

Section 3.7 Energy

Introduction

This section discusses the environmental setting and effects of the alternatives with regard to energy. Specifically this section covers potential effects of the alternatives on energy resources, including electricity, diesel fuel, and gasoline consumption. Energy consumption throughout this section is presented in British Thermal Units (BTUs).

In addition to prior environmental documentation, key sources of data used in the preparation of this section include the following:

- California Energy Commission 2009 Integrated Energy Policy Report
- California Energy Commission Full Fuel Cycle Assessment: Well-to-Wheels Energy Inputs, Emissions, and Water Impacts (2007)
- Electricity and natural gas billing records as provided by VTA
- VMT projections for travel modes as provided by the VTA

For background on relevant energy regulations, please see the Capitol Expressway Corridor Background Report.

Affected Environment

EXISTING CONDITIONS

State Electricity Supply, Use and Growth in Demand

In 2008, California energy sources included natural gas (46 percent), coal (18 percent), large hydroelectric plants (11 percent), and nuclear (14 percent) (California Energy Commission 2009a). The remaining 11 percent is supplied by renewable sources, including geothermal, biomass, small hydroelectric, wind, and solar sources. The percentage of electricity imports varies annually, but roughly 32 percent of California's electricity was imported in the year 2008. Electricity imported from outside the state, particularly the southwest region, relies more heavily on coal, which tends to emit higher greenhouse gas (GHG) emissions per kilowatt-hour produced than other sources.

Electricity consumption in California is forecast to grow 1.2 percent annually between 2008 and 2018, with peak demand growing at a slightly higher annual rate of 1.3 percent. The California Energy Commission does not provide electricity demand forecasts beyond 2018. Because of lower expected economic growth in both the near and long term as well as increased expectations of savings from energy efficiency, the most recent 2009 California Electricity Demand (CED) forecasts 5 percent lower

annual and 3.5 percent lower peak consumption relative to what was predicted in the 2007 CED (California Energy Commission 2009b).

Population increase is the key cause of increased electricity consumption in the future due to increased residential and commercial demand and the related increased demand from water pumping and other public services. California's population is expected to increase 1.2 percent annually until 2020, which is less than the 1.4 annual growth rate that the state experienced from 1990 to 2008 (California Energy Commission 2009a).

Increases in peak demand create inefficiencies within the electricity system. As demand goes up during peak hours, power companies generally dispatch power plants in decreasing order of efficiency; therefore as the load goes up, the overall efficiency of producing electricity goes down (California Energy Commission 2009a).

Regional Electricity, Transmission and Distribution

Pacific Gas and Electric Company (PG&E) provides electricity to most of northern California, pursuant to an interconnection agreement regulated by the Federal Energy Regulatory Commission (FERC). PG&E provides approximately 95 percent of the electricity to VTA operations; the remaining electricity is provided by the City of Santa Clara and the City of Palo Alto.

PG&E provides electricity that is generated primarily from hydroelectric facilities to Santa Clara County facilities (i.e., tenants). PG&E's energy production varies by season and by year depending on hydrologic conditions. In addition, PG&E's electricity load profile is dramatically higher in the summer because the higher summer temperatures drive increased demand for air-conditioning. PG&E's hydroelectric portfolio is the largest under private ownership in the United States, drawing water from approximately 100 reservoirs along 16 river basins, with a maximum electric output of 3,896 MW (Pacific Gas and Electric Company 2009).

State Natural Gas Supply, Use and Growth in Demand

Forty percent of the state's natural gas consumption is due to its use as a source of electricity. The remainder is direct consumption for heating and cooking. Forty-six percent of California's electricity is generated from combustion of natural gas. Even as the state shifts to renewable energy sources, natural gas will likely be paired with these renewable energy sources in order to ensure reliable peak demand service. California produces approximately 13 percent of its natural gas from in-state wells. The rest is imported by pipeline from Canada and the Rocky Mountain and Southwestern states. California's dependence on out of state natural gas purchases has grown by approximately 7 percent since 1990 (California Energy Commission 2009a).

Regional Natural Gas, Transmission and Distribution

PG&E provides natural gas to most of northern California, pursuant to an interconnection agreement regulated by the FERC. Within Santa Clara County, PG&E provides natural gas that is obtained primarily from various oil and gas fields in California and from outside of the state of California. The heating value of natural gas supplied by PG&E will vary depending upon the sources being used. In addition, PG&E's natural gas load profile is dramatically higher in the winter because the colder temperatures drive increased demand for natural gas heating.

State Transportation Fuel Use

In 2008, Californians consumed approximately 14.9 billion gallons of gasoline, which is 740 million (0.05 percent) less than 2007. In 2007, Californians consumed 3.1 billion gallons of diesel fuel (California Energy Commission 2008). Over the 12-month period from July 2008 through June 2009, gasoline demand was down 3.4 percent compared to the previous 12-month period. Over the same 12 month period, diesel fuel demand was down 10.1 percent compared to the previous 12-month period (July 2007 through June 2008). By 2030, the California Energy Commission estimates that gasoline consumption will decrease between 8.5 and 13.3 percent, largely as a result of high fuel prices, efficiency gains, and competing fuel technologies. However, diesel consumption is estimated to increase between 35 and 42 percent over the same time period.

Environmental Consequences

APPROACH AND METHODS

Methodology

For this analysis, the scenario conditions are defined as follows:

- **Existing Conditions**—Current energy use in the VTA service area 2009. Energy use includes: gasoline and diesel fuel for personal automobiles; gasoline and diesel fuel for buses operated by the VTA; and electricity and natural gas consumed for VTA operations (including light rail).
- **No-Build Alternative**—Energy uses in the VTA service area in 2035, assuming no modifications or extensions are made to the Light Rail system. Energy use includes: gasoline and diesel fuel for personal automobiles; electricity used for the BART; gasoline and diesel fuel for buses operated by the VTA; and electricity and natural gas consumed for VTA operations (including light rail).
- **Light Rail Alternative**—Energy use in the VTA service area in 2035 including the proposed extension between Alum Rock and Eastridge station (including the optional Ocala Avenue Station). Energy use includes: gasoline and diesel fuel for personal automobiles; electricity used for the BART; gasoline and diesel fuel for

buses operated by the VTA; and electricity and natural gas consumed for VTA operations (including light rail).

- **Light Rail Alternative with No Ocala Station**—Energy use in the VTA service area in 2035 including the proposed extension between Alum Rock and Eastridge station (not including the Ocala Avenue Station). Energy use includes: gasoline and diesel fuel for personal automobiles; electricity used for the BART; gasoline and diesel fuel for buses operated by the VTA; and electricity and natural gas consumed for VTA operations (including light rail).

The direct energy requirements for the above project scenarios were estimated based on the vehicle miles traveled (VMT) forecast for each major transportation mode in 2009 and 2035 (Jaworski pers. comm. 2010). VMT was annualized for each mode using expansion factors derived from conceptual service plans (in the case of transit modes) and historical relationships of weekday and annual vehicle trips (in the case of autos).¹

Table 3.7-1 summarizes the estimated annual VMT for each project alternative by mode. As shown in Table 3.7-1, the No-Build Alternative is projected to generate the largest total VMT in 2035, primarily due to an increase in personal auto/truck VMT. At the transportation system level, however, differences between alternatives are minor (0–3 percent). Table 3.7-1 shows that 2035 Light Rail Alternative results in a decrease in between 2 and 4 million VMT by personal autos/trucks, relative to the No-Build Alternative, a significant transportation mode shift in 2035 from personal vehicles to transit.

To determine the effects on energy resulting from the alternatives, VMT was converted to energy use using fuel efficiency factors for both gallons of gasoline or diesel fuel or kilowatt hours (kWh) of electricity consumed per vehicle mile. These factors are listed in Table 3.7-2. Because transit and auto modes consume different types of energy, to provide for a common measure of comparison, kWh of electricity or gallons of fossil fuels consumed (or saved) were converted to their BTU equivalents. Energy use is expressed at two levels: in terms of the direct energy content of electricity and fuels consumed (or saved) as well as the total energy content of each energy unit. The former is the specific energy available at the point of use while the latter also includes the energy required to generate/refine and transmit/transport the energy unit to the final point of use. For instance, a kWh has a final or direct energy content of 3,416 BTUs, but approximately 4,600 BTUs of additional energy is required to generate and transmit the kWh to its point of use. Therefore, the total energy content of a kWh is estimated at approximately 8,000 BTUs.

¹ The annual VMT were estimated by multiplying average weekday VMT by 291. This factor accounts for the decreased VMT on weekends as compared to weekdays.

Direct and total energy use, by mode, for vehicle operations was converted to direct and total energy use for each project alternative by multiplying energy use in BTUs (Table 3.7-2) per vehicle mile by the annual VMT by mode (Table 3.7-1).

Table 3.7-1. Annual VMT (in millions) for Vehicle Operations by Mode (2035)

Transportation Mode	2009 Existing	2035 No-Build Alternative	2035 Light Rail Alternative	2035 Light Rail Alternative, No Ocala Station
Bus	18.42	16.20	16.20	16.20
LRT	3.64	7.14	7.37	7.37
BART	0.00	122.56	122.56	122.56
<i>Subtotal</i>	<i>22.06</i>	<i>145.90</i>	<i>146.13</i>	<i>146.13</i>
Auto/Truck	3,969.58	6,208.97	6,204.43	6,206.05
Total	3,991.63	6,354.87	6,350.55	6,352.17
Difference from No-Build Alternative			-4.32	-2.70
Percent Change over No-Build Alternative	NA	NA	-0.07%	-0.04%

Source: ICF 2010.

Notes: Auto/Truck represents regional VMT. Original source of data was C. Jaworski, VTA, 2010.

Table 3.7-2. Direct and Total Energy Use by Transit and Auto Mode (millions of VMT)

Mode	Energy Unit ^a	Direct Energy BTU per Energy Unit ^b	Total Energy BTU per Energy Unit ^c	Ratio Total to Direct	Modal Energy Vehicle use Per Mile ^d	Direct BTUs	Total BTUs
Bus	gallons diesel equivalent ^e	127,460	162,370	1.27	0.17 gallons	21,668	27,603
LRT	kilowatt-hour	3,416	8,000	2.34	8.50 kWh	29,036	68,000
BART	kilowatt-hour	3,416	8,000	2.34	4.00 kWh	13,664	32,000
Auto/ Truck	gallons gasoline equivalent ^f	113,430	150,210	1.32	0.04 gallons	4,537	6,008

Sources: California Energy Commission 2007.

^a Primary form of energy used. For bus and auto, various energy sources may be in use by 2035, including electric, hybrid gas-electric, fuel cell, and gasoline. These have been expressed in one energy type and in the energy content equivalent for that type.

^b BTU = British thermal unit. The net energy content of energy unit at its point of use.

^c The total energy content of a unit, including energy used to recover, refine, and transport to the point of use.

^d Assumed bus fuel economy of 6 miles per gallon (mpg) and combined auto/truck economy of 28.5 mpg.

^e Diesel values are reported for ultra low sulfur diesel.

^f Gasoline values are reported for California reformulated gasoline, which is blended with an oxygenate (ethanol).

Existing conditions are defined as service levels for VTA bus and rail, as well as regional traffic volume for calendar year 2009. The No-Build Alternative is defined as anticipated service levels in calendar year 2035 for VTA bus and rail, BART and traffic volume if the project did not occur. The Light Rail Alternative is defined as anticipated service levels in the calendar year 2035 for VTA bus and rail with the extension to Eastridge, after the construction activities have completed, BART, and traffic volume if the project did occur.

Additionally, this analysis examines the potential demand on both base and peak period electricity. The peak-period electricity demand was determined using the daily energy consumption data as supplied by VTA for 4 of the VTA's 32 sub-stations, considered to be representative of daily demand fluctuations for all sub-stations. Absolute peak electricity demand and the relative difference between peak and average demand are discussed qualitatively in the context of recent projections of peak and annual demand in California (California Energy Commission 2009b).

This is a cumulative analysis because it includes an assessment of the energy consumed by autos and light duty trucks in the region, energy consumed by VTA's

regional bus network, energy consumed by VTA’s Light Rail and other operations as well as energy consumed by BART. Further, the analysis combines the electricity demand estimates for the proposed alternatives with statewide demand when making the determination as to whether electricity generating and transmitting infrastructure would be adequate to supply electricity to the proposed alternatives in addition to each of the other existing and future electricity consumers.

EFFECTS AND MITIGATION MEASURES

This section assesses the environmental consequences due to the following: direct power usage for powering the light rail and supporting buildings, fuel consumed by buses, and fuel consumed by regional passenger vehicles. Construction related energy consumption was not included in this analysis. However, a qualitative discussion of construction impacts to Energy is included in Section 3.18 *Construction*.

No-Build Alternative

Impact: Place a Substantial Demand on Regional Energy Supply or Require Substantial Additional Capacity

Annual direct and total energy use for vehicle operations of all modes are shown in Table 3.7-3. As the No-Build Alternative would not introduce any new transit that would result in increased demand on energy supply, it is not anticipated to contribute to any adverse energy impacts. Planned projects in the project area would be evaluated in their own separate environmental analyses to identify impacts and determine mitigation measures, as necessary. The No-Build Alternative would result in higher regional energy use by auto/truck and lower electricity demand for Light Rail compared to the Light Rail Alternatives. Although the No-Build Alternative does not include any new demands on energy supply, it is the scenario with the largest net energy consumption in 2035, (refer to Table 3.7-4) of all alternatives studied.

No adverse effects. No mitigation required.

Impact: Increase Peak and Base Period Electricity Demand

The No-Build Alternative would result in no adverse impacts on peak electricity demand. Planned projects included in the No-Build Alternative would be evaluated in separate environmental analyses to identify impacts and determine mitigation measures. The No-Build Alternative would result in higher electricity demand relative to current conditions but lower relative to the Light Rail Alternative. Because peak demand scales with annual electricity demand as shown in Table 3.7-4, peak electricity demand for the No-Build Alternative would be the lowest of all alternatives studied.

No adverse effects. No mitigation required.

Light Rail Alternative

Impact: Place a Substantial Demand on Regional Energy Supply or Require Substantial Additional Capacity

Annual direct and total energy for vehicle operations of all modes are shown in Table 3.7-3. Vehicle operations of the Light Rail Alternative are estimated to consume 14.1 billion fewer BTUs per year in direct energy and 12.2 billion fewer BTUs in total energy than No-Build Alternative conditions (<0.05 percent).

In addition to energy for vehicle operations, energy for facility operations was estimated for each transportation mode and scenario. This additional energy requirement was calculated on a percentage basis. For example, it was estimated that approximately 25 percent of BART's existing power requirements are for station and other facilities operations (the other 75 percent is for vehicle propulsion) (Silicon Valley Rapid Transit Corridor EIS 2010). The facilities and other energy requirements for bus and light rail transit modes were estimated at 10 percent of the total power requirements for a mode. No facilities or other energy requirements were estimated for autos. This was because the change in auto VMT between the Light Rail Alternative scenarios and No-Build Alternative conditions was marginal relative to total transportation system auto VMT. The relatively small change was determined not to have a measurable effect on the annual energy required to operate and maintain the road and highway system. Like the analysis of propulsion energy impacts, the energy requirements for facilities and other operations were estimated in terms of both direct and total energy.

Table 3.7-3. Annual Direct and Total Energy Use (in Million BTUs) for Vehicle Operations by Mode and Alternative

Mode	Existing (2009)		2035 No-Build Alternative		2035 Light Rail Alternative		2035 Light Rail Alternative (No Ocala)	
	Direct	Total	Direct	Total	Direct	Total	Direct	Total
Bus	399,094	508,402	351,067	447,221	351,067	447,221	351,067	447,221
LRT	105,625	247,366	207,422	485,766	213,877	500,883	213,877	500,883
BART	0	0	1,674,639	3,921,871	1,674,639	3,921,871	1,674,639	3,921,871
<i>Subtotal</i>	<i>504,720</i>	<i>755,769</i>	<i>2,233,128</i>	<i>4,854,858</i>	<i>2,239,584</i>	<i>4,869,976</i>	<i>2,239,584</i>	<i>4,869,976</i>
Auto/Truck	18,010,763	23,850,805	28,171,328	37,305,961	28,150,728	37,278,682	28,158,075	37,288,411
Total	18,515,483	24,606,573	30,404,456	42,160,819	30,390,312	42,148,657	30,397,659	42,158,387
Difference from No Build Conditions	NA	NA	NA	NA	-14,145	-12,162	-6,798	-2,432
Percent Change from No-Build Conditions	0.00%	0.00%	0.00%	0.00%	-0.05%	-0.03%	-0.02%	-0.01%

Source: ICF International 2010.

The estimates of energy consumed in vehicle propulsion and in facilities operation were combined to yield a net energy requirement for all transit modes under all alternatives. Table 3.7-4 shows the net annual direct and total energy use, with a further breakdown by mode. The Light Rail Alternative is estimated to require 13.4 billion fewer BTUs per year in direct energy and 10.5 billion fewer BTUs in total energy than No-Build Alternative conditions (<0.04 percent).

This relationship reflects the annual energy savings under the Light Rail Alternative operations due to reduced auto travel, which more than offsets the additional energy requirements of operating more transit service under No-Build Alternative conditions.

The Light Rail Alternative would result in no adverse energy impacts. Direct and total energy use by the Light Rail Alternative are shown in Tables 3.7-3 and 3.7-4. The Light Rail Alternative results in the lowest total, net energy use in 2035 (Table 3.7-4) of all alternatives. Future energy use that would result from the Light Rail Alternative is not considered to place a substantial demand on the energy supply for the following reasons:

1. Direct energy consumption in the region is driven by the use of personal autos (> 93 percent for all scenarios). Therefore, the ability of the VTA operations and proposed activities to impact total energy in the region use is limited. However, the Light Rail Alternative does result in a reduction in VMT and consequent energy consumption by this end use sector.
2. The Light Rail Alternative results in a transportation mode shift, i.e. riders move from single passenger cars to multi-passenger trains.
3. The Light Rail Alternative results in the lowest total, net energy use in 2035 as compared to the 2035 No Build and 2035 Build No Ocala Alternatives.
4. As with the No Build Alternative, planned projects included in the Light Rail Alternative would be evaluated in separate environmental analyses to identify impacts and determine mitigation measures.

No adverse effects. No mitigation required.

Impact: Increase Peak and Base Period Electricity Demand

In 2008, peak electricity demand for California was 286,771 gigawatt hours (GWh); the peak demand projected for 2016 is 320,178 GWh.² Peak period LRT service occurs in the mornings (8:30–9:45am) and early evening (5:15pm–5:45pm), based on service data (VTA 2010). The VTA utilizes 32 traction power sub-stations. Daily data at 4 sub-stations (VTA 2010) indicate that peak demand is roughly 3 times that of the average daily demand. Data from these 4 sub-stations indicate that the load factor at VTA substations is approximately 39 percent, indicating that the current VTA power infrastructure has additional capacity. Data from these 4 sub-stations was considered to be representative of conditions at all VTA sub-stations. Peak period electricity demand is discussed for the Light Rail Alternatives relative to annually averaged conditions, as follows.

² California Energy Commission, Integrated Energy Policy Report, December 2009.

Table 3.7-4. Net Annual Direct and Total Energy Use (in Million BTUs) for Vehicle Operations by Mode and Alternative

Mode	Existing (2009)		2035 No-Build Alternative		2035 Light Rail Alternative		2035 Light Rail Alternative, No Ocala	
	Direct	Total	Direct	Total	Direct	Total	Direct	Total
Bus	443,438	564,891	390,075	496,913	390,075	496,913	390,075	496,913
LRT	117,362	274,851	230,469	539,740	237,641	556,537	237,641	556,537
BART	0	0	2,232,852	5,229,161	2,232,852	5,229,161	2,232,852	5,229,161
<i>Subtotal</i>	<i>560,800</i>	<i>839,743</i>	<i>2,853,396</i>	<i>6,265,814</i>	<i>2,860,568</i>	<i>6,282,611</i>	<i>2,860,568</i>	<i>6,282,611</i>
Auto/Truck	18,010,763	23,850,805	28,171,328	37,305,961	28,150,728	37,278,682	28,158,075	37,288,411
Total	18,571,563	24,690,548	31,024,724	43,571,775	31,011,296	43,561,293	31,018,643	43,571,022
Difference from No Build Conditions	0	0	NA	NA	-13,427	-10,482	-6,080	-753
Percent Change from No-Build Conditions	<i>0.00%</i>	<i>0.00%</i>	<i>0.00%</i>	<i>0.00%</i>	<i>-0.04%</i>	<i>-0.02%</i>	<i>-0.02%</i>	<i>0.00%</i>

Source: ICF International 2010.

The Light Rail Alternative would likely increase the peak period energy use since the number of trains operating during this time will almost certainly increase relative to the No Build Alternative. Assuming approximately 18 hours of operation per day, annual data as presented in Table 3.7-3 suggest that a peak electricity demand for the Light Rail Alternative would be approximately 286 million BTUs or 3 percent greater than the No Build Alternative. The 2010 CAISO Transmission Plan indicates that the state’s power infrastructure and supply will have sufficient thermal capacity to handle the Greater Bay Area, including peak periods, through 2024 (CAISO 2010). Given the state’s current projections as well as VTA’s additional capacity, this increase in electricity demand during peak periods is not considered to represent an adverse effect.

No adverse effects. No mitigation required.

Proposed Option

The above discussion is generally inclusive of the Light Rail Alternative without the Ocala Station option. Direct and total energy use associated with the Light Rail Alternative without the Ocala Station is within 0.02 percent of the No-Build Alternative in 2035. Total VMT for on-road vehicles in 2035 is projected to be approximately 6,352,170,000 if the Ocala Station is not constructed. Traffic impacts of the Light Rail Alternatives are essentially identical as energy impacts are dominated by on-road transportation fuel consumption. For the purposes of discussing energy impacts, the Light Rail Alternatives (with or without the Ocala Station) are indistinguishable. Operation of the Ocala Station would result in slightly more operational energy requirements to power the station, although this is less than one half of one percent of total annual energy use in 2035 for VTA operations.

CUMULATIVE EFFECTS

No-Build Alternative

The No-Build Alternative would not contribute to cumulative impacts on energy. Planned projects included in the No-Build Alternative would be evaluated in separate environmental analyses to identify impacts and determine mitigation measures.

Light Rail Alternative

The Light Rail Alternative in combination with other reasonably foreseeable projects could potentially result in cumulative impacts to energy. The analysis presented in this section inherently accounts for cumulative impacts on energy consumption for the region as it relies on forecasts of regional traffic, forecasts of VTA energy requirements and forecasts of BART energy requirements. Additionally this analysis relied on future projections of state and PG&E service area energy demand, which are

also based on projected population growth and thus inherently account for other projects in the region.

Further, through the Renewables Portfolio Standard (SB 1078 and SB 107), the state has set forth a goal to provide 33 percent of California's electricity demand in a renewable form by 2020. Although it is uncertain if electricity providers in the state will be able to meet this target, the RPS guarantees that more and more of the state's electricity needs will be met by renewable power in future years. Consequently, the mode shift from on-road passenger vehicles to rail passengers will result in a larger and larger percentage of passenger miles being powered by renewable sources in the region. For these reasons, the Light Rail Alternative will not result in cumulative adverse effects to energy use.