Vehicle Miles Traveled
<b>ZETB</b>	Zero-Emission Truck and Bus Pilot Commercial Deployments Projects
<b>ZEV</b>	Zero Emission Vehicle

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## Executive Summary

Lake Transit Authority (LTA) is the sole public transit agency serving Lake County, providing fixed-route services on nine routes and Dial-a-Ride services in Clearlake and Lakeport. The region is isolated by distance and terrain, creating challenges especially in the event of an emergency and/or disruption in the fuel/energy supply. The Lake County/City Area Planning Council (Lake APC) received a Federal Transit Administration (FTA) Section 5304 –Transit Planning Grant from Caltrans to develop a transit energy use reduction plan. Lake Transit’s fuel and energy expenses exceeded \$500,000 in 2012. The energy consumption from LTA’s Operations & Maintenance Facility and bus fleet were included in the energy use reduction plan. LTA’s Operations and Maintenance Facility consumes approximately 65,000 kWh per year and 3,000 gallons per year of propane. Combined electricity and propane contribute approximately 3% of the total energy operating costs. While the facility represents a small proportion of the overall energy cost, it offers opportunities for immediate energy savings with low implementation cost. The remaining 97% of the energy operating costs are from transportation fuel for the vehicle fleet which consists of 70% gasoline and 30% diesel.

The objectives of the project are to conserve energy and increase operational efficiency of the transit system and its facilities, reduce unnecessary transit operating expense, protect the environment by reducing greenhouse gas (GHG) emissions and ensure a reliable, consistent and cost effective energy supply for Lake Transit. It was also important to consider energy availability and transit operations during emergencies and disasters and identifying fuel strategies that anticipate and mitigate safety, odor, and pollution concerns while promoting a healthier environment and more efficient transit system.

The Advanced Clean Transit Rule (ACT), the Global Warming Solutions Act (AB32) and Executive Orders S-3-05 and B-30-15, and the Low Carbon Fuel Standard (LCFS) were considered when developing the plan. The ACT is an update to the Zero Emission Bus Rule and still in the development stages. It will be designed to transition public transit bus fleets to zero emission technologies but it is unclear how small fleets and cutaway buses will be handled in the new regulation. The AB32 Global Warming Solutions Act is one of the main driving forces for transportation policy in California and requires California to reduce its GHG emissions to 1990 levels by 2020. Executive Order B-30-15 and S-3-05 establish interim and longer-term goals of reducing GHG emissions to 40 percent below 1990 levels by 2030 and 80 percent below 1990 levels by 2050. Converting to lower emissions alternatives or newer vehicle technologies will help to meet these goals. Lastly, the LCFS is a technology forcing regulation in the transportation sector that incentivizes the use of lower carbon fuels in place of conventional fuels. Owners and operators of transit fleets consuming low carbon fuels including biofuels, natural gas and RNG, hydrogen, and electricity will be able to generate credits which are a potential revenue source for transit agencies to help reduce annual operating costs and/or the payback period for capital expenditures.



ICT investigated strategies for reducing energy use and cost for the LTA facility and driver operations which included replacing indoor and outdoor lighting with LEDs,<sup>1</sup> installing solar, constructing a bus canopy, installing ultraviolet film on south facing windows and improve driver training. The investigation for each strategy included determining the upfront capital cost, operating cost savings, and payback period. ICF recommends that Lake Transit consider immediately implementing the indoor and outdoor light replacements and UV film installation. These strategies have a 2-3 year simple payback period (including PG&E rebates) and result in a combined savings of over \$4,000 per year. ICF recommends Lake Transit include required driver training in the new Request for Proposals for the Lake Transit vehicle and facilities operating and maintenance contract. Lastly, depending on the availability of grant funding, Lake Transit should investigate the construction of a solar bus canopy or installing solar at the current facility. In the absence of grant funding, Lake Transit could team with a private solar developer through a solar power purchase agreement (PPA) to install the bus canopy at little or no cost to Lake Transit. Lake Transit would purchase electricity from the developer at a fixed rate and the private developer can take advantage of solar tax credits.

The fleet energy reduction and cost savings analysis looked at converting a portion or the entire fleet to alternative fuels and technologies including diesel hybrid, gasoline, electricity, natural gas and propane. These fuels were compared to a baseline of new diesel buses that have increased fuel efficiency and emission controls. Depending on funding availability, ICF recommends Lake Transit investigate an electric bus project of four buses and a solar canopy with an estimated capital cost of \$2.2 million. Electric buses result in significant operating cost savings of \$60,000 per year and are a path towards ACT Rule compliance. In addition to the small electric bus fleet, Lake Transit should pursue a partial fleet conversion to propane. Converting 10 buses to propane could save Lake Transit \$1.1 million over 10 years. While it is unknown how ACT will handle propane buses, if Lake Transit has to abandon propane for the ACT Rule, the refueling infrastructure can easily be removed from the site. The potential cost savings from propane outweigh concerns of switching back to another fuel in 10 years. Lastly, due to the size of Lake Transit's fleet and limited annual fuel consumption per vehicle, it does not make financial sense for Lake Transit to pursue natural gas. Natural gas can only provide 15% of the operating cost savings on a per vehicle basis that propane can and requires a \$1.5 million station investment. The table below summarizes the Energy Use Reduction Plan recommendations, capital costs and operating cost savings.

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<sup>1</sup> Mendo-Lake Energy Watch performed an energy audit specifically identifying the potential cost savings from LED lighting at Lake Transit

**Table ES-1. Summary of Plan Recommendations, Capital Costs and Operating Cost Savings**

Recommendation	Capital Cost	Operating Cost Savings
LED Lighting and UV Film	\$12,800 <sup>2</sup>	\$4,000
Solar Bus Canopy	\$291,000	\$34,000 <sup>3</sup>
Electric Buses (4)	\$1.9 million <sup>4</sup> (\$1.4 million incremental over diesel)	\$60,000
ZETB Electric Bus Grant Funding	\$1.425 - \$1.9 million <sup>5</sup>	
Propane Buses (10)	\$792,000 (\$142,000 incremental over diesel) <sup>6</sup>	\$110,000
Estimated Total	\$1.10 - \$1.57 million <sup>7</sup>	\$208,000

The three main potential funding programs for the electric buses and stations, and potentially the solar canopy, are the Zero-Emission Truck and Bus Pilot Commercial Deployments Projects (ZETB)<sup>8</sup>, Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)<sup>9</sup>, and Low Carbon Transit Operations Program (LCTOP)<sup>10</sup>. An additional source of funding for the solar canopy is through the 1% interest rate loan program for financing energy efficiency and energy generation projects including solar.<sup>11</sup> To increase the chances of being awarded funding through the ZETB program, it is recommended that Lake Transit partner with neighboring counties and transit agencies, including Mendocino and Yolo, and propose using electric buses for intercity bus routes. There are potential funding sources for propane buses, but it is likely Lake Transit would have to invest in the refueling station and incremental vehicle costs with its own funds.

<sup>2</sup> Net the PG&E rebate

<sup>3</sup> Includes \$26,000 cost savings from grid electricity cost to zero fuel cost for the electric bus fleet and \$8,000 facility electricity savings

<sup>4</sup> Only includes bus and charging station cost; does not include potential grant funding that could offset 75% or more depending on cash and in-kind cost shares within the ZEBT application

<sup>5</sup> 75%-100% of capital investment; ZETB can cover fund activities as truck and bus purchases and deployments, infrastructure, refueling, operation and maintenance, workforce training, data collections and administrative costs; if LTA funding of solar canopy can be considered the cash contribution, ZETB could offset 100% of capital

<sup>6</sup> Includes \$710,000 in propane bus costs (\$60,000 incremental over diesel) and \$82,000 for the propane station

<sup>7</sup> Takes into account potential ZETB grant funding for electric buses

<sup>8</sup> <http://www.arb.ca.gov/msprog/aqip/solicitations.htm>

<sup>9</sup> <http://www.arb.ca.gov/msprog/aqip/solicitations.htm>

<sup>10</sup> <http://www.dot.ca.gov/hq/MassTrans/lctop.html>

<sup>11</sup> <http://www.energy.ca.gov/contracts/PON-13-401/>

# 1 Energy Use Reduction Plan

## 1.1 Introduction

Lake Transit Authority (LTA) is the sole public transit agency serving Lake County, providing fixed-route services on nine routes and Dial-a-Ride services in Clearlake and Lakeport. Lake Transit also serves portions of Napa and Mendocino counties with intercity services and links to other transportation providers. The region is isolated by distance and terrain, creating challenges especially in the event of an emergency and/or disruption in the fuel/energy supply. Lake Transit is a primary transportation provider in the event of an emergency where evacuations are needed and/or emergency personnel and supplies need to be transported.

The Lake County/City Area Planning Council (Lake APC) received a Federal Transit Administration (FTA) Section 5304 –Transit Planning Grant from Caltrans to develop a transit energy use reduction plan. As identified in response to “Project Justification” in the grant application, Lake Transit’s fuel and energy expenses exceeded \$500,000 in 2012. Lake Transit Authority has a 7,000 square-foot Operations & Maintenance Facility that is half shop space and half offices. The energy consumption from this facility is also to be included in the energy use reduction plan. Table 1 below lists the vehicles within the Lake Transit fleet to include in the reduction plan.

**Table 1-1. Lake Transit Fleet Vehicles**

Vehicle Type	# of Vehicles	Fuel Used	Schedule Replacement Date
Eldorado Elite	1	Gasoline	2012/13
Eldorado MST II	2	Diesel	2014/15
Eldorado Aerotech	5	Gasoline	2013/14 (2); 2016/17 (3)
Optima Opus	2	Diesel	2014/15
Glaval Titan	5	Diesel	2016/17
Glaval Entourage	3	Gasoline	2016/17
Glaval Universal	8	Gasoline	2017/18 (5); 2019/20 (3)
Glaval Legacy 37’	1	Diesel	2019/20
Glaval Titan II	1	Diesel	2020/21
Glaval Legacy 32’	4	Diesel	2020/21
Total	32		

The objectives of the project identified in the Lake APC Grant Application and reiterated in the RFP are as follows:

- Conserve energy and increase operational efficiency of the transit system and its facilities.
- Reduce unnecessary transit operating expense in order to preserve service, provide greater value for public investment, and maximize the level of service available.

- Protect the environment by reducing greenhouse gas (GHG) emissions and considering the security and safety of fuel handling and storage options.
- Ensure a reliable, consistent and cost effective energy supply for Lake Transit
- Increase accessibility and mobility by utilizing operational savings for more service.
- Increase security of the transportation system by ensuring adequate and available fuel and energy resources to operate the transit system, especially during emergencies and disasters.
- Support economic vitality by inviting suppliers and other potential fuel users to participate in the energy use reduction plan.
- Reflect community values by encouraging public involvement in fuel and facility decisions with particular emphasis on identifying fuel strategies that anticipate and mitigate safety, odor, and pollution concerns while promoting a healthier environment and more efficient transit system.

There were also state legal and regulatory precedents considered when developing the plan: the Advanced Clean Transit Rule, the Global Warming Solutions Act (AB32) and Executive Orders S-3-05 and B-30-15, and the Low Carbon Fuel Standard (LCFS).

- **Advanced Clean Transit (ACT) Rule.** The ACT, an update to the Zero Emission Bus Rule, is still in the development stages and will be designed to transition public transit bus fleets to zero emission technologies. The program would include phasing in zero emission bus purchase requirements starting in 2018 with a goal of complete transit fleet transition by 2040. Until the complete transition, the ACT will require the use of renewable fuels and the cleanest available engines as soon as feasible. This includes transitioning to renewable diesel for diesel bus fleets and renewable natural gas (RNG) for natural gas fleets, and require use of engines with the lowest emissions of nitrogen oxides (NOx) available engines. It is unclear how small fleets and cutaway buses will be handled in the new regulation. Currently, only buses running on diesel, natural gas, hydrogen and electricity are captured in the regulation, but not gasoline and propane. The requirement for transition to the cleanest engines and fuel could start as early as 2017. Early adopter of zero-emission buses could potentially generate credits.
- **AB32 and Executive Orders S-3-05 and B-30-15.** The AB32 Global Warming Solutions Act is one of the main driving forces for transportation policy in California. AB 32 requires California to reduce its GHG emissions to 1990 levels by 2020. Executive Order S-3-05 establishes a longer-term goal of reducing GHG emissions to 80 percent below 1990 levels by 2050. Executive Order B-30-15 added an interim target of reducing GHG emissions to 40 percent below 1990 levels by 2030. Achieving this level of GHG reductions in California will require significant effort across all sectors of the economy, including transit fleets and rural/small transit fleets. Converting to lower emissions alternatives or newer vehicle technologies will help to meet these goals.
- **Low Carbon Fuel Standard (LCFS).** The LCFS is a technology forcing regulation in the transportation sector that incentivizes the use of lower carbon fuels in place of conventional fuels. The regulation requires providers of transportation fuels in California to reduce the average carbon intensity of their fuels 10% by 2020. Owners and operators of transit fleets

consuming low carbon fuels including biofuels, natural gas and RNG, hydrogen, and electricity will be able to generate credits proportional to the carbon intensity reduction compared to the annual standard value. Propane is not an eligible fuel under the LCFS. Credits generated under the LCFS are a potential revenue source for transit agencies to help reduce annual operating costs and/or the payback period for capital expenditures.

## 1.2 Facility

### 1.2.1 Review of Existing Facility and Operations

Lake Transit has a 7,000 square-foot Operations & Maintenance Facility that is half shop space and half offices. Data collected for a 2+ year period approximates annual facility and fuel energy use as:

- Electricity consumption: 65,000 – 70,000 kWh/yr (\$10,000 - \$13,000/yr)
- Propane consumption: 2,300 – 3,500 gal/yr (\$4,000 - \$6,000/yr)

From the information collected, Lake Transit spends approximately \$500,000 per year on facility and fleet energy, approximately 3% of the total energy operating costs.

ICF and Lake Transit conducted an initial walkthrough of the facility to identify opportunities for Lake Transit to reduce facility energy use. The following were important notes from the walkthrough that led to the strategies for energy reduction and the decision to have an energy audit performed.

- Outdoor lamp poles are metal halide units that frequently burn out and require a contractor with a scissor lift for replacement, making them expensive and inefficient.
- Buses are stored outside in the direct sun. During the summer and warm months the buses require extra idling time to cool down before going on routes.
- The building during the summer has a high air conditioning electricity load, especially in the rooms with south facing windows.
- Computers and servers are required to run all night for system updates.

On April 2, 2015, Mendo-Lake Energy Watch<sup>12</sup>, a partnership between the Community Development Commission of Mendocino County (CDC) and Pacific Gas and Electric Company (PG&E), performed an energy audit of the facility to assist ICF in determining where the main areas of energy conservation are. The audit was performed as service provided by PG&E at no cost to Lake Transit. The auditors reviewed and counted light fixtures, air conditioning and cooling, and propane heating. Mendo-Lake's main findings were that conventional light-bulbs could be replaced with LEDs in the existing fixtures and that outdoor light poles could be retro-fitted to LED fixtures. The table below shows the estimated amount of light-bulbs or fixtures that can be replaced or retrofitted.

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<sup>12</sup> <http://mendoenergy.org/>

**Table 1-2. Opportunities for Lighting Replacement or Retrofit**

Location	Quantity
Indoor Bulbs	143 bulbs
Outdoor Wall Fixtures and Poles	33 Fixtures and Poles

### Selected Strategies for Further Investigation

Based on conversation with Lake Transit and the results of the Mendo-Lake energy watch audit, the following were the selected strategies for further investigation and cost analysis. Driver training is included in this section since the following section focuses solely on alternative fuels and vehicles. Each strategy is discussed below including a description of the strategy, an analysis of the capital costs and operating savings, and calculation of a simple payback period.

- Replacing indoor lighting to LEDs
- Replacing outdoor lighting to LEDs
- Installing solar
- Bus canopy
- Ultraviolet film on windows
- Driver training

## 1.2.2 Facility, Operations and Maintenance Strategies

### Replace Indoor Lighting to LEDs

#### Strategy Description

Lake Transit's facility uses a mixture of fluorescent bulbs<sup>13</sup> to light the indoors of its office and maintenance facility. There are more energy efficient LED bulbs available that can be substituted for the existing fluorescent bulbs in order to save energy.

#### Strategy Analysis

The April 2015 energy audit<sup>14</sup> found 143 bulbs (79 bulbs on the interior of the building and 64 bulbs in the maintenance area) that could be directly replaced with LED tubes. This is a 'plug-



<sup>13</sup> A mixture of T4 and T8 bulbs.

<sup>14</sup> See Appendix A

and-play' solution that does not require any change to the fixtures.

The table below provides an estimate of the cost impact of the retrofit. The expected energy savings included lighting during normal operating hours. Following an initial outlay of about \$8,000 for the retrofit, Lake Transit can expect to see a payback of the upfront costs in less than 3 years. Thereafter the agency will net almost \$2,200 per year in savings.

**Table 1-3. Indoor Bulb Replacement Cost Analysis**

Line No.	Cost Item/Metric	Value	Source/Formula
(1)	Total Contractor Cost to Replace the Bulbs (Parts + Labor)	\$7,997	Contractor estimate contained within the energy audit report
(2)	PG&E Incentive	\$2,178	estimated using PG&E formula
(3)	Net Cost to Lake Transit	\$5,819	=(1)-(2)
(4)	Estimated Annual Electricity Cost Savings	\$2,184	analysis of periodic replacement cost for fluorescent and LED bulbs and estimated energy usage
(5)	Simple Payback Period	2.7 years	=(3)/(4)

### Recommendation

Contract with Mendocino-Lake Energy Watch recommended contractors to perform the retrofit as scoped.

### Retrofit Outdoor Lighting to LEDs

#### Strategy Description

Lake Transit's parking lot and bus yard uses 'streetlamp' style metal halide fixtures. The fixtures can be retrofitted to use more energy efficient LED bulbs.



#### Strategy Analysis

The April 2015 energy audit<sup>15</sup> found 33 metal halide fixtures that could be retrofitted and equipped with LED bulbs.

The table below provides an estimate of the cost impact of the retrofit. The expected energy savings took into account normal operating hours for the outdoor fixtures as described by Lake Transit. Following an initial outlay of about \$11,300 for the retrofit, Lake Transit can expect to see a payback of the upfront costs in a little over 2 years with the annual savings on electricity and bulb replacement. Thereafter the agency will net approximately \$2,000 per year in savings.

<sup>15</sup> See Appendix A

**Table 1-4. Outdoor Bulb Replacement Cost Analysis**

Line No.	Cost Item/Metric	Value	Source/Formula
(1)	Total Contractor Cost to Retrofit Fixtures and Replace the Bulbs (Parts + Labor)	\$11,354	estimated as part of energy audit
(2)	PG&E Incentive	\$4,831	estimated using PG&E formula
(3)	Net Cost to Lake Transit	\$6,522	=(1)-(2)
(4)	Estimated Annual Electricity Cost Savings	\$2,044	analysis of periodic replacement cost for metal halide and LED bulbs and estimated energy usage
(5)	Simple Payback Period	2.3 years	=(3)/(4)

**Recommendation**

Contract with Mendocino-Lake Energy Watch recommended contractors to perform the retrofit as scoped.

**Install Solar****Strategy Description**

In 2014 and 2015, Lake Transit was billed under PG&E's A-10 (Medium General Demand-Metered Service) Rate Schedule. Under this electric rate schedule, Lake Transit is charged at a per kWh rate with an additional demand charge based on the maximum demand (in kW) per month. After November 2014, the schedule automatically changed to time-of-use (TOU) rates where the cost per kWh changes depending on the time of day the electricity is consumed. Depending on facility electricity use and demand, Lake Transit could save money by switching to a different rate schedule. With the switch to TOU rates, the time of day and amount of electricity that Lake Transit facilities use can be offset by installing photovoltaic (PV) solar panels. Benefits are maximized when a PV system is sized to match the energy consumption of the facilities.

**Strategy Analysis**

Data from PG&E for Lake Transit electricity usage was compiled and examined based on the time of use. The table below shows the amount of electricity used by rate period (peak, partial peak, and off peak) and peak demand for each month, June 2014 to May 2015.



**Table 1-5. Electricity by Rate Period and Peak Demand for Each Month**

Usage (kWh)	June 2014	July 2014	Aug 2014	Sept 2014	Oct 2014	Nov 2014	Dec 2014	Jan 2015	Feb 2015	Mar 2015	Apr 2015	May 2015	Total
<b>Off-Peak</b>	2,335	3,005	2,979	2,384	2,766	2,591	2,776	2,894	2,421	2,648	2,755	2,954	<b>32,508</b>
<b>Partial-Peak</b>	1,380	1,873	1,557	1,423	1,576	2,225	2,686	2,313	2,208	2,257	2,421	1,141	<b>23,061</b>
<b>Peak</b>	1,681	2,210	1,793	1,644	1,436							1,106	<b>9,870</b>
<b>Total</b>	5,396	7,088	6,329	5,451	5,778	4,816	5,462	5,207	4,628	4,905	5,177	5,202	<b>65,439</b>
<b>Demand (kW)</b>	22.56	22.56	22.56	20.64	22.56	18.72	18.72	15.84	15.84	14.4	18.72	22.08	

By applying the different rates offered by PG&E to Lake Transit's typical electricity usage, costs on two different rate schedules – the current A-10 TOU schedule and the A6 Small General TOU Service – can be compared. The A6 rate is an alternative rate available to Lake Transit that has the demand change incorporated into the energy rate. Understanding this rate is important because solar PV systems can only offset electricity rate costs (e.g. \$/kWh) and not demand charges. If Lake Transit were to install solar PV, it is in Lake Transit's best interest to convert to the A6 rate schedule so the solar PV can offset the entirety of the electricity costs. The purpose of comparing the rates is to confirm that the A10 rate is providing Lake Transit the lowest energy costs. The table below shows Lake Transit's projected annual electricity costs (without making LED lighting changes) on the different schedules.

**Table 1-6. PG&E Electricity Rate Schedules Available to Lake Transit**

Rate Schedule	Annual Energy Cost	Annual Demand Cost	Total Annual Cost
A6	\$16,122	n/a	<b>\$16,122</b>
A10	\$9,213	\$2,976	<b>\$12,189</b>

As long as peak loads on the facility meter remain low, Lake Transit would not reduce costs by switching from the A-10 to the A-6 schedule.

To reduce PG&E charges, Lake Transit alternatively can install solar PV panels to displace the facility electricity use. To determine the size of a PV system required to offset the facility electricity use, we used an online calculator from the National Renewable Energy Laboratory (NREL) called PVWatts.<sup>16</sup> From June 2014 to May 2015, Lake Transit consumed approximately 65,000 kWh of electricity. Accounting for expected 25,000 kWh reduction from replacing indoor and outdoor lighting to LEDs,

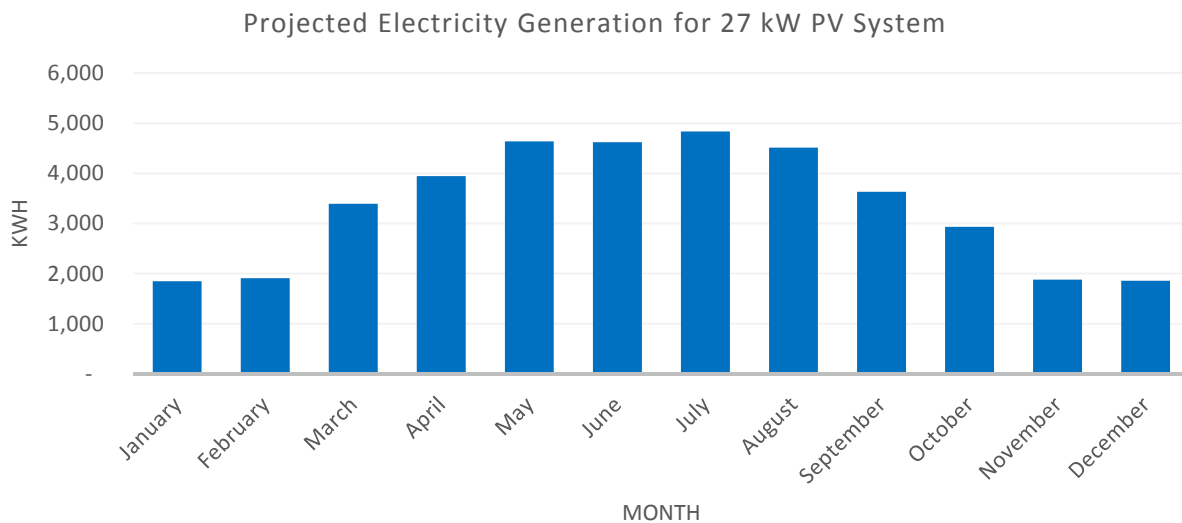
<sup>16</sup> PVWatts tool available at <http://pvwatts.nrel.gov/>.

projected annual electricity use is 40,000 kWh. According to the PVWatts tool, a 27.04 kilowatt (kW) system would be required to generate 40,000 kWh at Lake Transit.

The table and chart below show the projected electricity to be generated by a 27 kW system.

**Table 1-7. Projected Electricity Generated from a 27 kW System**

Time Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
9:30pm to 8:30am	84	124	337	463	680	666	635	563	442	332	157	103	<b>4,586</b>
8:30am to Noon	692	742	1,198	1,351	1,564	1,522	1,585	1,536	1,306	1,181	794	760	<b>14,231</b>
Noon to 6pm	1,071	1,043	1,857	2,128	2,370	2,373	2,553	2,404	1,884	1,418	931	994	<b>21,027</b>
6pm to 9:30pm	0	0	0	2	25	61	61	8	0	0	0	0	<b>157</b>
<b>Total</b>	<b>1,848</b>	<b>1,909</b>	<b>3,392</b>	<b>3,945</b>	<b>4,639</b>	<b>4,622</b>	<b>4,834</b>	<b>4,512</b>	<b>3,632</b>	<b>2,932</b>	<b>1,881</b>	<b>1,857</b>	<b>40,001</b>



**Figure 1-1. Projected Electricity Generated from a 27 kW System**

The actual electricity generation would depend on the physical design of the PV system. The results from the PVWatts tool assumes a 20 degree tilt on a roof-mounted system.<sup>17</sup> At approximately 16 Watts (W) per square foot, a 27 kW system would require 1,700 square feet.<sup>18</sup> Solar installed cost of \$2.2 per W was supplied by Rodda Electric resulting in a total estimated cost of \$59,000. Following an initial outlay of about \$59,000, Lake Transit can expect to see a payback of the upfront cost in 7-8 years with the annual savings on electricity. Thereafter the agency will net approximately \$8,000 per year in savings

<sup>17</sup> Other default values used in the tool include: module type, standard; array azimuth, 180 degrees; system losses, 14%; inverter efficiency, 96%; and DC to AC size ratio, 1.1.

<sup>18</sup> 16 W/sqft is based the power rating and size of a market-standard photovoltaic panel.

at the current rates. These savings will likely increase annually since energy prices escalate faster than inflation.

**Table 1-8. Solar Cost Analysis**

Line No.	Cost Item/Metric	Value	Source/Formula
(1)	Solar Installed Cost	\$59,000	Cost factor of \$2.2/W supplied by Rodda Electric
(2)	Annual electricity savings	\$8,000	Estimated \$12,000 - \$4,000 savings from LED lighting
(3)	Simple Payback Period	7-8 years	=(1)/(2)

### Recommendation

Schedule a site visit with solar installation companies (e.g. Rodda Electric) for a specific installed cost at Lake Transit and investigate available funding programs including the low interest loan program for public agencies through the California Energy Commission (CEC).

## Bus Canopy

### Strategy Description

Lake Transit's buses currently must park in an uncovered lot during storage, inspection and start-up. Direct sun shining on these buses requires the air conditioning to be operated continuously on many days, which in turn requires burning fuel to idle buses while air conditioning systems are operating. A bus canopy would shade buses during inspection and start-up in order reduce or eliminate the need for air conditioning while buses are in the yard.

As an additional benefit, the bus canopy would provide new surface area for the installation of solar PV cells. The canopy is sized similarly to that discussed in the electric bus and solar canopy section.

### Strategy Analysis

The table below provides an estimate of the cost impact of the strategy. There are two different options with a bus canopy: (1) a minimal carport structure where solar panels are the sun-blocking portion of the canopy, and (2) a fully structured stand-alone canopy similar to those used by Santa Clarita Transit and Mendocino Transit. For the analysis, a 116 kW solar canopy was assumed to coincide with the electricity requirements in the electric bus analysis, which includes the facility electricity requirements of 27 kW and bus requirements of 90 kW. A comparable sized fully structured canopy is an estimated 10,000 square feet. Rodda Electric supplied a fully installed cost estimate for Option 1 of \$2.5 per W. The fully structured canopy has an estimated cost of \$41.70 per square foot developed from information supplied by Santa Clarita Transit. The bus canopy has a capital cost of about \$290,000 for option 1 and \$420,000 for option 2. Option 1 was chosen for the cost analysis since it is the less expensive bus canopy option and includes the installation of solar panels. Lake Transit Authority can see a payback of the upfront cost in 45-60 years with the annual savings from reduced idling. The payback period is reduced to 20-23 years when the \$8,000 in annual facility electricity savings is included, as shown in the table

below. This strategy would produce cost savings of \$4,800 - \$6,400 immediately, plus \$8,000 facility electricity savings, if grant funding can be found for upfront cost. This cost analysis does not include potential revenue from selling excess power to the grid.

**Table 1-9. Bus Canopy Cost Analysis**

Line No.	Cost Item/Metric	Value	Source/Formula
(1)	Construction Cost for Bus Canopy	\$290,000	Cost factors based on information from Rodda Electric
(2)	Annual Fuel Savings for Entire Bus Fleet	\$4,800 - \$6,400	=(2d)*(2e)
(2a)	days per year requiring start-up air conditioning	200	Lake Transit
(2b)	number of buses	32	Lake Transit
(2c)	gallons saved per bus per day	0.25	Assuming 0.5 gal/hr during idle and 30 minutes of idling per day
(2d)	gallons saved per year for entire bus fleet	1,600	=(2a)*(2b)*(2c)
(2e)	fuel cost per gallon	\$3-4	Lake Transit
(5)	Simple Payback Period	45-60 yrs (20-23 yrs)	=(1)/(2) (With electricity savings)

### Recommendation

Based on the upfront cost, this strategy would require significant grant funding. Without significant grant funding, it is difficult to make an economic justification for implementing the solar bus canopy alone. The solar canopy option is based on generating power for both the facility and to power an electric bus project. The solar canopy could save \$26,000 per year in electricity on top of the fuel cost savings from the electric buses without solar.<sup>19</sup> It then becomes viable with a much shorter payback period (approximately 9 years), particularly if buses are grant funded.

Lake Transit could also work with a private solar developer through a solar power purchase agreement (PPA) to install the bus canopy at little or no cost to Lake Transit and purchase electricity from the developer at a fixed rate.

### Ultraviolet Film on Windows

#### Strategy

The temperatures in Lake County can be hot during the summer and sunlight, especially ultraviolet (UV) light, entering the building through the windows can put stress on the air conditioning system and

<sup>19</sup> See the fleet and electric bus analysis on pages 34-37

require a significant electrical load. UV films can block up to 99% of UV rays and save up to 30% of cooling cost.

### Strategy Analysis

The table below provides the estimated cost impact of the strategy. UV film cost of \$2 per square foot was developed from product cost and estimated installation costs. 200 square feet of windows has an estimated installed cost of \$400. Lake Transit Authority can see a payback of the upfront cost in less than one year with the annual cooling load savings.

**Table 1-10. UV Film Cost Analysis**

Line No.	Cost Item/Metric	Value	Source/Formula
(1)	Film Installed Cost	\$2/sq ft	Product website (\$0.50/sqft) + assuming 4x for installed cost
(2)	Windows on south side (sq ft)	200	Estimate from pictures of the building
(3)	Net Cost to Lake Transit	\$400	=(1)*(2)
(4)	Estimated Annual Electricity Cost Savings	\$500	Est 5% electricity cost savings
(5)	Simple Payback Period	<1 year	=(3)/(4)

### Recommendation

Due to very low cost of product and installation, proceed with having a UV coating installed on the south facing windows.

### Driver Training

#### Strategy Description

A driver training program instructs drivers on habits that can reduce fuel consumption. Driver training programs involve some combination of initial training, behavior monitoring, and real-time feedback devices. SmartDRIVER is an example of a driver training program managed by the Canadian Urban Transit Association (CUTA). While CUTA has allowed APTA members to participate in SmartDRIVER in the past, the program is no longer open to non-CUTA members. Other training programs offering a similar service to SmartDRIVER for US based fleets include TAPTCO<sup>20</sup>, Gold Cross Safety Corporation<sup>21</sup>, and L-3<sup>22</sup>.

Alternative methods for managing driving behavior are to use a telematics device such as the one produced by GreenRoad or onboard camera diagnostic solutions like SmartDrive. While these are other applications for managing driver behavior, they all involve some combination of driver training, behavior

<sup>20</sup> <http://taptco.com/transit-bus-driver-training/>

<sup>21</sup> <http://goldcross.net/index.html>

<sup>22</sup> <http://www.l-3training.com/transit>

monitoring, and real-time feedback devices. There is more data available for SmartDRIVER to quantify the benefits of efficient driving, the benefits of GreenRoad and other telematic/data driver services will achieve similar and overlapping results to driver training programs.

### Strategy Analysis

We analyzed the likely cost and fuel savings from implementing a program similar to the SmartDRIVER program at Lake Transit.

Agencies participating in SmartDRIVER have seen fuel savings from 5% to 25%<sup>23</sup>. To be conservative, we assume that Lake Transit would achieve 5% fuel savings through the SmartDRIVER program.

The table below analyzes the expected payback of participating in the SmartDRIVER program. Startup costs include a one-time subscription fee charged by CUTA, a training fee of \$1,500 for one person, and purchase of a handheld device to read information from buses' ECMs. We also assume that each driver must be paid for 8 hours of training. Total startup costs are estimated to be \$24,800.

Reducing fuel use by 5% in Lake Transit's 32 buses would save \$22,500. Therefore the SmartDRIVER program would pay back the upfront cost in a little over a year.

**Table 1-11. Driver Training Cost Analysis**

Line No.	Cost Item/Metric	Value	Source/Formula
(1)	SmartDRIVER One-Time Fee	\$6,000	CUTA
(2)	Train-the-Trainer	\$1,500	CUTA
(3)	Handheld ECM Interface Device	\$1,500	CUTA
(4)	Labor Cost For Driving Training	\$16,000	=40 drivers*8 hours*\$50/hour
(5)	Total Cost	\$24,800	=(1)+(2)+(3)+(4)
(6)	Annual Fuel Savings	\$22,500	=5% savings*3,750 gallons/bus/year*32 buses*\$3/gallon
(7)	Simple Payback Period	1.1 years	=(5)/(6)

### Recommendation

While CUTA has allowed APTA members to participate in SmartDRIVER in the past, the program is no longer open to non-CUTA members. Lake Transit should consider including required training in the Request for Proposals for the vehicle and facility operations contract.

<sup>23</sup> Interview with Kevin Brown, CUTA.

## 1.3 Vehicle Fleet and Alternative Fuels

### 1.3.1 Review of Fleet Operations

ICF collected and reviewed Lake Transit fleet data for a 2+ year period and approximated annual fuel energy use as:

- Total Fuel – 112,000 – 127,000 gallons/yr
  - Diesel – 30,000 – 40,000 gal/yr (\$120,000 - \$175,000/yr)
  - Gasoline – 80,000 – 85,000 gal/yr (\$300,000 - \$325,000/yr)

From the information collected, Lake Transit spends approximately \$500,000 per year on facility and fleet energy, approximately 97% of the total energy operating costs.

ICF and Lake Transit conducted an initial walkthrough of the facility to determine areas and ways that Lake Transit could reduce fleet energy use and costs. The following were important notes from the walkthrough related to fleet energy use.

- There are four different bus maintenance schedules:
  - A – Basic service, performed at 3,000 miles/45days, inspection based
  - B – A plus service work, oil, filters, etc., performed at 6,000 miles/60 days
  - C – B plus transmission service
  - D – C plus brake and differential lubrication changes
- There is no policy on vehicle idling. There are very minimal layovers with little opportunity for idling.
- Current F550s have insufficient tank capacity (40 gallons) and can require 3 fill-ups in one day.
- Three quarters of the fleet requires 2 fill-ups per day.

ICF investigated potential fuel and technology conversions for the Lake Transit fleet to determine if they would result in energy reduction and cost savings. This subsection discusses the following:

- Descriptions of Alternative Fuel Options
- Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis
- Existing Lake Transit Fleet Analysis
- Fleet Alternatives Cost Analysis

### 1.3.2 Alternative Fuel Options

Lake Transit currently consumes only gasoline and diesel in its fleet. This section describes the potential alternative fuel options to displace gasoline and diesel.

## Biodiesel

### Description

Biodiesel is a renewable fuel made by reacting animal or vegetable fats with alcohol. Approximately 70% of the nation's biodiesel is produced in the Midwest, where soybean oil is the dominant biodiesel feedstock.<sup>24</sup>

Most biodiesel is used in low-level blends, usually as 5% or 20% biodiesel blended with conventional diesel (referred to as B5 or B20, respectively). B20 is the highest blend of biodiesel commonly used in the United States as it provides good cold-weather performance, is generally cost effective, and can be used in most engines without modification. Fifty percent (B50) and pure biodiesel (B100) are available in the marketplace and can be used in some engines without modification, although equipment changes may be necessary in other engines.



### Uses and Applications

In contrast to most other alternative fuels, biodiesel does not require a specific alternative fuel vehicle. Depending on the blend level, biodiesel can be used in most conventional diesel vehicles. High-level blends tend to have a solvent effect that cleans a vehicle's fuel system and releases deposits accumulated from previous petroleum diesel use. Once released, these deposits may initially clog filters and require filter replacement in the first few tanks of high-level biodiesel blends. As such, vehicle operators should consult their vehicle and engine warranty statements before using biodiesel, particularly before using biodiesel blends higher than B5.

Biodiesel can have a limited shelf life due to factors such as contamination and exposure to air, extreme temperatures, and additives. Shelf life issues are a greater concern with higher blends. Proper fuel management can dramatically extend biodiesel's shelf-life to a year or more, which is on par with conventional diesel.

A majority of the biodiesel used in the United States is consumed by commercial fleets and government entities, including transit agencies, waste haulers, and school districts. Information from the American Public Transportation Association suggests that 7.4% of public transit buses in the U.S. use biodiesel.<sup>25</sup>

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24 U.S. Energy Information Administration, 2012, "Monthly Biodiesel Production Report: May 2012," <http://www.eia.gov/biofuels/biodiesel/production/>

25 American Public Transportation Association, "Public Transportation Industry Is a Green Industry," April 16, 2015. [http://www.apta.com/mediacenter/pressreleases/2015/Pages/150416\\_Earth-Day.aspx](http://www.apta.com/mediacenter/pressreleases/2015/Pages/150416_Earth-Day.aspx)



Most heavy-duty diesel engine manufacturers state that using up to B20 will not void engine warranties. Many fleets have successfully used B50 to B99 blends for several years or more.<sup>26</sup> In 2008, the American Society for Testing and Materials adopted biodiesel standards for blends up to B20 and for B99.

## Renewable Diesel

### Description

Renewable diesel is produced from the same feedstocks as biodiesel from a more energy intensive hydrotreating process, creating a product that is 100% fungible with diesel. Renewable diesel meets the same ASTM specifications as ultra-low sulfur diesel (ULSD) and therefore does not have any blend limitations. The largest worldwide producer of renewable diesel is Neste Oil with production facilities in Singapore and Europe. Facilities are being built in the United States including Diamond Green in Louisiana.

### Uses and Applications

Renewable diesel, similar to biodiesel, does not require an alternative fuel vehicle. But unlike biodiesel, it does not have any blend limitations, issues with solvency, and can be used in any current and future diesel engine. Use of renewable diesel will not void engine warranties at any blend level.

## Natural Gas

### Description

One-quarter of the energy used in the United States is produced by natural gas. With plentiful reserves bolstered by newly accessible gas in shale formations, natural gas is a reliable, primarily domestic source of clean-burning fuel. Advances in hydraulic fracturing technologies have provided access to large volumes of natural gas from shale formations. In addition, natural gas can be derived from biogas, which is produced through anaerobic digestion of organic matter in biomass waste materials.

Natural gas in compressed (CNG) or liquefied (LNG) form is used as a transportation fuel. The high octane number of natural gas makes it suitable for spark ignition (gasoline) engines with some modifications. Heavy-duty natural gas vehicles are also available. Some use spark ignition natural gas systems, while others use high-pressure direct injection in a compression ignition (diesel) cycle.

CNG is stored onboard a vehicle in cylinders pressurized at 3,000–3,600 pounds per square inch (psi). A CNG-powered vehicle has a similar fuel economy to a gasoline vehicle on a gasoline gallon equivalent (GGE) basis, with a GGE equal to approximately 5.66 pounds of CNG. CNG is used in light-, medium-, and heavy-duty vehicles.

Purifying natural gas and super-cooling it to -260°F creates LNG. Because it must be kept at cold temperatures, LNG is stored in double-walled, vacuum-insulated pressure vessels. Liquid is more dense than gas (CNG), so LNG is beneficial for vehicles that require a longer driving range—as more energy can

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26 California Energy Commission, 2009, "Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program," <http://www.energy.ca.gov/2009publications/CEC-600-2009-008/CEC-600-2009-008-CMF.PDF>

be stored by volume in an LNG tank. As such, LNG is typically used in medium- and heavy-duty vehicles. A gallon of LNG has approximately 66% of the energy in a gallon of diesel; consequently, a diesel gallon equivalent (DGE) equals approximately 1.5 gallons of LNG.

### Uses and Applications

Natural gas can be used in virtually all types of on-road vehicles. There are actually three different types of natural gas vehicles (NGVs):

- Dedicated, which run only on natural gas
- Bi-fuel, which use either natural gas or gasoline
- Dual-fuel, which run on natural gas and use diesel for ignition assistance

Dual-fuel vehicles are traditionally limited to heavy-duty vehicles (HDVs). Dedicated NGVs tend to demonstrate better performance and produce lower emissions than bi-fuel vehicles. Because dedicated NGVs have only one fuel tank, they weigh less than bi-fuel NGVs and offer more cargo capacity.

Although extra storage tanks can increase the range of an NGV, the additional weight may decrease the amount of cargo the vehicle can carry.

For light-duty uses, the only NGV currently available from an original equipment manufacturer (OEM) is the CNG Honda Civic, and Honda has announced it will no longer offer this vehicle beginning in 2016. More models are available for medium-duty truck and van applications. For example, a 2013 GMC Savana cargo van is available in a CNG version.<sup>27</sup> Many of the other on-road NGVs in use today are conversions.

Among transit buses, natural gas has been the dominant alternative fuel. Approximately 12,000 natural gas transit buses are in operation nationwide, or 19% of the national bus fleet.<sup>28</sup>



<sup>27</sup> <http://www.gmc.com/savana-cargo-van.html>

<sup>28</sup> National Transit Database 2012, Table 17 – Energy Consumption.  
<http://www.ntdprogram.gov/ntdprogram/pubs/dt/2012/excel/DataTables.htm>

## Propane

### Description

Liquefied petroleum gas (LPG) is commonly referred to as propane. *Autogas* is another term specific to propane used in transportation. Propane turns into a colorless, odorless liquid when stored under pressure inside a tank. As pressure is released, the liquid propane vaporizes and turns into a gas, which is used for combustion. Propane presents no threat to soil, surface water, or groundwater. Additionally, propane has a high octane rating, which allows for increased vehicle power and performance.

Nearly all U.S. propane supply is produced in North America either as a by-product of natural gas processing or by crude oil refining. Pipelines, railroads, barges, trucks, and tanker ships are used to ship propane from its points of production to bulk distribution terminals. Trucks are filled at the terminals, and propane dealers then distribute propane to end users, which include retail fuel sites.

### Uses and Applications

Propane is mainly used in light-duty pick-up trucks, taxis, medium-duty vans, and heavy-duty school and transit buses. Propane is well suited for spark ignition engines, and gasoline engines can be converted relatively easily to use propane. The high octane rating of propane (104–112 compared to 87–92 for gasoline), combined with low carbon and oil contamination characteristics, results in engine life that can last up to two times longer than a gasoline engine. Propane can be stored onboard a vehicle as a liquid at a low pressure—between 100 and 200 psi, allowing for refueling times comparable to gasoline refueling.



The cruising speed, power, and acceleration of propane vehicles are similar to those of gasoline-powered vehicles. Propane has approximately 73% the energy content of gasoline per gallon; therefore, the typical range of a light duty vehicle equipped with a 20-gallon tank is approximately 250 miles. Driving range can be increased by adding additional storage tanks; however, the added weight displaces payload capacity.

Because few propane vehicles are offered by OEMs, propane normally requires conversion of a gasoline vehicle. Companies providing propane conversions include Bi-Phase Technologies, CleanFuel USA, Icom North America, IMPCO Technologies, and Roush CleanTech.

Propane has a niche among transit fleets and can also be well suited to off-road applications such as fork lifts, commercial mowers and other grounds maintenance equipment, and airport ground support equipment.

## Electricity

### Description

Electricity can be used to power all plug-in electric vehicles (PEVs), which include battery electric vehicles (BEVs, which run exclusively on electricity) and plug-in hybrid electric vehicles (PHEVs, which can run both on electricity and other fuels, typically gasoline). Electricity can also power fixed guideway transit applications such as heavy rail (e.g. Bay Area Rapid Transit, Los Angeles Metro), light rail (e.g. Sacramento Regional Transit), and trolleys (San Diego Metro). All PEVs draw electricity from off-board electrical power sources (i.e., the electrical grid) and store the electricity as chemical energy in onboard batteries. In a BEV, the battery powers an electric motor. PHEVs also have an electric motor that uses energy stored in a battery, as well as an internal combustion engine (ICE) that can run on petroleum or alternative fuel depending on the vehicle design. All PHEVs commercialized at scale today use electricity and gasoline.

Note that PEVs differ from conventional hybrid-electric vehicles, which typically use regenerative braking to charge a small on-board battery that can power the vehicle during idling and low speeds. There are many diesel-electric hybrid transit buses currently in service. These vehicles cannot be charged using an external power source.

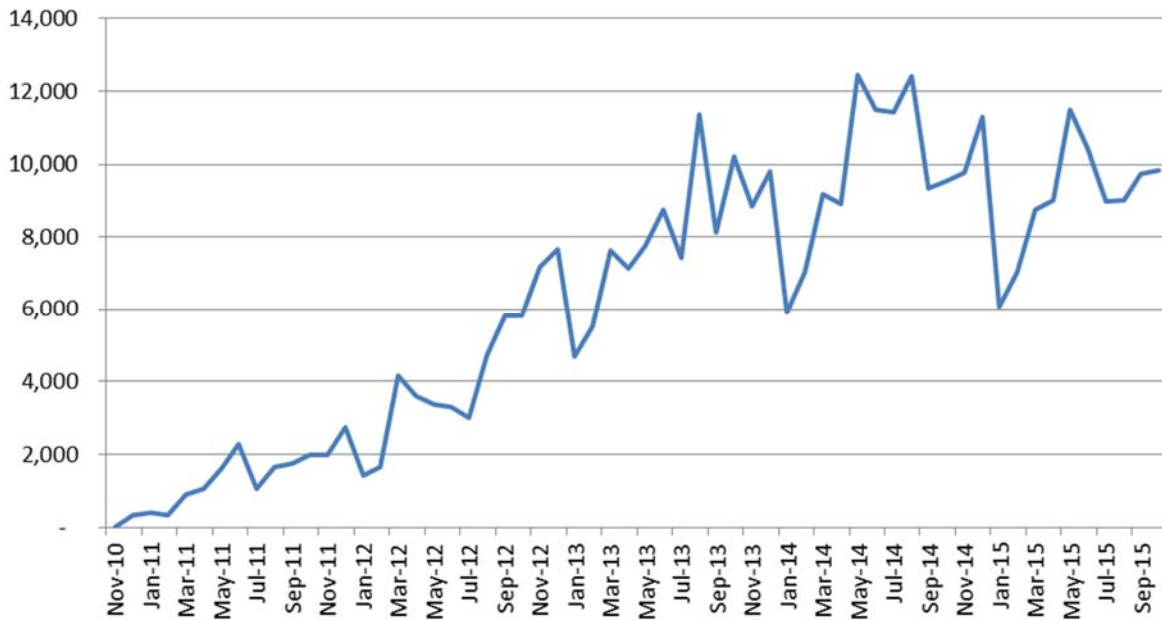
PEVs are charged by plugging into charging equipment, often known as electric vehicle supply equipment (EVSE). Electric vehicle supply equipment is generally categorized in terms of its level, a term that refers to the range of current or voltage at which the equipment is designed to support the charging of the vehicle. Charging times vary and can range from 15 minutes to 20 hours or more, depending on factors such as battery size and type, and the type of charging equipment used. AC level 1 EVSE supports conductive charging at current levels up to 16 amperes (A), at voltage levels of 120 alternating current volts (VAC), common in standard outlets. AC level 2 EVSE supports conductive charging at current levels between 12 and 80 A, using 208 to 240 VAC circuits. A third type or level of equipment, known as DC fast charge (sometimes referred to as DC level 3), uses direct current). This type of equipment enables charging at much higher current, and has a rated power in the order of 50kW. DC fast charging equipment uses a charger included in the equipment, while level 1 and 2 use the charger in the vehicle. DC fast chargers require a different connector, for which a standard is currently being developed in the United States. In addition, inductive charging uses an electromagnetic field to transfer electricity. Charging equipment using inductive charging has been used since the 1990s, but conductive charging has been the dominant mode in the current large-scale commercialization of PEVs. It is possible to use inductive charging in wireless charging systems. This technology has had limited but successful deployments at transit agencies including Long Beach Transit, Monterey-Salinas Transit, and Antelope Valley Transit Authority.

As of the date of this writing, there were 8,250 EV charging stations installed and reported across the country, with a total of over 20,000 outlets.

**Uses and Applications**

The cumulative sales of PEV in the United States grew to over 211,000 by the time of this writing. PEV sales in May 2014 alone amounted to 12,453, with 6,651 PHEV and 5,802 BEV; record sales in both categories. Figure 1-2 shows the monthly sales of PEVS from November 2010 to October 2015.

**Figure 1-2. Monthly Electric Vehicle Sales in the United States (November 2010 – October 2015)**



Source: [www.hybridcars.com](http://www.hybridcars.com), Hybrid Market Dashboard

There currently are 19 different models of PEVs offered in the market. The focus of large auto manufacturers is heavily on the light-duty vehicle market. The table below lists plug-in vehicles currently commercially available. This table excludes concept models, such as the Audi e-tron or limited production models, such as the McLaren P1. As manufacturers increase their model year offerings, sales are expected to increase. PEVs currently make up 0.8% of all U.S. LDV sales.<sup>29</sup>

<sup>29</sup> <http://www.hybridcars.com/may-2014-dashboard/>

**Table 1-12. Light-Duty Plug-in Electric Vehicles Offered in the United States**

Make	Model	Platform	Type	Battery Size (kWh)
BMW	I3	BEV	Compact/Subcompact	21
BMW	I3 with range extender	PHEV	Compact/Subcompact	
BMW	I8	PHEV	Sport	-
Cadillac	ELR	PHEV	Large	16.5
Chevrolet	Spark	BEV	Minicompact	20
Chevrolet	Volt	PHEV	Compact/Subcompact	16.5
Fiat	500e	BEV	Minicompact	24
Ford	C-Max Energi	PHEV	Midsized	7.6
Ford	Focus	BEV	Compact/Subcompact	23
Ford	Fusion Energi	PHEV	Midsized	7.6
Honda	Accord	PHEV	Midsized	6.7
Honda	Fit	BEV	Small station wagon	20
Kia	Soul	BEV	Compact	16.4
Mercedes Benz	B-Class Electric	BEV	Midsized	28
Mitsubishi	i-MiEV	BEV	Compact/Subcompact	16
Nissan	Leaf	BEV	Midsized	24
Porsche	Panamera SE	PHEV	Sport	9.4
Scion	iQ EV	BEV	Minicompact	12
Smart	fortwo	BEV	Two Seater	17.6
Tesla	Model S	BEV	Large	60
Toyota	Prius plug-in	PHEV	Midsized	5.2
Toyota	RAV 4 EV	BEV	SUV	41.8
Volkswagen	E-Golf	BEV	Midsized	24.2
Wheego	LiFe	BEV	Two Seater	30

There are some medium-vehicle (MDV) and heavy-duty vehicle (HDV) plug-in models commercially available. The table below summarizes the HDV models currently available indicating the application.



**Table 1-13. Medium and Heavy-Duty Electric Vehicles Currently Commercialized**

Manufacturer	Model/Chassis	Application	Platform
BYD	eBus	Transit Bus	All electric
Proterra	Catalyst	Transit bus	All electric
Trans Tech	SST-e	School bus	All electric
DesignLine Corp.	Eco Smart 1	Transit bus	All electric
New Flyer	Xcelsior	Transit bus	All electric
Balgon	Nautilus XRE 20	Tractor	All electric
Balgon	Nautilus MX-30	Tractor	All electric
Balgon	Mule M100	Truck	All electric
Boulder Electric Vehicle	500 Series	Truck, van	All electric
Boulder Electric Vehicle	1000 Series	Truck, van	All electric
Electric Vehicles International	EVI-MD	Truck, van	All electric
Electric Vehicles International	EVI Walk-in Van	Van	All electric
Enova Systems	Enova Ze	Van	All electric
Freightliner Custom Chassis	MT E-Cell	Van	All electric
Smith Electric Vehicles	Newton	Van, school bus	All electric
Orange EV	T-Series	Yard Truck	All electric

### 1.3.3 SWOT Analysis

ICF conducted a SWOT analysis of current and potential future fuel and energy sources. SWOT analysis is a standard approach for strategic planning, and helps to illuminate a full range of key criteria and risk factors for decision making.

The SWOT analysis considered the following factors:

- Current and likely future availability of fuel and energy sources to include diesel, gasoline, electricity, renewable electricity (particularly solar), propane, natural gas, and biofuels. We used our knowledge of fuel sources in California, and conducted interviews with local and regional fuel providers as necessary.
- State/Federal air pollution policy – Policies that could affect the operations of Lake Transit, such as diesel anti-idling rules or ARB’s proposed ACT rule. We consulted the Lake County Air Quality Management District and the California Air Resources Board for applicable regulations or challenges with individual fuel sources.
- Developing technologies – New kinds of hybrid and electric buses continue to come to market. Some innovative rural transit agencies, such as 9 Town Transit in Connecticut, have retrofit



cutaway vehicles with hybrid transmissions with great success.<sup>30</sup> Mendocino Transit Authority implemented diesel-hybrid cutaway buses with dismal results. New technologies, while offering great benefits, are also untested and caution should be used in evaluating new products.

- Reliability and likely disruptions in the supply of individual energy and fuel types, including potential utility as a backup fuel in emergency situations.
- Emergency response demands – We looked at the history of local emergencies and Lake Transit’s role in providing emergency relief including the most recent wildfires in 2015. The impact of each fuel option on emergency services will be considered. For example, electric vehicles may provide sufficient service normally. But the additional power available from diesel vehicles could be critical in an evacuation and the additional weight from an electric bus battery could compromise the response of heavy, larger vehicles.

The following table shows the results of the SWOT analysis for diesel, gasoline, biodiesel, renewable diesel, natural gas, electricity and propane.

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<sup>30</sup> ICF International for Transit Cooperative Research Program, TCRP Synthesis 106: Energy Saving Strategies for Transit Agencies, Transportation Research Board, Washington DC, 2013.



**Table 1-14. SWOT Analysis**

Fuel	Strength	Weakness	Opportunity	Threat
Gasoline (G) and (D) Diesel	(G,D) currently used and easily accessible; over 150,000 gallons stored in Lake County; (G) Lower tailpipe emissions than diesel; (D) all bus types available with diesel option	(G,D) Rising and/or unpredictable fuel cost (G) larger cut-away gasoline buses are not available (D) Highest tailpipe GHG and criteria pollutant emissions	Hybridized vehicles to reduce fuel consumption	Potential for national/international supply disruptions and price spikes
Biodiesel (BD) and Renewable Diesel (RD)	(BD,RD) Does not require alternative fuel vehicles; (RD) fully interchangeable with diesel (BD) below 20% blend interchangeable with diesel	Currently more expensive than diesel; some testing has shown higher BD blends produce increased NOx emissions	Advances in feedstock and fuel production could reduce costs; can be used in existing vehicles allowing for future fuel switching; possible local supply; lower GHG emissions; RD could assist in ACT Rule Compliance	Higher blend BD use could void some vehicle warranties
Natural Gas	Reliable and consistent US supply and pricing; vehicles available for all sizes	No pipeline access; trucked into Lake County as LNG; requires new vehicles and infrastructure	LCNG station with an estimated month's storage capacity; cheaper than diesel and gasoline on a BTU basis; lower GHG and criteria pollutant emissions; RNG could assist in ACT Rule Compliance	Closest current natural gas station is Santa Rosa if there are supply disruptions from natural disasters (i.e. fire, earthquake)
Electricity	Available onsite and does not need to be truck into Lake; increased vehicle efficiency and no tailpipe emissions	Limited vehicle options; increased vehicle and infrastructure cost; duty-cycle limitations	Cheaper fuel cost; lower GHG emissions and no criteria pollutant emissions; ACT Rule compliance	No additional "fuel storage" besides extra batteries
Propane	Vehicle conversion kits available; propane already delivered onsite; 30,000+ gal of propane is currently stored in Lake County	Increased vehicle and infrastructure cost (more onsite storage required); limited onboard storage since propane has a lower energy density than gasoline and diesel	Cheaper than diesel and gasoline on a gallon basis but limited cost savings on BTU basis; lower GHG and criteria pollutant emissions; no renewable option restricts assisting in ACT Rule compliance	Propane is produced from refining petroleum and natural gas production and could be subject to national/international supply disruptions and price spikes

## Conclusions

Based on the results of the SWOT analysis, there are no fuels that can be completely ruled out for Lake County. Since there is no pipeline access for natural gas in Lake County a fleet conversion would require significant onsite storage to ease emergency response and reliability concerns. Fuels such as electricity and propane that would have little (propane) to no (electricity) onsite storage would be candidates for partial fleet conversions. Electricity is the only fuel that does not need to be trucked into Lake County.

### 1.3.4 Fleet Analysis

The Lake Transit fleet analysis was done for the current 31 cutaway buses that run on both gasoline and diesel fuel. Cutaway buses are buses based on cutaway van chassis as opposed to conventional transit buses. Figure 1-3 and Figure 1-4 below show examples of cutaway and conventional transit buses.



Figure 1-3. Cutaway Bus



Figure 1-4. Transit Bus

Cutaway buses are divided into four (4) different categories, Class A, B, C and E. Class A, B and C cutaways are smaller and can transport 8, 12 and 16 passengers, respectively. Class E cutaways are larger and designated by the length of their chassis (e.g. 25 feet to 40 feet). Longer chassis cutaways have a larger passenger capacity and also require larger engines. The Class A, B and C cutaway buses are built on Ford E-450 or similar (GM 4500) chassis and the Class E cutaway buses are built on Ford F-550 (28 feet to 32 feet) or Freightliner/International/Cummins chassis (28 feet to 40 feet). The table below shows the Lake Transit fleet assumed for the analysis including replacement years and fuel type.

Table 1-15. Lake Transit Fleet Replacement Years by Vehicle Class by Fuel

	2015	2016	2017	2018	2019	2020	2021	Total
Class C	2 (G)	3 (G)	5 (G)		3 (G)	1 (D)		14
Class E – 32'	3 (1-G, 2-D)	8 (3-G, 5-D)				2 (D)		13
Class E – 35'							2 (D)	2
Class E – 38'	2 (D)					1 (D)		3
Total	7	11	5	-	3	4	2	32

(D) – Diesel; (G) - Gasoline

Analysis of Lake Transit feet shows approximately 900,000 miles per year of travel. ICF collected over 2 years of fleet fuel consumption and vehicle miles traveled (VMT) from July 2012 – September 2014. From the analysis we found that the annual VMT per vehicle type was indistinguishable by vehicle type either due to driving pattern, route, and passenger load. This is mainly due to the vehicles being cycled through multiple routes. For the cost analysis in the next section, it is assumed that each bus travels approximately 30,000 miles per year. In addition the data showed that newer diesel buses achieve approximately 8 miles per diesel gallon. This is equivalent to 6 miles per gasoline gallon when taking into account the reduced efficiency of a gasoline engine<sup>31</sup> and the lower energy density of a gasoline gallon.<sup>32</sup>

### 1.3.5 Fleet Alternatives Cost Analysis

ICF developed estimates for the cost of fuels and energy alternatives. These costs include fuel, vehicles, refueling infrastructure, and operations and maintenance for vehicles and refueling stations.

#### Cost and Vehicle Operation Inputs

##### Fuel Price Projections

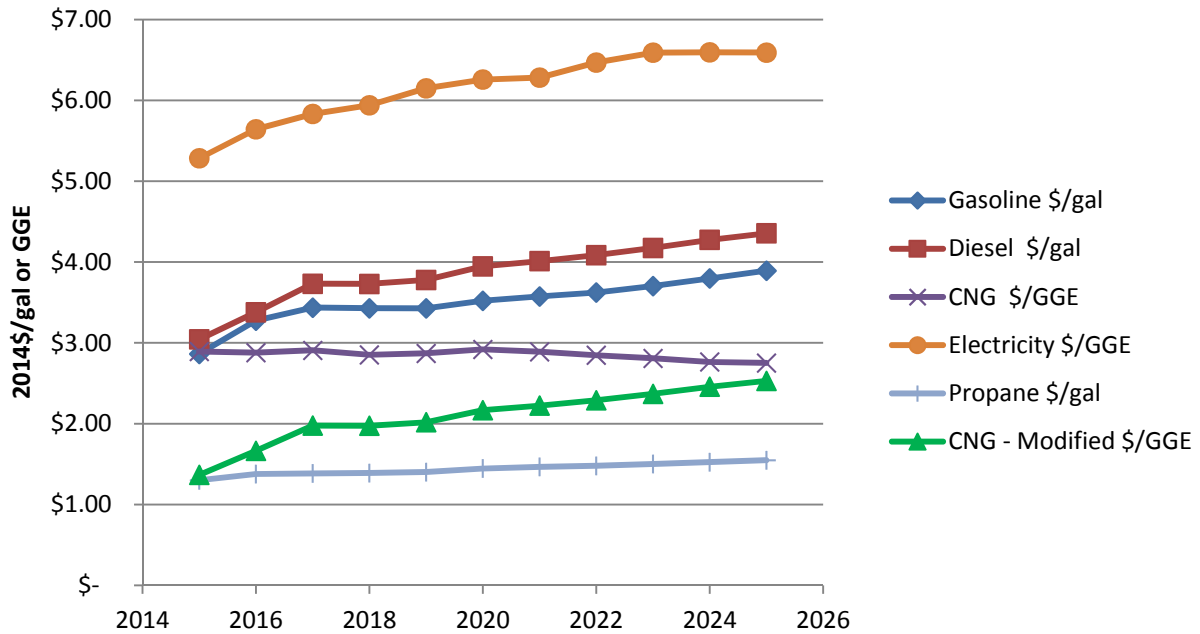
Fuel costs were projected by using a combination of the U.S. Energy Information Administration (EIA) Annual Energy Outlook (AEO) for 2013 Pacific Region and California Energy Commission (CEC) Integrated Energy Policy Report (IEPR) for 2013 to modify the AEO2015 Pacific Region to a California cost scenario. The 2013 IEPR was used because the 2015 final draft fuel price projections had not been released at the time of the report.

The fuel costs were compared and calibrated against current prices in Lake County. The fuel price projections for gasoline and diesel were in line with current prices for Lake County but the prices for propane, natural gas and electricity were modified to be Lake County specific. The county contract for propane, which Lake Transit is eligible to participate in, is based on the spot price plus \$0.22 per gallon and \$0.36 per gallon for the state fuel tax (\$0.30 for Motor Fuel Vehicle Tax and \$0.06 for the Use Fuel Tax). Lake Transit, as a public transit agency, is only required to pay \$0.01 of the \$0.06 per gallon Use Fuel Tax. This fuel price is significantly less than the EIA and IEPR 2013 forecasted values and the cost analysis forecast was scaled to the county contract. The EIA and IEPR 2013 natural gas transportation costs were high compared to the diesel forecast. Cost estimates from natural gas providers to Lake Transit estimated a \$1 per diesel gallon equivalent (DGE) cost savings compared to diesel. The cost analysis forecast uses a \$1 per DGE cost savings compared to diesel. The electricity costs were scaled to the annual average off-peak rate without increased demand costs. Figure 1-5 below shows the fuel cost projections utilized in the cost analysis.

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<sup>31</sup> Gasoline engines are approximately 85% as efficient as a diesel engine on an energy basis

<sup>32</sup> Energy density of low-sulfur diesel and gasoline are approximately 127,460 and 109,786 btu/gallon, respectively



**Figure 1-5. Cost Analysis Fuel Price Projections**

**Vehicle Cost**

Lake Transit is a member of the California Association for Coordinated Transportation (CalACT) and can purchase through the CalACT/Morongo Basin Transit Authority (MBTA) purchasing cooperative.<sup>33</sup> The following are a range of costs for diesel, gasoline, propane and CNG vehicles that can be purchased through CalACT. The table below shows the cutaway bus costs utilized in the analysis. The numbers below are lower than the actual cost because they do not include all of the add-on items usually requested by transit agencies but accurately represent the incremental cost per vehicle between conventional and alternative fuel transit buses.

<sup>33</sup> <https://www.calact.org/purchasingco-op>

**Table 1-16. CalACT Vehicle Cost**

	Gasoline	Diesel	Diesel Hybrid	Propane	CNG
Class C	\$52,000 - \$61,000	\$65,000 - \$73,000	None	\$71,000 - \$80,000	\$75,000 - \$84,000
Class E – 32' <sup>34</sup>	\$79,000 - \$87,000	\$85,000 - \$98,000	\$142,000 - \$154,000	\$100,000 - \$109,000	\$104,000 - \$112,000
Class E – 38'	None	\$119,000 - \$147,000	\$186,000 - \$204,000	None	\$155,000 - \$172,000 <sup>35</sup>

ICF contacted BYD and Proterra to investigate the cost of battery electric buses. The table below shows the electric bus options and costs. Lake Transit has shown interest in the 30' BYD bus since it fits within their current bus fleet<sup>36</sup> and the buses are relatively affordable for an electric bus.

**Table 1-17. Electric Bus Options and Costs**

Company	Vehicle Size	Vehicle Cost	Charging Type	Charger Cost
BYD	30', 35', 40'	30' - \$450,000 35' - \$700,000 40' - \$800,000	Overnight (80kW, 100A) and fast charge options	Overnight – Free Fast – Upwards of \$1 mil
Proterra	35', 40'	35' - \$669,000 40' - \$749,000	Overnight and fast charge options	Overnight – Free Fast – Upwards of \$1 mil

### Vehicle Fuel Economy

The results from the Fleet Analysis (Section 1.3.4) showed that new diesel buses achieved approximately 8 miles per gallon. ICF reviewed the EPA certification database for F550s running on gasoline, natural gas, diesel and propane<sup>37</sup> and utilized the energy economy ratios (EERs) from the ARB Low Carbon Fuel Standard (LCFS)<sup>38</sup> to convert the new diesel fuel economy into fuel economies for other fuels and technologies. EER is the fuel economy ratio in the same energy units of an alternative fuel to a conventional fuel in a similar application or vehicle (e.g. light-duty car, transit bus, heavy-duty truck). For

<sup>34</sup> Bundled the 35' buses into the 32' buses since Propane and Gasoline are not available in the 35' bus

<sup>35</sup> The Cummins platform convertible to CNG on the 38' chassis should be available next year from Creative Bus Sales

<sup>36</sup> 30' electric buses have comparable passenger capacity to conventional 35'-38' cutaway buses.

<sup>37</sup> <http://www3.epa.gov/otaq/certdata.htm>

<sup>38</sup> <http://www.arb.ca.gov/regact/2015/lcfs2015/finalregorderlcfs.pdf>

example, a light-duty electric car with a fuel economy of 100 miles per gasoline gallon equivalent (GGE) and a comparable light-duty gasoline car with a fuel economy of 30 miles per gasoline gallon would result in an EER of 3.33.<sup>39</sup>

**Table 1-18. Vehicle Fuel Economy by Fuel/Technology**

Fuel/Technology	Analysis Fuel Economy <sup>40</sup>	Comments
Diesel	8 miles per diesel gallon	Taken from Lake Transit data
Diesel Hybrid	10 miles per diesel gallon	25% fuel economy improvement
Gasoline	6.8 miles per diesel gallon equivalent (DGE)	15 % fuel economy penalty on an equivalent energy basis to diesel
Natural Gas	6.8 miles per DGE	15 % fuel economy penalty on an equivalent energy basis to diesel
Propane	6.8 miles per DGE	15 % fuel economy penalty on an equivalent energy basis to diesel
Electricity – BYD 30' Bus	32 miles per DGE	Assumes an EER of 4 to the 8 mi/DGE cutaway bus
Electricity – BYD 35', 40', Proterra 40'	20 miles per DGE	Assumes an EER of 4 to a conventional 5 mi/DGE transit bus

### Vehicle Operations and Maintenance (O&M)

ICF researched vehicle and fleet O&M costs for conventional and alternative fuel vehicles. The table below shows the cost analysis assumptions for O&M that were utilized to estimate the future vehicle and fleet conventional diesel and alternative fuel O&M costs.

**Table 1-19. Conventional and Alternative Fuel O&M Cost Analysis Assumptions**

Fuel	O&M For the Cost Analysis	Comments
Diesel/Diesel Hybrid	\$0.38/mi	TCRP 41 <sup>41</sup>
Natural Gas	\$0.43/mi	Natural gas on average 12% higher O&M than diesel <sup>42</sup>

<sup>39</sup> 100 mi/GGE divided by 30 mi per gallon = 3.33.

<sup>40</sup> 1 mile per DGE is approximately 0.885 mile per gasoline gallon equivalent

<sup>41</sup> <http://onlinepubs.trb.org/onlinepubs/tcrp/tsyn41.pdf>

<sup>42</sup> TCRP 132, [http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp\\_rpt\\_132.pdf](http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_132.pdf)

Fuel	O&M For the Cost Analysis	Comments
Propane	\$0.19/mi	Propane is 50% lower than diesel <sup>43</sup>
Electricity	\$0.158/mi	Cutaway electric buses estimated to be 64% <sup>44</sup> of electric 40' buses <sup>45</sup>

### Fueling Station Infrastructure and O&M

The last cost element for the cost analysis is the station infrastructure and O&M costs. ICF spoke with fueling experts from each fuel category to estimate the fueling infrastructure and O&M costs.

**Table 1-20. Fueling Infrastructure and O&M Costs**

Fuel or Technology	Fueling Infrastructure Cost	Fueling Infrastructure O&M	Comments
Diesel	\$150,000	\$6,800/yr	Diesel station infrastructure and O&M an estimate from diesel fuel supplier; O&M includes estimate for electricity for pumping <sup>46</sup>
Diesel Hybrid	\$150,000	\$6,500/yr	Same as above
Natural Gas	\$1.5 million installed	\$3,000/mo; \$36,000/yr	Minimum volume LCNG station cost estimate from NG fuel supplier; Monthly cost based on traditional repair and maintenance contracts
Propane	\$70,000 – equipment \$47,000 – site prep \$117,000 - total	\$2,568	Cost estimates from a propane station developer; base O&M assumed to be ½ diesel based annual (\$5,000) plus electricity for pumping

<sup>43</sup> <http://www.masstransitmag.com/article/11346544/control-maintenance-costs-on-multiple-fuel-fleets>

<sup>44</sup> <http://onlinepubs.trb.org/onlinepubs/tcrp/tsyn41.pdf>

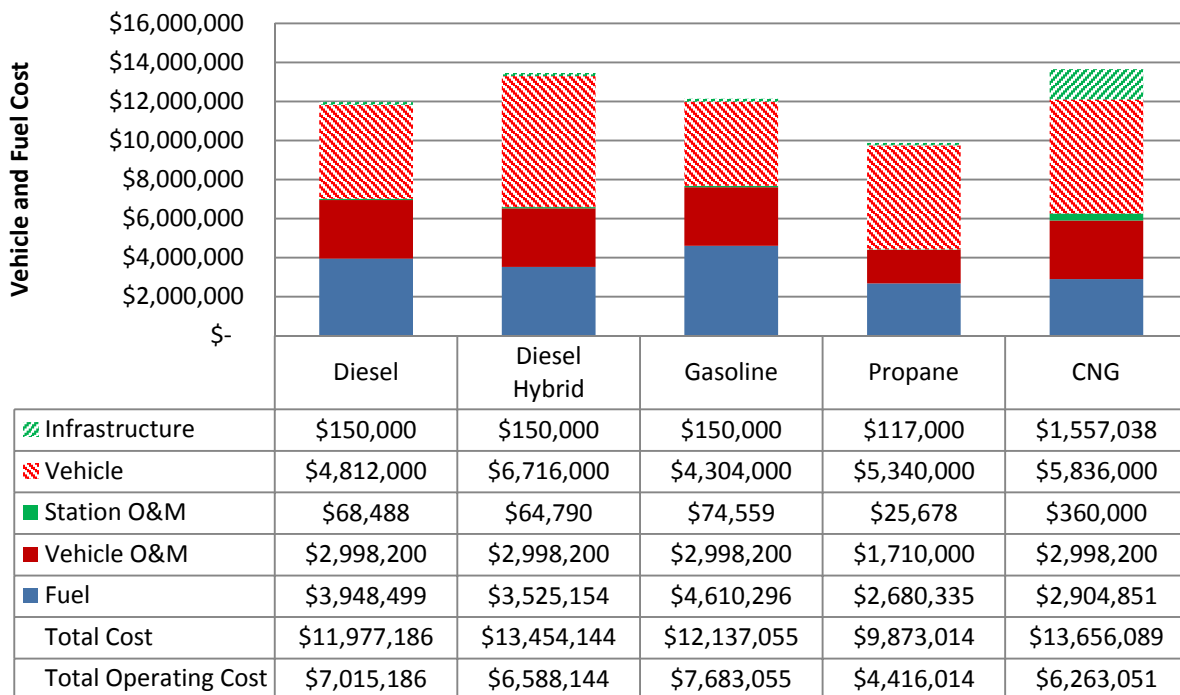
<sup>45</sup> [http://cahigheredusustainability.org/documents/ThomasWard\\_Jun173113Adams4.15pm\\_000.pdf](http://cahigheredusustainability.org/documents/ThomasWard_Jun173113Adams4.15pm_000.pdf)

<sup>46</sup> Infrastructure for diesel refueling would allow for Lake Transit to take advantage of lower diesel prices through the Lake County fuel contract. This is not a necessary action that does involve environmental risk, but would be worth the monetary investment to save on fuel costs.

Fuel or Technology	Fueling Infrastructure Cost	Fueling Infrastructure O&M	Comments
Electricity	\$100,000	\$0	The fueling infrastructure cost is for electricity upgrades from PG&E estimate; assume there is no cost to maintain the conventional charge station

### 10 Year Analysis

ICF combined the cost analysis assumptions above with the Lake Transit bus replacement timeline to develop comparative 10 year cost analyses. The values shown represent only the new vehicles purchased and no legacy vehicles in the existing fleet. For the gasoline and propane cases, since the Class E – 38’ buses are not available in gasoline and propane, it is assumed that new diesel buses would be purchased. For the natural gas station, it assumed that a 3% interest rate was applied by the station provider during the lease back. An alternative would be purchasing the station outright. Figure 1-6 shows the 10 year cost analysis results.



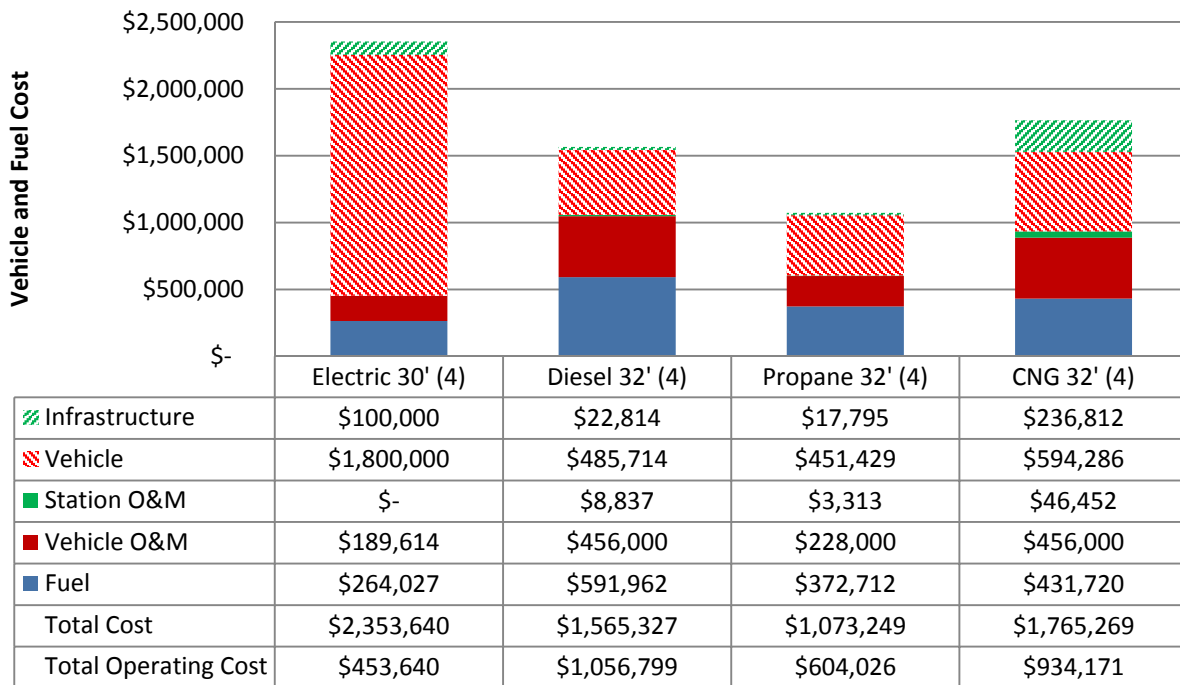
**Figure 1-6. 10 Year Fleet Cost Analysis for New Vehicles**

The diesel hybrid and CNG cases have the highest total cost and diesel, diesel hybrid, and gasoline cases have the highest total operating cost. Propane has the lowest total cost and total operating cost. The propane case results in approximately \$260,000 in annual operating cost savings compared to diesel.



Electricity is omitted from Figure 1-6 since Lake Transit would only consider replacing a limited number of buses. Lake Transit could generate \$1,000 - \$4,000 annually in LCFS credit revenue upon complete fleet conversion to CNG. This revenue is not included in the figure above.<sup>47</sup> The LCFS credit revenue can be passed on as a price credit from the fuel supplier or a lump sum at the end of each LCFS quarterly reporting period. If Lake Transit were to use RNG instead of CNG, they would likely not see additional LCFS credit revenue since this increased revenue is traditionally distributed between the RNG producer and fuel provider. The poor performance of diesel hybrids at Mendocino Transit, who are the only transit agency to purchase hybrids through CalACT, has ruled out their implementation at Lake Transit. In addition, the analysis above shows that diesel hybrid fuel savings do not pay for the incremental cost of the vehicles.

ICF performed a 10 year analysis to replace just four (4) buses with 30' BYD electric buses. The total fleet infrastructure and station O&M costs for diesel, propane and CNG from Table 1-20 are allocated per vehicle. The figure below shows the results of the analysis.



**Figure 1-7. 10 Year Cost Comparison for Replacing Four (4) 32' Diesel Buses**

Since cutaway buses have an operational lifetime of seven (7) years, the vehicle costs in the figure above for diesel, propane and CNG cases include one full round of vehicle purchasing and 43% (3/7) of a second round of vehicle purchasing. The BYD electric buses have a >10 year vehicle life and only require one round of vehicle purchasing. The cost results for the electric buses are dominated by the cost of the bus but the analysis shows that four (4) BYD 30' electric buses would save approximately \$60,000 per

<sup>47</sup> Assuming LNG carbon intensity if 80g/MJ and a range in credit price from \$50 - \$200 per credit.

year in annual operating cost. The electric buses could potentially generate \$6,000 to \$24,000 in LCFS credit revenue annually<sup>48</sup> which is not included in the figure above. These credits could increase the annual operating savings from \$60,000 to \$66,000 - \$84,000. If Lake Transit were able to secure funding for electric buses, this option would be a significant energy and operating cost reduction strategy. This figure also shows that four propane buses can achieve significant operating cost savings of \$45,000 per year compared to diesel. Implementing electric buses would necessitate switching to the A-6 rate structure to eliminate the high demand charges from electric bus charging.

### Environmental Impact Comparison

Each fuel option has unique GHG and criteria pollutant emissions based on the fuel economy of the vehicles and the type of fuel consumed (i.e. diesel vs renewable diesel in the same engine). As discussed in Section 1.3.4, new diesel buses average around 8 mi per diesel gallon. Utilizing the relative fuel economies above and fuel carbon intensities from the LCFS<sup>49</sup>, ICF developed a GHG emission intensity for each fuel and technology in the units of grams of CO<sub>2</sub>e per mile (gCO<sub>2</sub>e/mi) shown below.

**Table 1-21. GHG Emission Intensity by Fuel and Technology**

Fuel Technology	Estimated gCO <sub>2</sub> e/mi
Diesel	1,700
Renewable Diesel (RD)	500
Diesel Hybrid	1,400
Diesel Hybrid - RD	400
Gasoline	2,000
Propane	1,800
CNG	1,500
Renewable Natural Gas (RNG)	600
Electricity (30' bus)	400
Electricity (40' bus)	700

In addition to GHG emissions, it is important to consider the criteria pollutant emissions, which can contribute to localized air pollution and associated health impacts. Criteria pollutants include oxides of nitrogen (NO<sub>x</sub>), carbon monoxide (CO), diesel particulate matter (diesel PM) and non-methane organic carbon (NMOC). Criteria pollutant emissions are not a major driver for Lake Transit since Lake County is in attainment for federal air quality standard, but Lake Transit would like to maintain Lake County's existing high levels of air quality. ICF reviewed EPA and ARB certification data for comparable diesel, gasoline, propane, and CNG vehicles to determine relative emissions compared to new diesel

<sup>48</sup> Assuming electricity carbon intensity of 105 g/MJ, EER of 4 and a range in credit price from \$50 - \$200 per credit.

<sup>49</sup> <http://www.arb.ca.gov/fuels/lcfs/lcfs.htm>

technology.<sup>50</sup> The table below shows the results of the certification analysis where negative values represent reductions and positive values represent increases.

**Table 1-22. Relative Criteria Pollutant Emissions to Diesel**

Fuel Technology	NOx	CO	Diesel PM	NMOC
Diesel	-	-	-	-
Diesel Hybrid	-20%	-20%	-20%	-20%
Gasoline	-50%	1000%	-100%	800%
Propane	-8%	900%	-100%	170%
CNG/RNG	-15%	2500%	-100%	98%
Electricity (tailpipe)	-100%	-100%	-100%	-100%

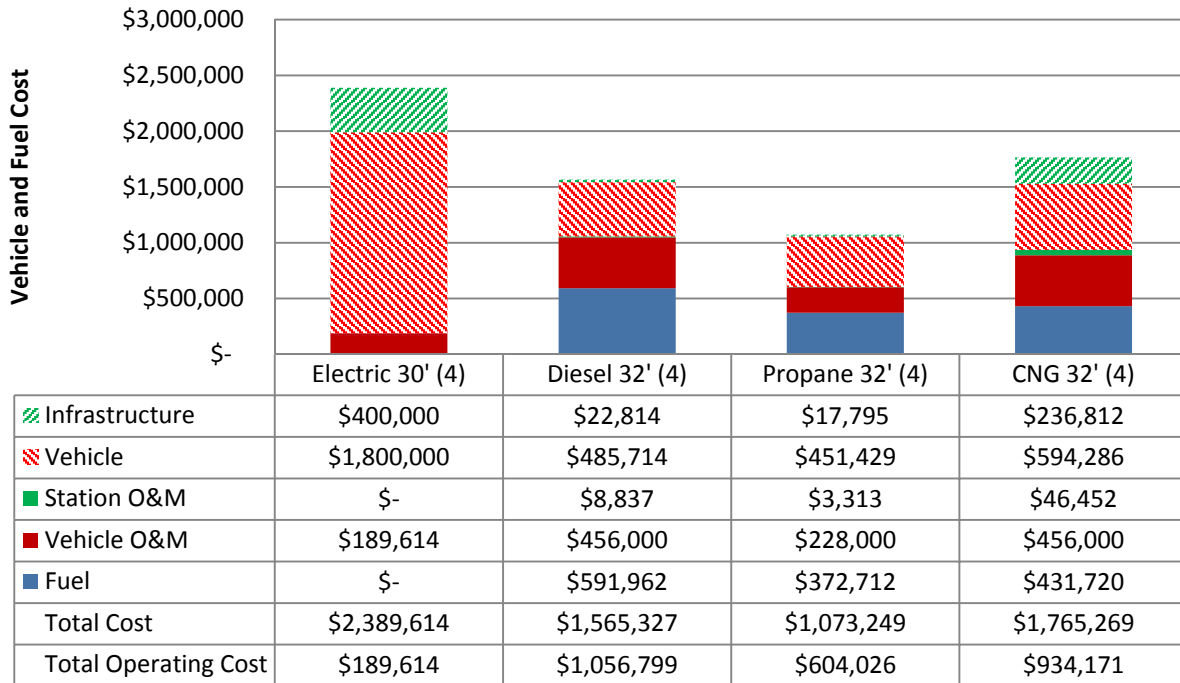
All fuel options reduce NOx and diesel PM emission, the most prevalent and health impactful emissions, but some increase CO and NMOC.

### Electric Bus plus Solar Canopy

Another option being explored is constructing a solar bus canopy that supplies enough power for the four (4) buses discussed above and the facility. After improvements for LED lighting, the facility will consume approximately 40,000 kWh/yr. It is estimated each 30' electric bus will consume 33,000 kWh/yr resulting in a total Lake Transit electricity consumption of approximately 172,000 kWh/yr (132,000 kWh/y from the buses alone). Based on the information supplied from NREL PVWatts tool<sup>51</sup>, the resulting canopy would need to be over 116 kW of solar panels. Rodda Electric supplied a fully installed cost estimate of \$2.5 per W resulting in an estimated total installed cost of \$300,000. The same vehicle, infrastructure and station O&M cost assumptions for diesel, propane, and CNG from Figure 1-7 are used in the figure below. Figure 1-8 shows the results of the 10 year cost analysis including the solar canopy for electric buses.

<sup>50</sup> <http://www.arb.ca.gov/msprog/onroad/cert/cert.php>

<sup>51</sup> PVWatts tool available at <http://pvwatts.nrel.gov/>.



**Figure 1-8. 10 Year Cost Comparison for Replacing Four (4) 32' Diesel Buses with Electric Buses and Solar**

The solar canopy and electric bus option could save Lake Transit almost \$87,000 in annual operating cost compared to diesel. In addition, the potential LCFS credit revenue would increase due to zero emission electricity to \$9,000 - \$34,000 per year<sup>52</sup> which is not included in the figure above. This revenue could increase the annual operating savings from \$87,000 to \$96,000 - \$121,000. If Lake Transit were to utilize the CEC public agency 1% solar loan program<sup>53</sup> for the solar bus canopy, the result would be an estimated annual payment of \$16,100 for a 20 year loan. The annual operating expense savings would decrease from \$87,000 to approximately \$71,000<sup>54</sup>. Also, installing the solar bus canopy would necessitate switching to the A-6 rate structure to eliminate demand charges and allow for Lake Transit to fully offset their electricity bill with solar.

### Partial Fleet Propane Bus Replacement

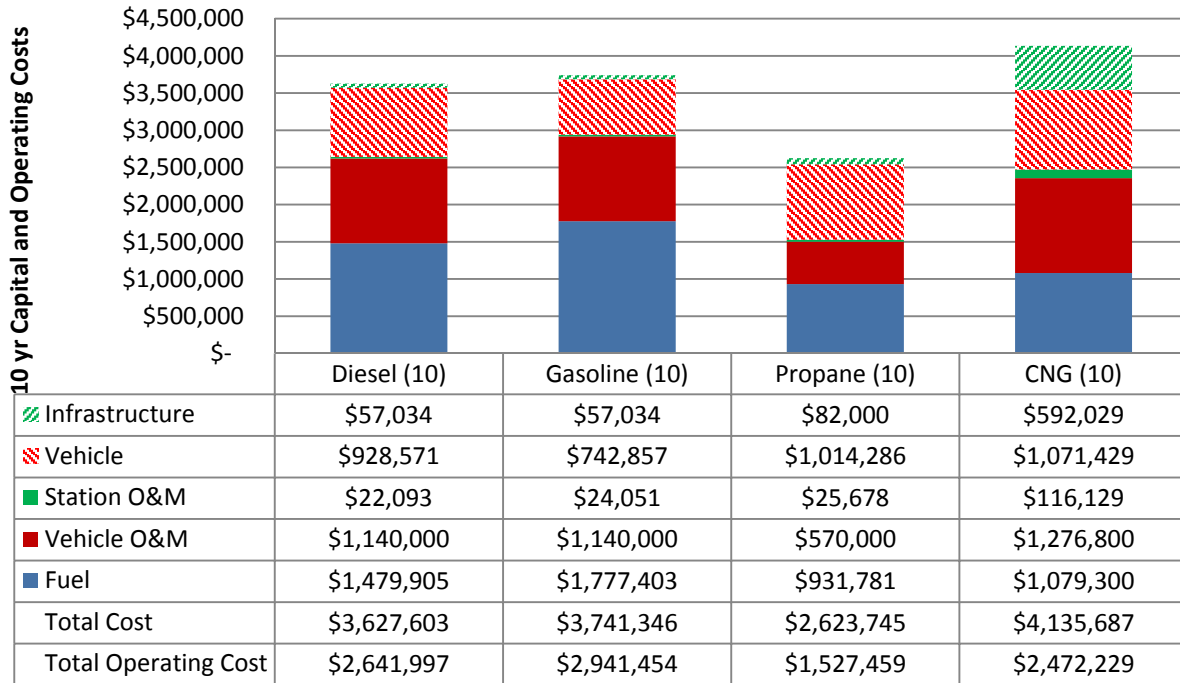
Currently the ACT Rule has not made a determination how to handle smaller transit agencies, smaller cutaway transit buses, and non-diesel/natural gas fueled buses that do not have a lower carbon fueling option (e.g. gasoline and propane). Also, propane vehicles have range limitations due to smaller fuel tanks and limited refueling locations. Due to the unknowns with the ACT Rule towards propane and vehicle range considerations, a practical option for Lake Transit would be a partial fleet conversion to propane. The partial fleet example demonstrated here is for one-third of Lake Transit’s fleet, specifically

<sup>52</sup> Assuming electricity carbon intensity of 0 g/MJ, EER of 4 and a range in credit price from \$50 - \$200 per credit.

<sup>53</sup> <http://www.energy.ca.gov/contracts/PON-13-401/>

<sup>54</sup> Annual total Lake Transit savings increase to \$89,000 when including the \$8,000 of facility electricity savings.

10 new purchase Class C E-450 buses, to be converted to propane. Ferrell Autogas provided an estimated cost of \$82,000 for a station sized to serve this partial fleet. This includes \$35,000 for the equipment and \$47,000 for site prep.<sup>55</sup> The pad size required is approximately 27' by 12'<sup>56</sup> with a construction timeline of 60-90 days. The total fleet infrastructure and station O&M cost for diesel, gasoline and CNG are allocated per vehicle. Figure 1-9 shows the cost analysis results to replace 10 Class C buses.



**Figure 1-9. 10 Year Cost Analysis for Replacing 10 Class C Buses**

Propane has a significantly lower total cost and total operating cost compared to gasoline and diesel. In addition, propane buses are likely to last longer without engine overhauls which increases their longevity in the fleet and potentially lengthen the time between vehicle purchases. A partial dedicated propane fleet could save Lake Transit almost \$110,000 per year in operating cost. In addition, the refueling infrastructure requires minimal space and can relatively easily be removed if Lake Transit decides to pursue another fueling option in the future.

<sup>55</sup> Conversations and emails with Rob Little of Ferrell Gas.

<sup>56</sup> Ferrel Gas presentation to San Joaquin.

## 1.4 Recommendations

### Facility Strategies

ICF recommends that Lake Transit consider immediately implementing the indoor and outdoor light replacements and UV film installation. These strategies have a combined 2-3 year simple payback and savings of over \$4,000 per year. Lake Transit should consider implementing the driver training program at its earliest convenience and include required driver training in the new Request for Proposals for the Lake Transit vehicle and facilities operating and maintenance contract. Lastly, depending on the availability of grant funding, Lake Transit should investigate the construction of a solar bus canopy or installing solar at the current facility. In the absence of grant funding, Lake Transit could also team with a private solar developer through a solar power purchase agreement (PPA) to install the bus canopy at little or no cost to Lake Transit. Lake Transit would purchase electricity from the developer at a fixed rate and the private developer can take advantage of solar tax credits.

### Electricity

Depending on funding availability, Lake Transit should fully investigate an electric bus project of four buses and a solar canopy which would cost an estimated \$2.2 million for vehicles and infrastructure (see Figure 1-8). Electric buses result in significant savings in operating expenses and a path towards ACT Rule compliance. Four electric buses can provide \$60,000 in annual operating savings plus an addition \$6,000 - \$24,000 in revenue per year from LCFS credits. The solar canopy could provide an additional \$26,000 in annual operating cost savings if paid for with grant funding (\$16,000 reduction in annual operating savings if a loan is required) plus an addition \$3,000 - \$9,000 in revenue per year from LCFS credits. The three main potential funding programs for the electric buses and stations, and potentially the solar canopy, are the Zero-Emission Truck and Bus Pilot Commercial Deployments Projects (ZETB)<sup>57</sup>, Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)<sup>58</sup>, and Low Carbon Transit Operations Program (LCTOP)<sup>59</sup>. An additional source of funding for the solar canopy is through the 1% interest rate loan program for financing energy efficiency and energy generation projects including solar.<sup>60</sup> To increase the chances of being awarded funding through the ZETB program, it is recommended that Lake Transit partner with neighboring counties and transit agencies including Mendocino and Yolo and propose using electric buses for intercity bus routes.

The Funding Plan describes in more detail the potential funding sources, application deadlines and the quantity of funding available from each program. The Expenditure Plan looks at an example timeline for implementing and spending funding for a solar canopy electric bus project.

### Propane

Irrespective of pursuing and implementing the four electric bus and solar canopy option, Lake Transit should investigate a partial fleet conversion to propane. Even though it is not yet known how propane

<sup>57</sup> <http://www.arb.ca.gov/msprog/aqip/solicitations.htm>

<sup>58</sup> <http://www.arb.ca.gov/msprog/aqip/solicitations.htm>

<sup>59</sup> <http://www.dot.ca.gov/hq/MassTrans/lctop.html>

<sup>60</sup> <http://www.energy.ca.gov/contracts/PON-13-401/>

will be addressed in the upcoming ACT Rule, Figure 1-9 shows that propane could save Lake Transit \$1.1 million over 10 years including the refueling station and increased vehicle capital cost. If Lake Transit has to abandon propane due to the ACT Rule, the refueling infrastructure can easily be removed from the site. The potential cost savings from propane out weight any concerns of switching back to another fuel in 10 years. Potential funding is available for propane stations through the Propane Education & Research Council (PERC) who have made funding available in the past for new propane stations. Also, San Diego Metro is preparing a Greenhouse Gas Reduction Fund (GGRF) application to pay for building a propane refueling station. While propane does not reduce GHG emissions, it does offset the use of petroleum. If they are successful, GGRF is another source of funding the propane station and potentially the incremental cost for propane vehicle conversions. Lastly the CEC 2015-2016 Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) funding plan<sup>61</sup> lists \$6.1 million available for propane vehicle deployment (approximately \$12,000 per vehicle), but with the caveat that the identified funding includes both completed and pending vehicle incentives, as well as encumbered funds for future incentives. After further research, the funding for this program has been exhausted but more could be allocated to this program and available in the future. The funding and expenditure plans identify a timeline for funding when spending could occur to implement the partial propane fleet conversion.

### Natural Gas

Natural gas can only provide 15% of the operating cost savings on a per vehicle basis that propane can and requires a \$1.5 million station investment. In addition it would be necessary to achieve full or almost full fleet conversion to increase fuel throughput at the natural gas station to reduce the per gallon cost. ICF recommends that Lake Transit only pursue a fleet conversion to natural gas if funding can be acquired to pay for a natural gas station. There are potential funding sources through the CEC 2015-2016 Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) for vehicles and stations. The 2015-2016 funding plan identifies \$64.6 million available for natural gas vehicles (approximately \$14,000 per vehicle) and \$16 million for natural gas fueling stations<sup>62</sup> (previous awards of \$250,000 - \$500,000 per station)<sup>63</sup>. These funding sources would be insufficient to cover the incremental cost of natural gas vehicles over diesel and would fund less than 33% of the station cost.

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<sup>61</sup> <http://www.energy.ca.gov/2014publications/CEC-600-2014-009/CEC-600-2014-009-CMF.pdf>

<sup>62</sup> <http://www.energy.ca.gov/2014publications/CEC-600-2014-009/CEC-600-2014-009-CMF.pdf>

<sup>63</sup> [http://www.energy.ca.gov/contracts/PON-14-608\\_NOPA.pdf](http://www.energy.ca.gov/contracts/PON-14-608_NOPA.pdf)



## 1.5 Electric Bus Case Study – Foothill Transit

Foothill Transit is a public transit provider that serves over 300 square miles in the San Gabriel and Pomona Valleys in Los Angeles County. Its fleet of 330 buses, 315 of which run on compressed natural gas, serve almost 50,000 passengers per week. Foothill Transit acquired three Proterra plug-in electric buses on 2010 running initially on the 291 route. This route of about 16 miles roundtrip connects La Verne and Pomona, in Southern California, with services starting at 4:00 a.m. and ending at 9:30 p.m.

By 2014, Foothill Transit had expanded its all-electric fleet to 15 units. In 2010, Foothill Transit successfully competed for Transportation Investment Generating Economic Recovery (TIGER) II funding, and with 10 percent matching funds from local sources they acquired 12 all electric buses from Proterra in 2013 (FTA, 2012). To serve their electric fleet, Foothill Transit installed two 500 kW fast charging stations at the Pomona Transit Center (Figure 1-10). These stations, typically operating at 400 kW, are capable of safely recharging the buses in a few minutes at the end of each route leg, thus enabling the uninterrupted service of the line. Because of this feature and because of the physical arrangement of the equipment, these stations are often referred to as *en-route overhead chargers*. The 12 units were received in early 2014 and since then they accumulated over 200,000 miles operating without interruption on line 291.



**Figure 1-10. Proterra electric buses operated by Foothill Transit, charging at the overhead charging stations in the Pomona Transit Center (photo, courtesy of Proterra)**

In June 2014, Foothill Transit’s Executive Board approved the procurement of two units of the Catalyst, the then newest 40-foot long Proterra model. These new units were operated on additional routes that were interesting with line 291 at the Pomona Transit Center, so that they could also use the en-route overhead chargers.



Demonstrating their interest to extend the electrification of their fleet, on April 2015, Foothill Transit placed an order for additional 13 units of the last-generation Proterra Catalyst Extended Range (XR) electric bus. The agency's Executive Board approved the exercise of this purchase option for an amount of almost \$9.9 million, after application of the HVIP voucher (approximately \$100,000 per bus). The base price of each Catalyst XR was \$798,000 before taxes. When these units enter service in 2016, they will be expanding Foothill Transit's electric fleet to 30 buses, or 10 percent of their total fleet. The extended range Proterra models purchased by Foothill Transit have a nominal all-electric range of approximately 150 miles, and are served by overhead charging stations similar to the ones already installed in Pomona Transit Center. These buses however use a different battery chemistry than the Catalyst and use lower charging power of about 350 kW. Foothill transit chose the extended range Proterra model to diversify their electric fleet and to make more efficient use of their charging infrastructure.

As one of their options to fund their latest order, Foothill Transit submitted an application to this year's TIGER Grant Program to support the electrification of Line 486. Foothill Transit requested \$15 million to buy 17 extended range Proterra electric buses and four charging stations to support their operation. Local funds in an amount of approximately \$5 million would have been used to match TIGER funding, for a total project budget of \$20 million. While Foothill Transit's proposal was not selected for award, Foothill Transit's intention is next to create a zero-emission bus corridor along the Line 486 route connecting the Pomona Transit Center and El Monte Station, installing fast charging stations at strategic points on the route. This route was in part chosen because it serves key employment and higher education centers. Foothill Transit was able to partner with neighboring cities and transit agencies and obtained letters of support for their project, showing a regional legitimation of a long-term project supporting zero-emission public mobility.

The three initial 30-foot Proterra electric buses purchased by Foothill Transit had a sticker price well over \$1 million per unit, and that price has come down to about \$749,000 for their newer units while increasing size to 40 feet and improving performance. According to Foothill Transit, the initial units had a number of issues that needed attention, primarily a consequence of being pilot units from a company in its very early stage. Issues with panels, air conditioning, and transmission, for example, were addressed over time in collaboration with Proterra and original equipment manufacturers. Foothill Transit reports that the more recent units represent a very significant evolution relative to the early ones.

The en-route overhead charging platform for these buses has a capital cost of about \$365,000, in addition to installation costs which vary depending on the type of upgrades needed at the specific location. These costs however can be amortized across multiple vehicle units. According to Proterra, each en-route overhead charging station can serve typically seven buses—this is consistent with Foothill Transit's experience, where a fleet of 15 on-route charge buses is served by two stations at their Pomona Central station. According to Foothill Transit, each Ecoliner electric bus saves about \$225,000 in fuel costs and \$135,000 in maintenance costs over the lifetime of the vehicle (Foothill Transit, 2015). Foothill Transit did a preliminary assessment of the maintenance costs of electric buses and found that they are about 20-30 percent lower than their CNG buses. Costs of preventive maintenance inspections are the same. In terms of fuel expenditures, Foothill Transit finds that CNG may be cheaper on a per-

mile basis than electric buses in the present state of technology. This applies for a rate of \$0.18 per kilowatt-hour, which Foothill Transit negotiated with their local electric utility, Southern California Edison.

Several aspects of the experience of Foothill Transit with electric buses thus far can be highlighted. Recognizing the early stage of commercialization of electric buses, Foothill Transit's key driver for their initial adoption of a small set of three units was their commitment to environmental stewardship. There was also a learning curve associated with the charging infrastructure. Foothill Transit quickly realized that that demand charges arising from the operation of the en-route overhead charging stations would have a significant impact on the overall economics of the program. As a consequence, they engaged their local utility, Southern California Edison which, along with Proterra, approached the California Public Utilities Commission to explore solutions. The result was a three-year waiver of the demand charge, which is set to expire soon and an agreement to let transit agencies use time of use rates for electric bus charging. Once the demand charge waiver expires, it add to fuel costs by about \$7,000 per 500 kW overhead charger per month. The impact of demand charges will be lower for larger fleets, as it can be amortized among multiple units.

Foothill Transit's director of maintenance & vehicle technology expressed that their experience using Proterra buses has been increasingly positive. They describe the performance of the electric buses as superior to that of their CNG buses of the same age. Electric buses have a smoother ride, they are quieter (at about 60 db), and they have higher acceleration. In addition, electric buses have shown to be more reliable than CNG buses. The Proterra body is made of carbon fiber, which not only makes the vehicle lighter and safer. End users of the Ecoliner have expressed satisfaction with the new units, in particular because of their environmental friendliness and their low noise levels<sup>64</sup>.

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<sup>64</sup> Phone call with Foothill Transit

## 2 Recommended Capital Expenditure Plan

The recommended capital expenditure plan identifies the expenditures to purchase or upgrade fixed assets including facility upgrades, buses, refueling infrastructure, and solar panels that have been recommended by ICF to reduce energy use and save costs. The paragraphs below identify the capital expenditures that will be seen over the new few years (up to 20 years for infrastructure that requires loan payments). The table that follows show the capital expenditures for fiscal years 2015-2016, 2016-2017 and 2017-2018. .The purchase of replacement propane buses would not occur till 2023.

### 2.1 Facility Improvements

The potential facility improvements and their costs are discussed in detail in Section 1.2.2 of the Energy Use Reduction Plan. The following recommended facility improvements included in the expenditure plan:

- Indoor LED Lighting - \$7,997 (PG&E incentive - \$2,178)
- Outdoor LED Lighting - \$11,354 (PG&E incentive - \$4,831)
- UV Film - \$400

### 2.2 Electric Bus and Charging Infrastructure

The Energy Use Reduction Plan recommends that Lake Transit pursue funding and grant opportunities for electric buses. The recommended configuration is one charging station that can charge multiple buses at one time and four (4) 30' BYD Electric Buses. The electric bus and charging facility upgrades included in the expenditure plan are the following:

- Electric Upgrades - \$100,000
- Four (4) 30' BYD Electric Buses - \$1,800,000

The ARB Zero-Emission Truck & Bus Pilot Commercial Deployment Projects grant program funds 75% of the total cost including truck and bus purchases and deployments, infrastructure, refueling, operation and maintenance, workforce training, data collections and administrative costs. The remaining 25% of the project cost must come from cash (at least 10%) and in-kind contributions (up to 15%). If the solar bus canopy is considered a cash contribution, then grant funding could cover almost all of the bus and infrastructure costs.

### 2.3 Propane Bus and Refueling Infrastructure

The Energy Use Reduction Plan recommends that Lake Transit implement a partial fleet conversion of ten buses to propane and construct an onsite propane refueling station. The propane bus partial fleet conversion and refueling infrastructure included in the expenditure plan are the following:

- Ten (10) propane Type C buses - \$710,000
- Propane refueling infrastructure - \$82,000

The propane buses and refueling infrastructure would be purchased with existing Lake Transit funds since little grant funding is currently available for propane buses and infrastructure. The ten propane buses have a total incremental cost of \$60,000 over conventional diesel Class C buses.

## 2.4 Solar

There are two different options to implement solar at Lake Transit recommended in the Energy Use Reduction Plan. The first option is solar to cover the facility electricity use only and second option, dependent on receiving grant funding for electric buses, is a solar bus canopy to cover facility and electric bus electricity use. The two solar options included in the expenditure plan are the following:

1. Facility solar only - \$59,000
2. Solar bus canopy with electric buses - \$291,000

Table 2-1. Capital Expenditure Plan

Capital Expenditures	FY 15-16	FY 16-17	FY 17-18
<b>Vehicle Procurement</b>			
Propane Vehicles <sup>65</sup>		\$355,000	\$355,000
Electric Vehicles <sup>66</sup>		\$1,800,000	
<b>Refueling Infrastructure</b>			
Propane Refueling <sup>67</sup>	\$82,000		
Electric Bus Charging Station <sup>68</sup>	\$100,000		
<b>Facility Improvements</b>			
LED Lighting	\$19,351 <sup>69</sup>	-\$7,000 <sup>70</sup>	
UV Film	\$400 <sup>71</sup>		
<b>Solar Options</b>			
(1) Facility Solar Only <sup>72</sup>		Total Cost - \$59,000 Loan - \$3,300	Loan - \$3,300
(2) Solar Canopy <sup>73</sup>		Total Cost - \$291,000 Loan - \$16,100/yr	Loan - \$16,100
<b>Capital Expenditures Total (Solar 1)</b>	\$201,751	\$2,439,000	\$355,000
<b>Capital Expenditures Total (Solar 2)</b>	\$201,751	\$2,207,000	\$355,000

<sup>65</sup> Class C Propane Buses, Figure 1-9, 3 month wait time, done in two segments since 5 Class C buses are ready for replace in 2016 and 2017; total of \$60,000 incremental over diesel for all 10 vehicles; from existing funding sources

<sup>66</sup> Cost for buses, 6 month wait time for bus orders, Figure 1-7; \$1,460,000 incremental cost over diesel

<sup>67</sup> Propane Station, Figure 1-9, 60-90 day lead time

<sup>68</sup> Electricity upgrade with PG&E for the charging infrastructure

<sup>69</sup> Indoor and outdoor LED lighting improvements (see Table 1-3, Table 1-4)

<sup>70</sup> Credit back from PG&E for installing LED; assume 3-6 month delay in payment of credits

<sup>71</sup> UV Film installation (Table 1-10)

<sup>72</sup> Total solar bus canopy cost is \$59,000; utilizing CEC 1% solar loan program result in \$3,300 for 20 years. Payments will continue till FY 2045-2046.

<sup>73</sup> Total solar bus canopy cost is \$291,000; utilizing CEC 1% solar loan program result in \$16,100 for 20 years. Payments will continue till FY 2045-2046.

## 3 Funding Plan

### 3.1 Potential Funding Programs

#### 3.1.1 Federal Programs

##### MAP-21 “Low or No Emission Vehicle Deployment Program” (LoNo Program)<sup>74</sup>

###### Description

FTA supports demonstration and deployment of low-emission and no-emission vehicles to promote clean energy and improve air quality. Eligible activities include acquiring or leasing low- or no-emission vehicles, constructing or leasing facilities and equipment, and rehabilitating or improving existing public transportation facilities to accommodate low- or no-emission vehicles. FTA made \$22 million available for the 2015-2016 fiscal program with application due on November 23, 2015.

###### Eligibility

Eligibility is restricted to areas defined under section 5213 as an area that is designated as a nonattainment area for ozone or carbon monoxide under the Clean Air Act or a maintenance area, as defined in section 5303, for ozone or carbon monoxide. Lake Transit is located within Lake County that is in attainment for ozone and CO, and therefore does not meet these criteria and is ineligible for LoNo Program funding.

##### Congestion Mitigation and Air Quality (CMAQ) Improvement Program<sup>75</sup>

###### Description

The CMAQ Improvement Program provides funding to state departments of transportation (DOTs), metropolitan planning organizations (MPOs), and transit agencies for projects and programs in air quality nonattainment and maintenance areas that reduce transportation-related emissions. Eligible activities include development of alternative fueling infrastructure and conversion of public fleet vehicles to operate on cleaner fuels among others. State funding is formula based.

###### Eligibility

Lake Transit is located within Lake County that is in attainment for federal air quality standards, and therefore does not meet these criteria and is ineligible for CMAQ.

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<sup>74</sup> <http://www.apta.com/gap/fedreg/Documents/FTA%20-%20FY13%20Discretionary%20Funding%20Opportunity-%20Low%20or%20No%20Emission%20Vehicle%20Deployment%20Program.pdf>

<sup>75</sup> [http://www.fhwa.dot.gov/environment/air\\_quality/cmaq/](http://www.fhwa.dot.gov/environment/air_quality/cmaq/)

## Transit Investments for Greenhouse Gas and Energy Reduction (TIGGER) Program<sup>76</sup>

### Description

The TIGGER Program is managed by FTA's Office of Research, Demonstration, and Innovation in coordination with the Office of Program Management and FTA regional offices. The TIGGER Program works directly with public transportation agencies to implement new strategies for reducing GHG emissions and for reducing energy use within transit operations. These strategies can be implemented through operational or technological enhancements or innovations. To align the TIGGER Program with other strategic initiatives, FTA encourages project implementation that will enhance operational efficiencies, demonstrate innovative electric drive strategies, and create an environment prioritizing public transportation through intelligent transportation systems or other related technology approaches to achieve efficiency and sustainability goals. Unfortunately the funding for the TIGGER program was stripped during the passage of the 2012 federal budget and had yet to be restored.<sup>77</sup>

### Eligibility

All public transit agencies were eligible for funding. TIGGER could be a potential source of funding in the future if the federal government restores the program.

## 3.1.2 State Programs:

### Low Carbon Transit Operations Program (LCTOP)<sup>78</sup>

#### Description

LCTOP is part of the Transit, Affordable Housing, and Sustainable Communities Program and was created to “provide operating and capital assistance for transit agencies to reduce greenhouse gas emission and improve mobility, with a priority on serving disadvantaged communities. Approved projects in LCTOP will support new or expanded bus or rail services, expand intermodal transit facilities, and may include equipment acquisition, fueling, maintenance and other costs to operate those services or facilities, with each project reducing greenhouse gas emissions.” The program is administered by CalTrans in coordination with ARB and funding by AB32 Cap and Trade auction proceeds, also known as Greenhouse Gas Reduction Funds (GGRF). Lake County currently has \$68,131<sup>79</sup> available for eligible allocation in 2015-2016.

#### Eligibility

LCTOP places a focus on reducing emissions in disadvantaged communities as determined by California Communities Environmental Health Screening Tool (CalEnviroScreen)<sup>80</sup>. Lake County has only a few

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<sup>76</sup> [http://www.fta.dot.gov/12351\\_11424.html](http://www.fta.dot.gov/12351_11424.html)

<sup>77</sup> <http://www.transportationissuesdaily.com/tiger-yes-tigger-no-in-2012/>

<sup>78</sup> <http://www.dot.ca.gov/hq/MassTrans/lctop.html>

<sup>79</sup> <http://www.dot.ca.gov/hq/MassTrans/Docs-Pdfs/Cap&Trade/2015-2016.lctop.eligibility.list.pdf>

<sup>80</sup> <http://oehha.ca.gov/ej/ces2.html>

areas marginally considered disadvantaged communities (CESDeciles 46-50% in the area of Lakeport; rest of county 35% or less) which is likely why the eligible funding is orders of magnitude less than Metropolitan Transportation Commission (MTC, SF Bay Area), Los Angeles County, Sacramento Area Council of Governments (SACOG), Orange County and others. ICF spoke with Jila Priebe at CalTrans about the potential projects being explored by Lake Transit and encouraged Lake Transit to submit an application for funding. It appears the maximum funding available to Lake Transit is \$68,131. The tentative LCTOP schedule is as follows<sup>81</sup>:

November 1, 2015 – State Controller’s Office (SCO) notifies transit operators of available funds

December 1, 2015 – CalTrans posts Updated LCTOP Guidelines

February 1, 2016 – Review and approval of eligible projects submitted to SCO

June 1, 2016 – SCO releases approved amount of funds to recipients

### **Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)<sup>82</sup>**

#### **Description**

Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) provides vouchers to help California fleets purchase hybrid and zero-emission trucks and buses. HVIP is one of multiple project within the ARB Air Quality Improvement Program (AQIP). HVIP aids the introduction of hybrid and electric trucks and buses by reducing the purchase price of these vehicles in California. The voucher is applied immediately at the point of sale. The table below was taken from the HVIP Implementation Manual<sup>83</sup>. The BYD and Proterra electric buses fall within the >26,000 GVWR category with the BYD 30’ and 40’ buses eligible for an estimated \$101,000 per bus and the 40’ Proterra eligible for \$115,000 per bus.<sup>84</sup> The difference between the values in the eligibility document and the table below are likely the adder for fleet funding.

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<sup>81</sup> [http://www.dot.ca.gov/hq/MassTrans/Docs-Pdfs/Cap&Trade/lctop.fact.sheet.final\\_updated102915.pdf](http://www.dot.ca.gov/hq/MassTrans/Docs-Pdfs/Cap&Trade/lctop.fact.sheet.final_updated102915.pdf)

<sup>82</sup> <http://www.arb.ca.gov/msprog/aqip/hvip.htm>

<sup>83</sup> [http://www.californiahvip.org/docs/HVIP\\_Y4\\_Implementation%20Manual\\_2014-08-01.pdf](http://www.californiahvip.org/docs/HVIP_Y4_Implementation%20Manual_2014-08-01.pdf)

<sup>84</sup> [http://www.californiahvip.org/docs/HVIP\\_Year4\\_EligibleVehicles.pdf](http://www.californiahvip.org/docs/HVIP_Year4_EligibleVehicles.pdf)



Table 3-1. HVIP Zero-Emission Truck and Bus Voucher Amounts

GVWR (lbs)	Base Vehicle Incentive		
	1 to 100 vehicles <sup>1</sup>		101 to 200 vehicles
	Outside DC <sup>2</sup>	Within DC <sup>2</sup>	
5,001 – 8,500	\$20,000	\$25,000	\$12,000
8,501 – 10,000	\$25,000	\$30,000	\$18,000
10,001 – 14,000 <sup>3</sup>	\$50,000	\$55,000	\$30,000
14,001 – 19,500	\$80,000	\$90,000	\$35,000
19,501 – 26,000	\$90,000	\$100,000	\$40,000
> 26,000	\$95,000	\$110,000	\$45,000

1 - The first three vouchers received by a fleet, inclusive of previous funding years, are eligible for the following additional funding amount: \$2,000/vehicle if below 8,501 lbs; \$5,000/vehicle if 8,501 to 10,000 lbs; and \$10,000/vehicle if over 10,000 lbs.

2 - 'DC' refers to a disadvantaged community.

3 - This weight range is not intended for vehicles utilizing a pick-up truck chassis/platform typically found in vehicles below 10,001 lbs GVWR. Vehicles at the lower end of the 10,001 to 14,000 lbs weight range will be evaluated on a case-by-case basis to determine eligibility for the full Base Vehicle Incentive.

### Eligibility

Lake Transit is eligible for these funds. Per the HVIP website, \$4.3 million is still available. The electric bus scenarios discussed in Section 1.3.5 would be able to request four (4) vouchers for the 30' BYD buses for approximately \$404,000.

### Zero-Emission Truck & Bus Pilot Commercial Deployment Projects (ZETB)<sup>85</sup>

#### Description

The Zero-Emission Truck & Bus Pilot Commercial Deployment Projects is also part of the AQIP program administered by ARB. Up to \$23,658,000 is available for this project from FY2014-2015 funds with up an additional \$65 million may be available for projects from future funds on or before June 30, 2016. This project complements the Zero-Emissions Drayage Truck and Multi-Source Facility Demonstration Projects solicitation. This project is intended to help accelerate the deployment of a variety of commercially available medium- and heavy-duty zero-emission vehicles by placing a significant number of zero- and near zero emission buses and freight and delivery trucks in strategic truck and bus "hubs" with a similar emphasis to LCTOP towards disadvantaged communities. The \$65 million from FY 2015-2016 Funding Plan does allow for up to \$17.5 million with no disadvantaged community requirement. The grantee is required to match a minimum of 25% of the total project cost (minimum 10% must be cash which can include funding from federal, local and state agencies other than ARB, see LCTOP; 15% or more can come from in-kind contributions)<sup>86</sup>. This Solicitation may fund such activities as truck and bus purchases and deployments, infrastructure, refueling, operation and maintenance, workforce training,

<sup>85</sup> <http://www.arb.ca.gov/msprog/aqip/solicitations.htm>

<sup>86</sup> <http://www.arb.ca.gov/msprog/aqip/solicitations/msc1524solicit.pdf>

data collections and administrative costs. Applications are due to ARB no later than 5:00pm on January 29, 2016.

### **Eligibility**

Lake Transit is eligible for this funding program but will need to be creative in gathering the match funding. Lake Transit has available Proposition 1B funds for local match. Another opportunity may be FTA 5311(f) funds if it is feasible to operate vehicles between Clearlake or Lakeport and Ukiah (Mendocino County) or Yolo County. HVIP vouchers may not be used to meet any part of the match requirements, and vehicles purchased with the help of HVIP vouchers may not be included as part of the pilot project's vehicle fleet. It appears that Lake Transit would need to apply with 25% matching funds on the full vehicle and project price shown in Figure 1-7 of approximately \$1.9 million (25% = \$475,000). Lake Transit can also include costs for vehicle service and repair facility upgrades, operations and maintenance cost, workforce training, data collection and administrative costs.

## **Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP)**

### **Description**

The California Energy Commission (CEC) administers the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) to provide financial incentives for businesses, vehicle and technology manufacturers, workforce training partners, fleet owners, consumers, and academic institutions with the goal of developing and deploying alternative and renewable fuels and advanced transportation technologies. Funding priorities are established in an annual Investment Plan. Funding previously has been available for electric, natural gas and propane vehicles and stations. The ARFVTP funding for electric vehicles has been limited to demonstration project, allowing for HVIP to handle deployment of commercially available vehicles, but has allocated \$38.3 million for electric vehicle charging infrastructure. The ARFVTP has allocated \$10 million for FY2015-2106 to support natural gas vehicle deployment and \$16 million for natural gas stations. The funding for propane has been exhausted<sup>87</sup> and the 2015-2016 plan does not include addition funding for propane.

### **Eligibility**

Lake Transit is eligible for the programs under the ARFVTP, but until the specific Project Opportunity Notices (PONs) are released, it is unknown whether the Lake Transit fleet conversion options will be eligible for the funding.

## **3.1.3 Regional Programs**

### **Western Propane Gas Association - California Propane Vehicle Incentive Program**

#### **Description**

The Western Propane Education & Research Council offers rebate and incentive programs for the purchase of propane vehicles, irrigation engines, and forklifts as well as the safe installation of propane appliances. Funds are available for California propane customers on a first-come, first-serve basis until

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<sup>87</sup> <http://www.energy.ca.gov/drive/technology/propane.html>

exhausted. Incentives of \$5,000 per vehicle (a maximum of five incentives will be paid per applicant per program year) are available to California propane customers who purchase a new propane vehicle or convert an existing vehicle with a propane system. The incentive recipient “agrees to maintain a monthly report of miles, gallons of propane used, and anecdotal performance characteristics that will be submitted to WPERC a year from the time the rebate is received.”<sup>88</sup> Applications are due by December 31, 2015.

### Eligibility

Lake Transit is eligible for the funding available under this program.

## 3.2 Fuel Funding Plans

### 3.2.1 Electricity

There are two grant funding opportunities that are mutually exclusive for implementing electric buses:: HVIP and the ZETB solicitation. HVIP vouchers cannot be used to purchase vehicles part of fleet requesting funds under ZETB. Using solely HVIP vouchers, the estimated \$1.9 million electric bus project would be reduced to approximately \$1.5 million (est \$100,000 per voucher). The less expensive path for Lake Transit is applying for ZETB solicitation funds. The required match is 25% (\$475,000). Of the 25%, 10% (\$190,000) needs to cash and remaining 15% (\$285,000) can be in-kind contributions. The match amounts will increase if Lake Transit includes costs for vehicle service and repair facility upgrades<sup>89</sup>, operations and maintenance costs, workforce training, data collection and administrative costs in the application. The table below shows the additional costs that could be included in the application.

**Table 3-2. Estimated ZETB Project Cost**

Cost Category	Cost	Comment
Vehicle and Station	\$1.9 million	\$1.8 million for four (4) 30’ BYD electric buses and \$100,000 for electric charging station upgrades <sup>90</sup>
Vehicle Service and Repair Facility Upgrades	\$50,000	Estimate, will need specific value for the application, discuss with BYD
Operations and Maintenance	\$190,000	Cost estimates from Lake Transit estimated operating miles and cost factors from Stanford e-bus project <sup>91</sup>

<sup>88</sup> <http://www.westernpga.org/uploadedFiles/State/Western/WPERC%20Propane%20Vehicle%20Incentive%20Program%202015.pdf>

<sup>89</sup> Only minor facility upgrades and improvements that do not involve construction are eligible for funding

<sup>90</sup> See Figure 1-7

<sup>91</sup> See Figure 1-7

Cost Category	Cost	Comment
Workforce Training	\$25,000	Estimated CUTA Smartdriver training cost <sup>92</sup>
Data Collection and Administrative Cost	\$190,000	Assume 8% of project cost, 3% for data collection and 5% for administrative
Total	\$2.34 million	Estimated total project cost; request funding for \$1.76 million

Based on Table 3-2, a total match of \$585,000 will be required with a cash match of \$234,000. The following are eligible costs that can be included as part of the cash or in-kind match. Another option is to include the solar bus canopy in the project, increasing the total cost to \$2.63 million and the solar canopy (\$291,000) would be a cash match of 11%.

**Table 3-3. Match Funding Descriptions**

Match	Description
10% Cash Match	Cash committed by the Grantee and/or technology provider (exclusive of providing in-kind contributions). Cash includes labor and money spent on the project during the term of the Grant Agreement. For public projects, cash match may also include funding from federal, local and state agencies other than ARB
15% In-Kind	May be through some combination of in-kind contributions such as labor, equipment, materials, equipment transportation, private financing, and federal or non-AB 118 and non-GGRF sourced state funds.

Also, it is important that Lake Transit identify a technology prior to application submission because “projects that already have all the needed participants, such as technology provider(s), identified end user of the proposed vehicles, and eligible Grantee, will score higher than those that do not have team members identified in advance.”<sup>93</sup> In addition, scoring criteria #9, “Potential for Project Scalability, Expansion, and Technology Transfer,” has the largest amount of potential points and it will be important for Lake Transit to demonstrate that this project is meant to demonstrate to other small and rural transit agencies that zero-emissions buses are an option that can significantly reduce operating cost while also a strategy to reduce emissions.

The following are action item steps for applying for the ZEBT solicitation:

<sup>92</sup> See Table 1-11

<sup>93</sup> <http://www.arb.ca.gov/msprog/aqip/solicitations/msc1524solicit.pdf> ; page 11 of 14

- Identify a technology and provider and rely on this technology provider for the majority of the application development
- Determine the sources of cash and in-kind match funding, these could include LCTOP funds, potential other CalTrans funds, available 5311 funds, labor for administrative and/or data collection and potentially workforce training
- Work with the technology provider for more detailed estimates of vehicle service and repair facility upgrades, data collection, and administrative cost

The ZEBT solicitation cannot cover the cost of the solar bus canopy. The most likely course Lake Transit will need to follow for the solar bus canopy is the 1% loan guarantee program through the CEC.<sup>94</sup> If Lake Transit decides to investigate the solar bus canopy, the follow are action items:

- Contact CEC immediately for the most current funding availability information
- Contact solar providers and engineering companies (such as Stronghold Engineering that served as a consultant on the Santa Clarita Transit project<sup>95</sup>) to develop a most detailed cost for a solar bus canopy
- Wait till preliminary grantee selection for ZEBT solicitation (February 25, 2016) before the deciding on the size of the solar array

### 3.2.2 Propane

Propane is only eligible for the small grant amount of \$500 per vehicle for the first five vehicles from the Western Propane Gas Association. The incremental cost of a propane Class C bus is approximately \$16,000 and a total of \$160,000 for 10 buses. The propane station is estimated to cost \$82,000. Propane has the potential of reducing annual operating expense by \$110,000 per year resulting in full project payback in about 2 years.

### 3.2.3 Natural Gas

Implementation of natural gas would require a complete fleet conversion to make economic sense. Currently the only program with available funding for natural gas stations is the ARFVTP which in the past has only contributed \$200,000 to \$300,000 per station. This would leave \$1.2- \$1.3 million to be financed by Lake Transit either through a lease back with the station developer or a loan. ARFVTP would also pay for the incremental cost of the natural gas buses through the Natural Gas Vehicle Incentive Project.<sup>96</sup> LCTOP funds could be used for the station or vehicles with the renewable natural gas for GHG reductions.

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<sup>94</sup> <http://www.energy.ca.gov/efficiency/financing/>

<sup>95</sup> [http://www.fta.dot.gov/documents/TIGGER\\_CA\\_77\\_0004\\_SantaClarita\\_r3\\_w150.pdf](http://www.fta.dot.gov/documents/TIGGER_CA_77_0004_SantaClarita_r3_w150.pdf)

<sup>96</sup> <https://ngvip.its.uci.edu/>

## 4 Management and Training Plan

### Strategy Description

A driver training program instructs drivers on habits that can reduce fuel consumption. The SmartDRIVER program developed by the Canadian Urban Transit Association (CUTA) has been training heavy duty and transit fleets for 18 years. The program trains an agency's trainers who in turn train their bus operators. Many buses already have an electronic control module (ECM) that collects data on bus performance, which can be used to quantify fuel consumption benefits and further provide a framework for positive feedback to operators.

Alternative methods for managing driving behavior are to use a telematics device such as the one produced by GreenRoad or onboard camera diagnostic solutions like SmartDrive. GreenRoad mounts on the dashboard and has an indicator with LED lights providing instant feedback to the driver. The red, yellow, and green lights flash, indicating whether the bus is being operated in a fuel efficient manner. By receiving instant feedback, drivers can self-correct and managers can also analyze trouble areas with specific drivers and routes. As a result, adding telematics to a training program may reduce retraining expense.

SmartDrive utilizes onboard cameras to develop "game films" for the drivers to analyze their actual driving performance and pinpoint areas of improvement. SmartDrive uses videos to help coach drivers on their individual performance and provide a true pictures of what is happening on the road. SmartDrive reports that greener driving from the program can yield up to 10% fuel savings. Veolia/Transdev operates Napa County's transit fleet and utilizes SmartDrive.<sup>97</sup>

While there are other applications for managing driver behavior, all of them involve some combination of driver training, behavior monitoring, and real-time feedback devices. SmartDRIVER, GreenRoad, and SmartDrive are three examples of these different approaches.

### Strategy Analysis

We analyzed the likely cost and fuel savings from implementing the SmartDRIVER program at Lake Transit. GreenRoad could be implemented with or without SmartDRIVER, and would likely increase any fuel savings achieved by SmartDRIVER alone. The GreenRoad option is not included in this analysis. There is more data available for SmartDRIVER to quantify the benefits of efficient driving and the benefits of GreenRoad and other telematic/data driver services will be similar and overlapping to driver training programs.

Agencies participating in SmartDRIVER have seen fuel savings from 5% to 25%.<sup>98</sup> To be conservative, we assume that Lake Transit would achieve 5% fuel savings through the SmartDRIVER program.

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<sup>97</sup> <https://www.smartdrive.net/smartdrivetransit.aspx>

<sup>98</sup> Interview with Kevin Brown, CUTA.

The table below analyzes the expected payback of participating in the SmartDRIVER program. Startup cost includes a one-time subscription fee charged by CUTA, a training fee of \$1,500 for one person, and purchase of a handheld device to read information from buses' ECMs. We also assume that each driver must be paid for 8 hours of training. Total startup cost is estimated to be \$24,800.

Reducing fuel use by 5% in Lake Transit's 32 buses would save \$22,500. Therefore the SmartDRIVER program would payback upfront cost in a little over a year.

**Table 4-1. Driver Training Cost Analysis**

Line No.	Cost Item/Metric	Value	Source/Formula
(1)	SmartDRIVER One-Time Fee	\$6,000	CUTA
(2)	Train-the-Trainer	\$1,500	CUTA
(3)	Handheld ECM Interface Device	\$1,500	CUTA
(4)	Labor Cost For Driving Training	\$16,000	=40 drivers*8 hours*\$50/hour
(5)	Total Cost	\$24,800	=(1)+(2)+(3)+(4)
(6)	Annual Fuel Savings	\$22,500	=5% savings*3,750 gallons/bus/year*32 buses*\$3/gallon
(7)	Simple Payback Period	1.1 years	=(5)/(6)

## Implementation Steps

While CUTA has allowed APTA members to participate in SmartDRIVER in the past, the program is no longer open to non-CUTA members. Other training programs offering a similar service to SmartDRIVER for US based fleets include TAPTCO<sup>99</sup>, Gold Cross Safety Corporation<sup>100</sup>, and L-3<sup>101</sup>.

Implementation of this strategy would involve:

- Selecting a service provider, to include training only, a telematics device only, or both. This decision will likely impact both cost and fuel savings. The GreenRoad telematics device discussed above costs \$230 per bus to install plus a monthly fee of \$30 per bus.
- Installing devices (if selected) and training current bus drivers
- Incorporating the training into standard on-boarding for new hires
- Ongoing monitoring of performance and period refresher courses for drivers. This function would require a small amount of additional staff time, but that can be minimized by the use of telematics devices that provide automated feedback.

<sup>99</sup> <http://taptco.com/transit-bus-driver-training/>

<sup>100</sup> <http://goldcross.net/index.html>

<sup>101</sup> <http://www.l-3training.com/transit>

## Appendix A – Mendocino-Lake Energy Watch Energy Audit