AB 1007 Workshop
May 31, 2007

PROPANE

New Vehicle Sales

For the Business-As-Usual (BAU) scenario, California Energy Commission staff relied on projections from the Western Propane and Gas Association (WPGA). WPGA believes that the industry can supply roughly 5,000 liquefied propane gas (LPG) vehicles for the California Market annually by 2010. To build the Cost-Effective Growth (CEG) scenario, staff made a number of assumptions that if realized, has the potential to double LPG vehicle sales from 5,000 units a year to 10,000 units a year after 2015. For the Aggressive Scenario (AS), staff made even bolder assumptions driving the sales volume of the Cost-Effective growth scenario and incorporated those changes as the drivers behind the Aggressive scenario that if realized, could achieve 15,000 LPG vehicles annually by 2018.

Assumptions for BAU Scenario: 5,000 vehicles annually by 2010:

- Conversion kits are available
- Infrastructure keeps up with vehicle demand
- LPG tanks are available
- Existing incentives stay in place

Assumptions for Cost-Effective Growth Scenario: 10,000 vehicles annually by 2015

- Align CARB certification process with EPA's certification process
  - Adopt either EPA or EU OBD II requirements
- Re-fueling infrastructure grows at a similar rate to overall LPG vehicle sales
- Fuel is:
  - Priced to consistently allow 18-24 month payback period to recover the incremental costs associated with vehicle and fuel infrastructure
  - Available readily and meets CARB specification
- The LPG industry and the state work together to understand if a fuel quality standard is needed for LPG use in the transportation sector
- Short term use of existing federal incentives (vehicle buy-down and fuel use) allows the industry to grow
- OEMs support LPG vehicle retrofitters with vehicle warranty issues
- State, OEMs, Retrofitters, and Fuel suppliers form partnership to coordinate and provide outreach, support, and training. This partnership will provide recommendations and monitor the progress of the emerging LPG transportation industry every 3-4 years.

Assumptions for Aggressive Scenario: 15,000 vehicles annually by 2018:

- Easier certification process and aligned with EPA
  - Adopt either EPA or EU OBD II requirements
- Re-fueling infrastructure keeps up with growth
- Fuel:
  - Is priced to consistently **allow 18 month** payback period
    - Is taxed less than gasoline/diesel. The State can exempt LPG from excise taxes until a certain annual volume of sales is reached.
    - Has favorable price differential between LPG and gasoline/diesel
  - Is available readily and meets CARB specification
- The LPG industry and the state work together to understand if a fuel quality standard is necessary for LPG use in the transportation sector
- Short term **BUT** aggressive use of incentives (vehicle buy-down and fuel use) allows the industry to grow rapidly
- OEMs support LPG vehicle retrofitters with vehicle warranty issues
- State, OEMs, Retrofitters, and Fuel suppliers form partnership to coordinate and provide outreach, support, and training
- OEMs offer new LPG vehicles
- Fleet and general consumer has wide choice of LPG vehicles

Based on interaction with the WPGA and other LPG stakeholders, the most likely vehicle classes suited to use LPG include full size passenger vehicles, pickup trucks, and medium/heavy duty trucks. These vehicle classes are typically found in fleet applications in diverse industries such as taxis, delivery vans, package delivery, construction and maintenance, agriculture, shuttle buses, and school buses. Staff assumed that under a BAU scenario, LPG vehicle sales will be limited to fleet operators but to achieve the higher sales volumes under the CEG and AS scenarios, the general consumer would also purchase LPG vehicles.

Staff made the assumption that sales of LPG vehicles by class will be consistent year to year after a certain time period depending on the scenario. This assumption, a steady-state sales goal, helps bring some structure and helps overcome some uncertainties associated with forecasting in general[1]. The first step in this process was to determine the initial sales volume and the ending sales volume for each vehicle class. These assumptions regarding initial and final annual sales volumes are shown in Table 1 for each scenario. The initial sales volume starts at 2008 for Light-Duty pickup trucks and is based on input

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[1] Note that while this simplification brings its own set of uncertainties, the emphasis is on what could happen if the assumptions underlying each scenario are realized and to quantify the impacts (petroleum reduction, GHG reduction etc) as best as possible.

provided by Roush.[2] For the other vehicle classes, staff made an assumption of what the expected sales volume could be if the underlying assumptions behind each scenario were to fully materialize.

Staff assumed that the initial sales volume would roughly be the same under each scenario but follow different growth trajectories in order to achieve the different annual sales goals. The constant rates of sales growth to achieve final annual sales volume are also given in Table 1.

Table 1: Growth Rate Calculation

	INITIAL (BEGINING SALES)	ENDING (BEGINING SALES)	ELASPED TIME (YEARS)	GROWTH RATE
BAU – Business As Usual				
TOTAL VEHICLES	2,000	5,000	4	22.9%
CEG – Cost-effective Growth				
TOTAL VEHICLES	2,000	10,000	9	17.9%
AS – Aggressive Scenario				
TOTAL VEHICLES	2,000	15,000	12	16.8%

Looking at the table, the growth rate in LPG vehicle sales is relatively high under any scenario. Chart 1 captures the stock of LPG vehicles given the expected sales of LPG vehicles before reaching the sustainable steady-state sales volume.[3]

[2] Meeting with Greg Zilberfarb on 2/23/07
[3] BAU: 5,000 vehicles after 2010, CEG: 10,000 vehicles after 2015, AG: 15,000 vehicles after 2018.

Chart 1: LPG Vehicle Stock by Scenario

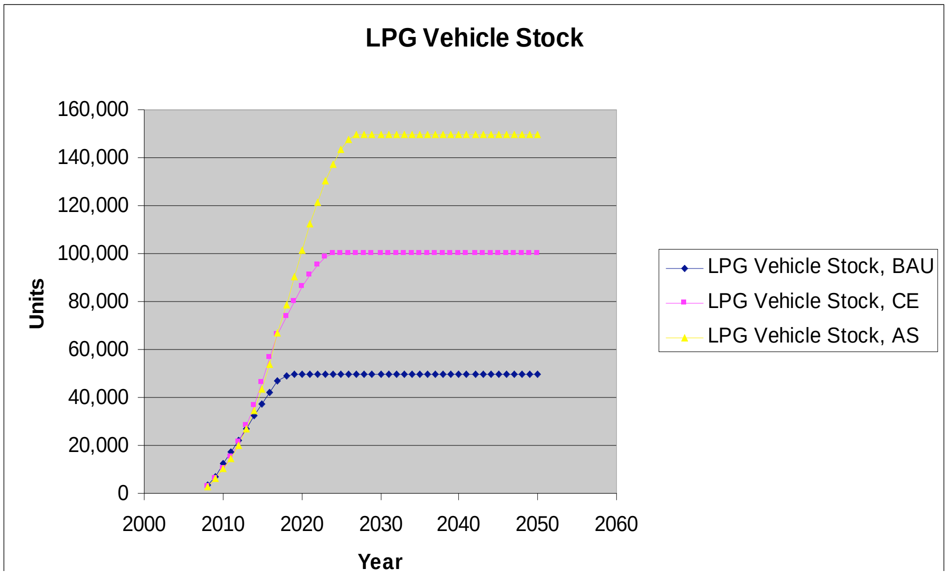

Chart 1 shows the stock of LPG vehicles for each scenario. The differences in the vehicle stock for each scenario can be attributed to the varying assumptions driving the sales of LPG vehicles.

Staff also examined what the implied penetration rate of the LPG vehicles would be given sales of gasoline and diesel vehicles[4]. This is captured in Table 3.

Table 3: LPG Vehicle Penetration

	2008	2010	2012	2017	2022	2030	2050
Conventional Vehicle Sales	333,272	321,172	330,321	324,042	333,282	354,597	351,034
BAU – Business As Usual							
Total LPG Vehicle Sales	3,162	5,000	5,000	5,000	5,000	5,000	5,000
Penetration Rate	0.9%	1.6%	1.5%	1.5%	1.5%	1.4%	1.4%
CEG – Cost-Effective Growth							
Total LPG Vehicle Sales	2,860	4,090	5,848	10,000	10,000	10,000	10,000
Penetration Rate		1.3%	1.8%	3.1%	3.0%	2.8%	2.8%
AS – Aggressive Scenario							
Total LPG Vehicle Sales	2,798	3,915	5,477	12,681	15,000	15,000	15,000
Penetration Rate	0.8%	1.2%	1.7%	3.9%	4.5%	4.2%	4.3%

[4] Sales forecast for light duty vehicles came from the Energy Commission's CALCARS model. Medium and Heavy duty sales volumes were based on 2003 DMV population count and a .9% overall growth from classes 3 through 8.

Table 3 shows that the penetration of LPG vehicles is very low in the initial years but increases over time as LPG vehicle growth increases in the later years and begins to displace sales of conventional vehicles. Under a BAU scenario, LPG vehicles capture roughly 1.4% of the market penetration of LPG vehicles is double of the penetration under BAU for the Cost-Effective and Aggressive scenarios respectively. At this point, it is extremely important to emphasis the assumptions, which were outlined earlier, necessary to achieve these penetration goals. For both, the Cost-Effective and Aggressive growth scenarios, the major drivers for higher LPG vehicle sales include:

- Easier certification process for retrofitted LPG vehicles
- Availability of fuel that is reasonably priced
- Re-fueling infrastructure keeps up with LPG vehicle population
- Support and partnership with OEMs to supply vehicles for the California market
- Increased outreach and training for early adopters

Overall, the penetration of LPG vehicles under the three scenarios is the same since staff assumed that the initial sales volume of LPG would be the same but would follow different growth path after the 2010-2012 time frame. The penetration rates decline but this is a result of assuming a constant sales volume of LPG vehicles while the sales of conventional vehicles are not constant.

Vehicle, Vehicle Operating Data, and Infrastructure Data

Vehicle Miles Traveled (VMT): Staff relied on data from the Energy Commission's CALCARS model for light duty vehicles and estimates from the U.S. Department of Energy for medium/heavy duty vehicle classes.

Fuel Economy: Staff adjusted the fuel economy of the conventional vehicle by vehicle class using the relative energy content in a gallon of LPG to gasoline in order to estimate the fuel economy of an LPG vehicle in the given vehicle class.[5]

Vehicle Life: Staff assumed an average vehicle life of 10 years for all vehicles in the analysis.

Based on the sales growth of LPG vehicles, fuel economy, and vehicle life, staff was able to calculate the stock of LPG vehicles and the displacement of gasoline from the increased use of LPG in the transportation sector. This information is showed in Chart 2 below.

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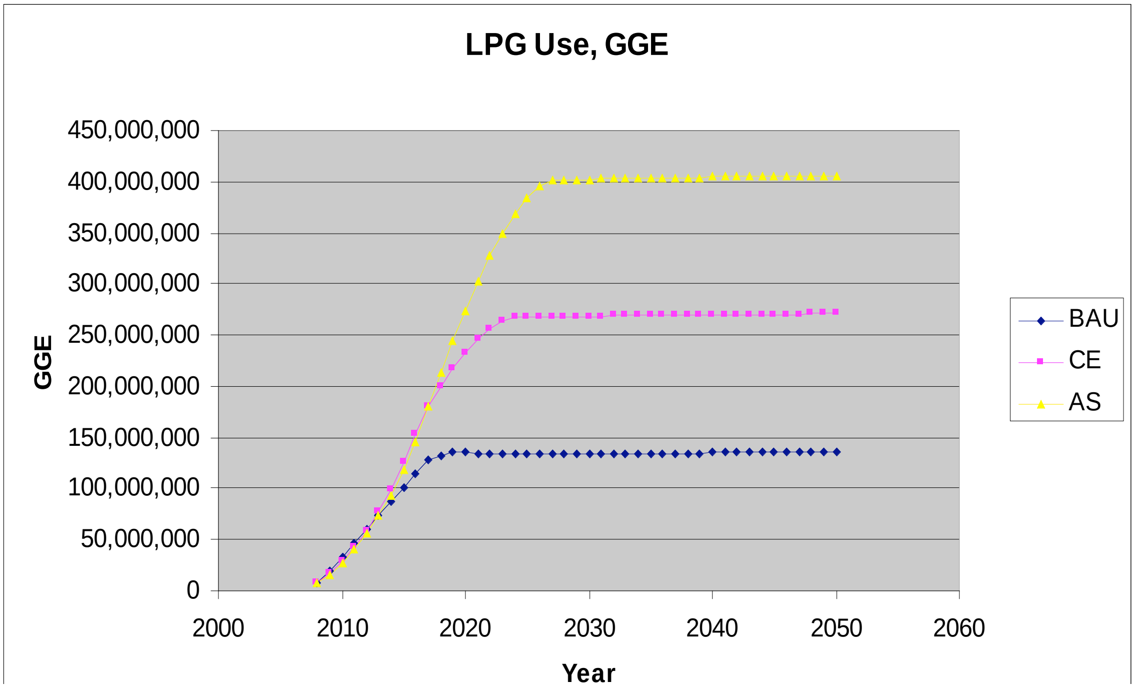
[5] Staff used the following (lower heating values commonly used by the Commission) values: LPG at 82,485 BTUs/gallon of LPG. Gasoline: 112,000 BTUs/gallon of gasoline.

Chart 2: LPG Consumption / Gasoline Displacement



Since staff is assuming a steady state level of vehicle sales and vehicle life, the displacement of gasoline is approximately 400 million gasoline gallons equivalent (GGE) annually after 2027 for Aggressive scenario, 268 million GGE annually after 2022 for the Cost-Effective Scenario, and 134 million GGE annually after 2027 for the BAU scenario.

Infrastructure Investments: To determine the number of re-fueling stations necessary to supply fuel to the growing LPG vehicle market, staff used data from the U.S. Department of Energy's Clean Cities grant program. The Energy Commission applied for these grants, which help to put alternative fuel infrastructure and vehicles in place, on the behalf of cities and private business in California. Based on the information contained in the grant application, staff determined that the overall cost of an LPG station to be roughly $100,000 with a storage capacity of 2,000 gallons of LPG and an average life of 25-30 years.

Stakeholders have informed staff that the infrastructure investment required for LPG is very cost-effective when compared to other alternative fuels with total equipment costs ranging from a low of $30,000 for a basic setup to as much as $100,000 for a high-end system with card lock access. Based on the penetration of LPG vehicles, VMT, and fuel economy, staff obtained estimates of annual LPG use by the transportation sector. The annual estimate was divided by 365 to estimate the overall daily demand. The estimated daily demand of LPG for transportation sector was divided by 500 gallons[6] to arrive at an estimate of the number of LPG stations that would be necessary to satisfy the daily demand.

Chart 3: LPG Refueling Infrastructure

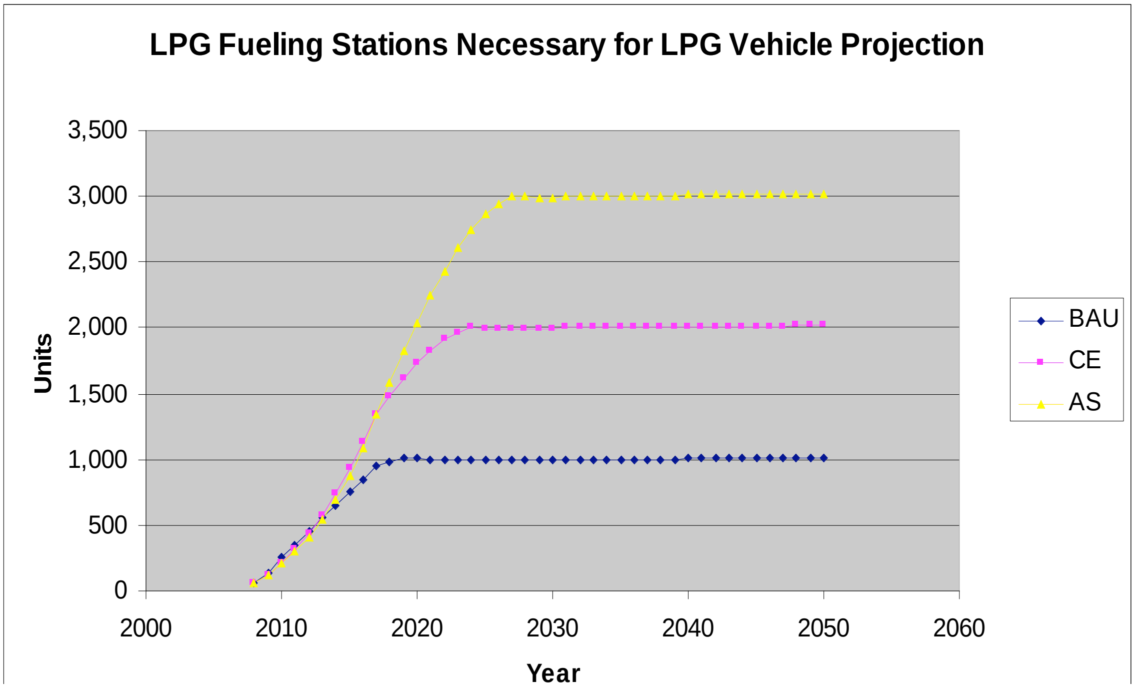


Chart 3 shows the number of LPG refueling stations that would need to be in place order to provide convenient fuel for LPG vehicles. The number of stations necessary becomes constant since staff assumed that sales of LPG vehicles will be constant for all three scenarios.

The number of stations is constant due to two main simplifying assumptions. First, vehicle sales were assumed to stabilize to a constant level out to 2050. Second, as stated previously, staff made an assumption that vehicle life was the same across vehicle classes and over time. The need for growth in the re-fueling infrastructure is but one of the many crucial elements necessary for a viable use of LPG in California's transportation sector.

The costs for re-fueling infrastructure were distributed to three groups: state government, federal government, and the private sector/LPG industry. Moreover, based on the advice of WPGA, staff applied a 5% escalation factor towards the overall cost of an LPG station[7]. Staff assumed that under the BAU scenario, state and federal government will each contribute 5% of the overall

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[6] Staff decided to use 500 gallons rather than the 2000 gallon capacity for the storage capacity of an LPG station. The reason for doing this centered around the uncertainties with re-fueling stations in this analysis such as: spatial or geographic variation, storage capacity vs daily use or demand, and uncertain regulatory requirements for installing LPG re-fueling infrastructure.
[7] WPGA, follow up data need, 5/13/07

costs associated with installing LPG re-fueling infrastructure each year out to 2031. The contribution of state and federal funds would increase to 7% of the overall re-fueling infrastructure costs out to 2031 under the CEG scenario and 10% for AS scenario. The capital investments necessary in LPG re-fueling infrastructure is shown in Table 5 for each of the three scenarios.

Table 5: LPG Refueling Infrastructure Investments

Infrastructure Investments (2007$, 5% Discount Rate)	
	Total (2008-2050)
BAU	
State Govt	$5,525,000
Federal Govt	$5,525,000
Private Sector	$99,400,000
Total	**$110,400,000**
CEG	
State Govt	$15,500,000
Federal Govt	$15,500,000
Private Sector	$190,000,000
Total	**$221,000,000**
AS	
State Govt	$33,000,000
Federal Govt	$33,000,000
Private Sector	$265,000,000
Total	**$331,000,000**

Based on the assumptions driving each scenario and the additional assumptions made on the number of re-fueling stations, total refueling investments would be $110 million dollars under a BAU scenario, $220 million dollars under the CEG scenario, and $330 million under the AS scenario.

Vehicle Incremental Cost

Stakeholders have informed staff that the complex and burdensome certification process for LPG vehicles in California adds significantly to the incremental cost of an LPG vehicle. Currently, the incremental cost for an LPG vehicle can range from $4,000 for a light duty passenger vehicle to $12,000 for medium/heavy duty vehicle. Since the LPG vehicle market is essentially a retro-fit market[8], LPG vehicles will face high incremental costs due to the lower volume of sales and a

[8] A vehicle retro-fitter is commonly understood to be a facility where conventional gasoline vehicles can be adapted to use propane as a motor fuel. The decline in the number of retro-fitting facilities and the lack of qualified technicians will be a significant barrier for the emerging LPG motor fuel industry.

limited overall market size unless OEM's enter the market to supply LPG vehicles[9]. This presents itself as a major barrier on top of the complex certification requirements imposed by the California Air Resources Board. Given the number of assumptions made by staff and the future uncertainty of what the level of incremental cost could be in the future, staff assumed that the incremental cost of an LPG vehicle will be the same under the three scenarios until about 2014. From here, staff assumed that the different assumptions in each scenario, if fully realized, will reduce the incremental costs associated with LPG vehicles in a stepwise fashion. Table 6 summarizes the incremental cost used by staff in this analysis.

Table 6: Incremental Cost of LPG Vehicles

	2008-2014	2015-2022	2023-2033	2034-2050
BAU				
Light Duty	$4,000 - $6,000	$3,500 - $5,800	$3,200 - $5,200	$2,900 - $4,700
Medium/Heavy Duty	$7,000 - $12,000	$5,800 - $10,800	$5,200 - $9,700	$4,700 - $8,700
CEG				
Light Duty	$4,000 - $6,000	$3,400 - $5,500	$2,800 - $4,600	$2,400 - $4,000
Medium/Heavy Duty	$7,000 - $12,000	$6,300 - $10,200	$5,400 - $8,600	$4,600 - $7,300
AS				
Light Duty	$4,000 - $6,000	$3,200 - $5,200	$2,500 - $4,000	$2,000 - $3,300
Medium/Heavy Duty	$7,000 - $12,000	$6,000 - $9,600	$4,800 - $7,600	$3,800 - $6,100

Staff assumed that the incremental cost of LPG vehicles by the different vehicles classes will be the same for all three scenarios from 2008 to 2014. After 2014, the incremental cost of an LPG vehicle was assumed to decline by a different percent for each scenario to reflect the convergence of the underlying assumptions driving each scenario, economies of scale, and learning curve effects as the LPG retrofit industry expands. Additionally, the same rate of decrease was used roughly every 10 years[10]. To illustrate, the incremental cost of an LPG fueled standard pickup was assumed to be equal to $6,500 from 2008 to 2014 in all three scenarios. This incremental cost declines, for the years 2015 to 2022, by 10% to $5,850 under the BAU scenario, 15% to $5525.00 for the CEG scenario, and 20% to $5,200 for the AS scenario. For the years 2023 to 2033, this incremental cost

[9] It is important to note that even if OEM's enter the market to supply LPG vehicles, OEMs will most likely offer the LPG version of a vehicle as an option and where the final assembly of the optional LPG re-fueling equipment will be outsourced to a vehicle retro-fitter. This is a practice most commonly practiced around the world where OEMs offer LPG as an option to conventional fueled vehicles.

[10] Staff is relying on a publication by US EPA (Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, EPA420-R-00-026, Dec 2000) that shows in general, every doubling of cumulative production reduces costs by 20%. Staff decided to error on the side of caution and applied the 20% rate over ever 10 year period rather than for every doubling of cumulative output.

declines by another 10% to $5,265.00 under the BAU scenario, another 15% to $4,696.25 under the CEG scenario, 20% to $4,160 for the AS scenario. Finally, for the time period 2034 to 2050, the incremental cost of the LPG pickup truck declines by another 10% to $4,738.50 under the BAU scenario, 15% to $3,991.81 under the CE scenario, and 20% to $3,328.00 under the AS scenario.

Vehicle Purchase Incentives

Under the BAU scenario, staff assumed that the state of California would provide a lump sum of $2,000 to interested individuals/fleet managers towards the retro-fit costs of an LPG vehicle from 2009 to 2026[11]. Finally, staff assumed that 30% of the cost differential, after taking into account any state incentives, would come from federal sources.

For the CEG scenario, staff assumed that the state of California would provide a lump sum of $2,500 to interested individuals/fleet managers towards the retro-fit costs of an LPG vehicle from 2009 to 2026. Finally, staff assumed that 40% of the cost differential, after taking into account any state incentives, would come from federal sources.

For the AS scenario, staff assumed that the state of California would provide a lump sum of $3,000 to interested individuals/fleet managers towards the retro-fit costs of an LPG vehicle from 2009 to 2026. Finally, staff assumed that 50% of the cost differential, after taking into account any state incentives, would come from federal sources.

Total Government and End User Cost

For each scenario, the different levels of incentives from the state government and federal government, on a per vehicle basis, is multiplied by the number of vehicles sold to arrive at the total cost to the state and federal government. The per vehicle end user cost, reduced by government incentives is also multiplied by vehicle sales in each year to arrive at the total cost to the end user for purchasing the LPG vehicle.

[11] Because the time horizon for state incentive (2009 to 2022) is quite long, it is possible that the LPG vehicle could become a factory option in which case the grant could also apply towards offsetting the incremental cost towards a purchase rather than offsetting the retro-fit cost. Additionally, staff did not make a distinction between dedicated or dual fuel LPG vehicles. That is, both vehicle types would qualify for any state incentive program.

Changes in Fuel Cost

LPG in transportation use will not be priced as it is for its conventional markets such as home heating or for use in portable barbeque cylinders. This is due to several factors:

- The price for LPG as a transportation fuel will be set by negotiations between the LPG marketer and the fleet manager.
- The lower energy content in a gallon of LPG relative to conventional gasoline or diesel.
- The limited fueling infrastructure for LPG due to its specific application as a "fleet" fuel.

Negotiations between the LPG marketer and the fleet manager will result in different prices for the same fuel throughout California. For the LPG price supplied, it may be convenient to think of them as an average price. The LPG marketer may also need to provide fueling infrastructure for the fleet organization where the cost of this investment is recovered over time through the use of LPG by the fleet organization. One of the main reasons that LPG (or another alternative fuel with emphasis on use by fleets) may be difficult to price as conventional petroleum fuels is that the pricing of LPG must be such that it can provide a reasonable payback to the end user/fleet manager. Stakeholders have informed us that the 18-24 month payback period is the assumed industry standard[12]. For any fleet wishing to switch to LPG, the incremental costs associated with the vehicles and fueling infrastructure must be recovered within the 18-24 month time period. Since each fleet organization has unique characteristics, it will be difficult for the LPG marketer to price LPG in a very narrow band and thus requires the marketer to be quite flexible in pricing especially if LPG use in the transportation sector is to become sustainable. Stakeholder groups have informed staff that to make LPG a competitive option, LPG needs to be discounted such that LPG is cheaper than gasoline on a gasoline gallon equivalent basis by at least 25%-30%. Based on this, staff took the Commission forecast of gasoline prices and adjusted them by 25%.

Lower fuel cost, in addition to environmental benefits such as lower greenhouse gas emissions, has been the driving force behind the popularity of LPG use in the transportation sector around the world. Based on prior estimates of relevant data such as vehicle sales, fuel economy, VMT, and fuel prices, staff was able to calculate the incremental savings in fuel cost between the use of LPG over gasoline by the different vehicle classes. This information is captured in Table 7 below.

[12] Staff has explicitly incorporated the 18-24 month payback period into the CE and AS scenarios. It should not be interpreted to mean that there is no payback in the BAU scenario but rather that the payback period can either be slightly longer or uncertain relative to the CE and AS scenarios.

Table 7: Fuel Cost Changes Between LPG and Gasoline/Diesel.

Fuel Cost Savings (2007$, 5% Discount Rate)						
	(2008-2050)	2012	2017	2022	2030	2050
BAU	$2,960,000,000	$38,000,000	$74,000,000	$77,000,000	$77,000,000	$77,000,000
CE	$7,676,000,000	$44,000,000	$136,000,000	$198,000,000	$215,000,000	$234,000,000
AS	$15,709,000,000	$53,000,000	$188,000,000	$357,000,000	$464,000,000	$531,000,000

In Table 7, positive values indicate a definite real savings to LPG vehicle owners from using LPG over gasoline or diesel. The table shows the overall changes in fuel cost for the study period and for 5 select years[13].

The final step is to compile the cost information for the different players, such as the end-user, fuel/infrastructure provider, vehicle retro-fitter, and the government sector. This summary will be the final inputs into the cost-effectiveness calculation. The total cost information is categorized by ten categories:

- Total vehicle incremental cost (without any incentives)
- Total infrastructure investments (without any incentives)
- Vehicle purchase incentives from the state government
- Vehicle purchase incentives from the federal government
- Incremental cost to the end-user (net of state and federal vehicle purchase incentives)
- Re-fueling infrastructure investments made by the state government
- Re-fueling infrastructure investments made by the federal government
- Re-fueling infrastructure investments made by the private sector
- Changes in fuel cost
- Changes in fuel tax consequences to state and federal government

This cost information collected for each category is then discounted at a 5% rate and then summed up in Table 8. Note that the sum of the amount of vehicle purchase incentives by state and federal governments plus the incremental cost to the end-user is equal to the total incremental costs associated with LPG vehicles. Similarly, the re-fueling infrastructure investments by the state and federal government plus the private sector will equal the overall re-fueling

[13] LPG savings over diesel occur from the use of LPG school buses or other medium/heavy duty vehicles such as heavy duty utility vehicles.

infrastructure investments.[14] The main emphasis of Table 8 is to show the distribution of costs/investment flows from the private and public sector that would be necessary under each scenario in order to achieve the LPG consumption and vehicle sales goals.

Table 8: Summary of Costs

Summary of Costs 2008-2050 (2007$, 5% Discount Rate)			
	Scenario		
	BAU	CEG	AS
Final Total, Vehicle	$501,000,000	$782,000,000	$931,000,000
Final Total, Infrastructure	$110,000,000	$221,000,000	$331,000,000
Vehicle Incentives, State Gov	$115,000,000	$230,000,000	$341,000,000
Vehicle Incentives, Fed Gov	$116,000,000	$221,000,000	$295,000,000
Vehicle Purchase, End User	$270,000,000	$331,000,000	$295,000,000
Infrastructure Invest, State Gov	$5,500,000	$15,000,000	$33,000,000
Infrastructure Invest, Fed Gov	$5,500,000	$15,000,000	$33,000,000
Infrastructure Invest, Private Sect	$99,000,000	$190,000,000	$265,000,000
Changes in Fuel Cost	$2,960,000,000	$7,676,000,000	$15,709,000,000
Changes in Fuel Tax, Federal Govt	$119,000,000	$203,000,000	$270,000,000
Changes in Fuel Tax, State Govt	$(177,000,000)	$(304,000,000)	$(403,000,000)

It is important to clarify at this point that a positive sign for the category labeled "Changes in Fuel Cost" should be interpreted as savings that would accrue to the end-user from using LPG over gasoline. Moreover, a positive sign for the category labeled "Changes in Fuel Tax, Federal Govt", should be interpreted as additional tax revenue to the federal government if LPG were to substitute for gasoline. Finally, a negative sign for the category labeled "Changes in Fuel Tax, State Govt" should be interpreted as the loss of tax revenue from the use of LPG over gasoline.[15]

[14] Additionally, the ratio of the total state government investment for infrastructure to total infrastructure investments comes close to the allocation made by staff in page 9. The differences are due to discounting.

[15] Staff used the current tax rates for gasoline and LPG from the Commissions website: http://www.energy.ca.gov/gasoline/fuel_tax_rates.html. Moreover, staff assumed that these rates would stay constant throughout the study period. The federal government gains from a substitution of LPG for gasoline because the higher consumption of LPG relative to gasoline more than makes up for the lower federal tax rate on LPG relative to gasoline. The state will lose tax revenue because the state tax rate on LPG is substantially lower than on gasoline (6 cents/gallon vs 18 cents/gallon) and additional consumption of LPG over gasoline is not enough to make up the shortfall.

Cost Effectiveness Calculation

Table 9 shows the distribution of costs to three market participants: the end-user, state government, federal government, and the private sector.[16] The end-user bears the cost of an LPG vehicle (net of any state or federal government incentive) and any changes in fuel costs. The state and federal governments bear the investments necessary to promote the sales of LPG vehicles, construction of re-fueling infrastructure, and fuel tax revenue consequences. The private sector, a proxy for the LPG marketer, bears the cost of investing in the LPG re-fueling infrastructure (net of any federal or state incentives).

Table 9: Aggregated Costs by Market Participant

Distribution of Costs by Market Participants (2008-2050) (2007$, 5% Discount Rate)			
	Scenario		
	BAU	CE	AS
Cost to End User	$(2,690,000,000)	$(7,345,000,000)	$(15,414,000,000)
Cost to State Gov	$298,000,000	$549,400,000	$777,000,000
Cost to Fed Gov	$2,600,000	$33,000,000	$59,000,000
Cost to Private Sector	$99,000,000	$190,000,000	$265,000,000

As Table 9 shows, the savings in using LPG over gasoline dominates all other associated costs such as vehicle purchase incentives and infrastructure investments. Under any scenario, the overall cost is negative which indicates significant savings to society[17].

Table 10 shows the cost-effectiveness of displacing gasoline by using LPG. Here, staff took the sum of the total incremental cost of LPG vehicles, changes in fuel cost, changes in fuel tax revenue for state and federal government from 2008 to 2050 under each scenario and divided it by the total use of LPG (on a gasoline gallon equivalent basis).

[16] Here, private sector is a proxy for those building the network of LPG re-fueling infrastructure.
[17] It should also be kept in mind that these big savings occur over a long time period, from 2008 to 2050.

Table 10: Cost-Effectiveness of LPG Over Gasoline

Cost-Effectiveness Table (2008-2050) (2007$, 5% Discount Rate)			
	Scenario		
	BAU	CEG	AS
Total Incremental Cost of Vehicle	$501,000,000	$782,000,000	$931,000,000
Changes In Fuel Cost	$2,960,000,000	$7,676,000,000	$15,709,000,000
Fuel Tax Revenue Consequences, State Govt	$118,660,000	$203,303,000	$269,523,000
Fuel Tax Revenue Consequences, Federal Govt	$(177,231,000)	$(303,653,000)	$(402,559,000)
Total	$(2,400,000,000)	$(6,793,000,000)	$(14,645,000,000)
GGE of Propane Used	5,115,264,000	9,474,347,000	13,319,530,000
C/E RATIO	**$(0.47)**	**$(0.72)**	**$(1.10)**

Note that the sum of state vehicle purchase incentive, federal government vehicle purchase incentive, and the final incremental cost to the end user is equal to the total vehicle incremental cost. The cost associated with the refueling infrastructure is assumed to be recouped from the gallon price of LPG and is not counted in order to avoid double counting. Overall, the analysis shows that the state can expect significant savings in using LPG to displace gasoline. This is due to the dominant effect of savings accruing to the end-user from using LPG over gasoline.