3.2.8 Energy

Regulatory Setting

The State CEQA Guidelines, Appendix F, Energy Conservation, state that EIRs are required to include a discussion of the potential energy impacts of proposed projects, with particular emphasis on avoiding or reducing inefficient, wasteful, and unnecessary consumption of energy.

NEPA (42 USC Part 4332) requires the identification of all potentially significant impacts on the environment, including energy impacts.

California's Energy Action Plan (updated in 2008) describes a coordinated implementation plan for state energy policies, and identifies specific action areas to ensure that California's energy resources are adequate, affordable, technologically advanced, and environmentally sound. In accordance with this plan, the first-priority actions to address California's increasing energy demands are energy efficiency and demand response (i.e., reduction of customer energy usage during peak periods to address system reliability and support the best use of energy infrastructure). Additional priorities include the use of renewable sources of power and distributed generation (i.e., the use of relatively small power plants near or at centers of high demand). To the extent that these actions are unable to satisfy the increasing energy demand and transmission capacity needs, clean and efficient fossil-fuel–fired generation is supported.

Affected Environment

This discussion is based primarily on the *Interstate 80/Interstate 680/State Route 12 Energy Technical Report* (Energy Report) prepared in 2010. The affected environment includes the physical boundaries of the roadway construction site as well as the total vehicle flow passing through the completed roadway. Traffic flow passing through the project area at build-out is intrinsically connected to traffic patterns throughout the region, underpinned by socioeconomic and regulatory factors throughout the state and nation. Thus the affected environment can best be thought of as the regional energy budget. For reasons discussed in detail below, a comprehensive analysis of the regional energy budget is beyond the scope of this report. This analysis therefore is restricted to direct energy consumption and indirect energy consumption as defined below.

Direct Energy Use

Direct energy use is the energy used in the actual propulsion of a vehicle using the facility. It can be measured in terms of the thermal value of the fuel (usually measured in British thermal units [BTUs]), the cost of the fuel, or the quantity of electricity used in the engine or motor.

Indirect Energy Use

Indirect energy is defined as all the remaining energy used to run a transportation system, including construction energy, maintenance energy, and any substantial impacts on energy expenditures related to project-induced land use changes and mode shifts, and any substantial changes in energy associated with vehicle operation, manufacturing or maintenance due to increased automobile use.

Environmental Consequences

Determination of Adverse Effects

There are no thresholds of significance for energy consumption. Instead, the Department and the Federal Highway Administration (FHWA) require a discussion of the potential energy effects of proposed projects, with particular emphasis on avoiding or reducing inefficient, wasteful, and unnecessary consumption of energy.

A qualitative comparison of the project alternatives was employed in this analysis. Direct energy consumption was relatively assessed across the project alternatives through a comparison of peak vehicle miles traveled (VMT) (a.m. and p.m.), total VMT, and delay hours. To assess indirect energy consumption, the construction parameters of the project alternatives were compared. The qualitative analysis was determined to be the simplest way of comparing the project alternatives. This approach limits the need for assumptions and avoids significant limitations in standard, but outdated methodologies.

Historically, transportation energy studies quantified direct and indirect energy expenditures. Quantitative analyses of direct energy consumption were a summation of the peak and non-peak energy for vehicle movement for the analysis period, which was typically the period from the completion of project construction to 20 years following the completion of project construction. In assessing the direct energy impact, assumptions are made when considering various factors, including vehicle fleet mix, annual VMT, fuel economy, and variation of fuel consumption rates over time and by vehicle type. Additional assumptions were made, including:

- New-model fleet fuel efficiency would always be improving.
- Vehicle fuel usage in rural settings would differ from vehicle fuel usage in urban settings.
- Multiple occupant vehicles could use high occupancy vehicle lanes.
- Pavement would be maintained in fair to reasonable condition.

Quantification analyses of indirect energy were the summation of energy required to construct, operate, and maintain the transportation network, as well as to manufacture and maintain on-road vehicles and transit vehicles. This approach relied on factors (construction equipment operation energy factors and maintenance energy factors) that have remained unchanged for 30 years. The methodology to estimate construction energy expenditures using project construction cost requires adjusting future construction costs to the 1977 highway construction price index, which is almost always overlooked.

Today we can no longer make these same assumptions. The on-the-road vehicle fleet mix can vary in type and age with the economy. The on-the-road vehicle fleet fuel usage rates will depend on the on-the-road vehicle fleet mix and can be propelled by gasoline or diesel fuels as well as by other means, including gasoline-electric hybrids, plug-in electricity, fuel cells, and compressed natural gas. New-model vehicle fleet fuel usage rates are known, but we do not know how the rates may change as vehicles age. There may be new or improved technologies during the analysis period that constitute significant leaps in vehicle fuel conservation rates and efficiency. With fuel injection technology, the commonly used assumptions about cold starts are outdated and are not deemed appropriate for this analysis. Vehicle fleet fuel efficiency doesn’t

always increase over time; vehicle fleet fuel efficiency actually decreased in the 1990s with the proliferation of sport utility vehicles. There may be no differences in vehicle fuel usage between rural and urban settings with urban expansion. Express (toll) lanes may replace high-occupancy vehicle lanes in the near future. Pavement condition may become worse over time if funding for maintenance improvements remains scarce. Construction equipment and techniques have improved in the last 30 years, so construction equipment operation energy factors require updating.

The project alternatives in and of themselves cannot influence the vehicle fleet, future fuel economy, or development patterns that steer regional driving patterns. All project alternatives would be equally affected by these uncertain future scenarios. However, at the writing of this document, both the regulatory environment and the market are responding to climate change concerns, and a transformation of American driving patterns and technologies seems likely within a generation. The practice of assuming present-day fuel economy and fleet conditions is commonly implemented as a worst-case scenario for energy analyses, but at this time the likelihood of large-scale changes in this sector would render that assumption grossly incorrect. This analysis has therefore relied on a comparison of the raw traffic numbers and has not converted them to BTUs.

In addition, numerous contributors to the energy balance within a project area require complicated and rigorous economic analysis. The decision of where people buy homes, how far they regularly commute, the choice of personal vehicle and the fuel price at which consumers begin to alter their transportation patterns are just a few examples of large-scale patterns that ultimately affect the number of vehicles in the project area. Traditional energy analyses for roadway projects have ignored these components, and consequently attributed increases in VMT uniquely to the implementation of the project—a gross oversimplification of the regional energy budget.

With so many unknowns and a multitude of future energy scenarios, a quantitative analysis has a high risk of being inaccurate and meaningless. Consequently, a qualitative analysis would provide more useful information upon which to judge a proposed project and its alternatives. The qualitative approach employed is described in detail in the “Methods” section.

Methods

The energy analysis addresses both direct and indirect energy. The direct energy analysis includes the potential for increased energy consumed by fossil-fuel–powered vehicles using the interchange. A discussion of motor vehicle traffic (VMT and average travel speeds) through the interchange is a component of the direct energy analysis because VMT and speeds can infer direct energy consumption. These VMT values were not converted to BTUs, avoiding the need to make assumptions about the future vehicle fleet or fuel economy. This approach essentially assumes that all future developments in fuel carbon content, fuel economy, fuel technology, and regulation affect the projected VMT equally across alternatives, and that the build alternatives would have no effect on these variables.

The indirect energy analysis addresses the energy associated with construction and maintenance of the interchange and other roadway infrastructures. This approach compares the amounts of various construction materials required for each alternative. Construction-related energy

consumption and energy consumption embodied in materials production is assumed to be directly proportional to roadway elevation, length, area and volume needed. By comparing the raw materials employed, the need to use speculative or outdated factors relating energy consumption to cost are avoided. The cost of acquiring individual materials may vary dramatically in response to global demand and availability. A lump cost estimate masks the effects of these fluctuations and is only very indirectly related to the true energy consumed.

Direct Energy Consumption

This analysis compares the estimated VMT, delay, and average network speed on the I-80/I-680/SR 12 interchange system-wide measure of effectiveness network (i.e., the portion of the network included in the traffic study) that would result under implementation of the project alternatives. The analysis parallels the *Air Quality Study Report* of the EIR by presenting direct energy (fuel consumption through VMT) calculations associated with estimated vehicle speeds from the traffic study.

A comparison of traffic metrics in the project area in 2015 and 2035 are shown in Tables 3.2.8-1 and 3.2.8-2. It is assumed that societal, economic, or regulatory changes affecting fuel economy are equally reflected in the VMTs for each project alternative. Thus assumed fuel economy is not required to convert VMT to energy consumption in order to compare alternatives.

Table 3.2.8-1. Traffic Flow during Operations in Year 2015 and Ranking of Alternatives (score in parenthesis)

Vehicles		No-Build	Alternative B Phase 1	Alternative C Phase 1
Project distance (miles)		–	6.23	10.17
VMT/hour	a.m. p.m.	449,870(*0*) 480,410(*0*)	451,325*(1)* 531,935*(1)*	448,800(*0*) 516,055(*0*)
Vehicle hours of delay/hour	a.m. p.m.	1,075(*0*) 5,100*(1)*	840(*0*) 2,150(*0*)	1,105*(1)* 3,110 (*0*)
Average network speed (miles per hour)	a.m. p.m.	51.2*(1)* 36.2*(1)*	52.6*(1)* 47.6(*0*)	51.0*(1)* 43.3(*0*)
Daily VMT		4,186,260(*0*)	4,424,670*(1)*	4,341,848(*0*)
Off-peak VMT		3,255,980(*0*)	3,441,410 *(1)*	3,376,993(*0*)
Total score		***3***	***5***	***2***

Source: Final Traffic Operations Report.

Table 3.2.8-2. Traffic Flow during Operations in Year 2035 and Ranking of Alternatives (score in parentheses)

Peak Hour Vehicles		No-Build	Alternative B	Alternative C	Alt B, Ph 1	Alt C, Ph 1
Project distance (miles)	–	–	21.17	22.95	6.23	10.17
VMT/hour	a.m. p.m.	539,445 *(0)* 413,160*(0)*	575,300*(0)* 660,290*(0)*	577,480 *(1)* 660,555 *(1)*	564,605 *(1)* 575,815 *(1)*	546,625*(0)* 480,410*(0)*
Vehicle hours of delay/hour	a.m. p.m.	3,695 *(1)* 19,065 *(1)*	1,335 *(0)* 5,420*(0)*	1,260*(0)* 5,995 *(0)*	1,845*(0)* 10,155*(0)*	3,020 *(1)* 16,095 *(1)*
Average network speed (miles per hour)	a.m. p.m.	41.8 *(1)* 15.9 *(1)*	52.4*(0)* 40.1*(0)*	52.7*(0)* 38.5*(0)*	48.9*(0)* 28.9*(0)*	44.2*(0)* 19.8*(0)*
Daily VMT	–	4,286,723*(0)*	5,560,155*(0)*	5,571,158 *(1)*	5,131,890 *(1)*	4,621,658*(0)*
Off-peak VMT	–	3,334,118*(0)*	4,324,565*(0)*	4,333,123 *(1)*	3,991,470 *(1)*	3,594,623*(0)*
Total points	**–**	***4***	***0***	***4***	***4***	***2***

Source: Final Traffic Operations Report

Tables 3.2.8-1 and 3.2.8-2 utilize a point system to compare No-Build Alternative with the various full-build alternatives (Alternative B and Alternative C) based on the various traffic flow metrics. One point was assigned to the alternative with the larger value for a particular traffic metric, presumably resulting in higher energy consumption relative to the other alternatives. The build and no-build alternatives are compared to estimate which would result in greater energy consumption, and a point is given if the alternative would potentially increase energy relative to the other alternatives. The higher the total points for each alternative, the greater the assumed direct energy consumption.

When comparing the fundable first phases of the alternatives to the no-build conditions, Alternative B, Phase 1 would result in increase in peak hourly, daily, and off-peak VMT while decreasing hours of delay when compared to both Alternative C, Phase 1, and the No-Build Alternative. The fundable first phases of both alternatives would increase VMT, reduce hours of delay, and increase average network speeds over 2035 no-build conditions. In general, energy consumption is minimized under traffic conditions that minimize delay hours, maintain speeds between 45 and 55 mph, and limit the need for vehicles to exit the freeway onto surface streets in order to avoid heavy traffic conditions. The relative scoring system shown in Table 3.2.8-1 indicates that at 2015, Alternative C, Phase 1 is the better performing build alternative for the specific metrics listed. However, neither fundable first phase would result in wasteful or excessive use of direct energy.

When comparing the two full build alternatives to no-build conditions, Alternative C would increase peak hourly VMT, daily VMT, and off-peak VMT compared to both Alternative B and the No-Build Alternative. Average network speed would improve for both build alternatives, but the resulting difference in fuel economy between the two is considered negligible. Alternative C would result in a greater increase in VMT relative to the No-Build Alternative and would decrease a.m. hours of delay and a.m. network speed. Alternative B would improve p.m. hours of delay and network speed. Total VMT is directly proportional to fuel consumed while average network speed is inversely proportional, through a certain range. The relative scoring system shown in Table 3.2.8-2 indicates that at 2035, Alternative B is the better performing full-build alternative for the specific metrics listed. However, neither full-build alternative would result wasteful or excessive use of direct energy.

This analysis does not take into account vehicles leaving the freeway in response to traffic conditions and the fuel consumption associated with surface-street driving patterns. Neglecting this activity likely introduces greatest error into the No-Build scenario because hours of delay are highest for this Alternative. A rigorous analysis accounting for these factors would allow more clear differentiation of Alternatives B and C, although it is expected that direct energy consumption is similar. Based on the data presented in Tables 3.2.8-1 and 3.2.8-2, Alternatives B and C should be considered comparable in 2035 for direct energy consumption, with Alternative B as a slightly better alternative.

Indirect Energy Consumption

This analysis compares the quantities of material for structures construction and numbers of structure types for the No-Build Alternative, Alternative B, and Alternative C. An additional metric used is lane-miles of roadway requiring maintenance after construction is complete. The total amount of energy required is inferred from these metrics and no assumptions regarding cost were made. Because many of the alternatives included in the proposed project are at conceptual planning stages and detailed construction information, such as the number of equipment, materials, and labor hours are not available, no detailed quantitative assessment of construction and maintenance impacts is possible. Were this information available, materials-specific energy factors and equipment-specific fuel economy could be employed to calculate construction-related energy consumption.

The qualitative comparison analysis presented here assumes that larger amounts of materials equates with more energy use due to increased labor hours, increased hauling of materials, and increased embodied energy consumption in materials manufacture. Construction- and maintenance-related metrics are presented for comparison in Table 3.2.8-3. An identical scoring system to that used for the direct energy evaluation was applied here.

Table 3.2.8-3 indicates that construction of Alternative B will require a larger volume of excavated roadway and a larger area of asphalt concrete (AC). Additionally, Alternative B requires more material associated with edge drains, median islands, sidewalk, curbs and gutters as compared to Alternative C. Conversely, construction of Alternative C will require a larger area be covered with Portland cement concrete (PCC) pavement and more barriers and guardrails. The total square footage of structures as defined by the client is larger in Alternative C. The total lane miles of roadway requiring maintenance would be higher for Alternative C. Without a more rigorous assessment of the energy associated with each of the unique construction activities listed in Table 3.2.8-3, it is impossible to quantify the total energy consumed for the aggregate of construction tasks. Some construction activities may be inherently more energy intensive than others, and thus apparent energy benefits in one metric could be negated in another. In general, Alternative B has larger values in more construction categories than Alternative C.

The estimated number of lane-miles for Alternative B, Alternative C, Alternative B Phase 1, and Alternative C, Phase 1 (Table 3.2.8-3) served as an estimate for maintenance energy usage. Based on the information from the *Draft Interchange Pavement and Interchange Configuration Data* (Nolte Associates 2009), the total estimated PCC and AC lane-miles for Alternative B and Alternative C are estimated to be approximately 86 to 90 lane-miles for PCC pavements and 20 to 25 lane-miles for AC pavements. According to Table C-14 in Appendix C of the Caltrans

1983 report, the estimated amount of energy factor required to maintain the roadway is approximately 16.3 and 17.8 billion BTUs per lane-mile for PCC and AC pavements, respectively.

According to the project description, Alternative C will have considerably more PCC and AC pavement to maintain than Alternative B and No-Build scenarios. For the fundable first phases of the project alternatives, Alternative C, Phase 1 will require more maintenance energy than Alternative B, Phase 1.

Based on the data presented in Table 3.2.8-3, Alternative B and C would result in comparable levels of indirect energy consumption. For the fundable first phases of the project alternatives, Alternative B, Phase 1 would result in slightly less indirect energy consumption. However, neither project alternative nor their fundable first phases are anticipated to result in wasteful or excessive indirect energy expenditures.

Table 3.2.8-3. Materials Consumption for Construction and Maintenance and Ranking of Alternatives (score in parentheses)

Indirect Energy	No-Build	Alternative B	Alternative C	Alt B, Phase 1	Alt C, Phase 1
Roadway excavation (cubic yard [cy])	–	2,800,000 *(1)*	2,523,000 *(0)*	750,000*(0)*	2,187,000*(1)*
Imported borrow (cy)	–	1,120,000 *(0)*	2,129,000 *(1)*	75,000*(0)*	607,400*(1)*
Portland cement concrete (PCC) pavement roadway (cy)	–	220,000*(1)*	126,852*(0)*	64,000*(0)*	137,611*(1)*
Asphalt concrete (AC) Pavement (cy)	–	280,000*(0)*	302,333*(1)*	60,000*(1)*	19,393*(0)*
Bridge structures PCC (cy)	–	106,000*(0)*	115,050*(1)*	54,000*(0)*	80,470*(1)*
Bridge structures rebar (pounds)	–	22,000,000*(0)*	23,895,000*(1)*	11,000,000*(0)*	16,713,000*(1)*
Lighting (units)	–	305*(1)*	206*(0)*	130*(1)*	108*(0)*
Traffic signals (units)	–	22*(1)*	16*(0)*	8*(1)*	7*(0)*
Overhead sign structures (units)	–	20*(0)*	20*(0)*	10*(0)*	10*(0)*
Ramp meters (units)	–	19*(1)*	17*(0)*	5*(0)*	6*(1)*
Striping (feet)	–	1,788,000*(1)*	1,566,000	710,000*(1)*	693,800*(0)*
Retaining walls (square feet)	–	475,000*(1)*	407,700*(0)*	388,300*(1)*	325,100*(0)*
Noise barriers (square feet)	–	25,000*(0)*	25,000*(0)*	33,000*(1)*	0*(0)*
Barriers and guardrails (feet)	–	108,000*(0)*	110,400*(1)*	32,300*(0)*	34,800*(1)*
Sidewalk, curb, and gutter(square feet)	–	243,500*(1)*	117,800*(0)*	120,700*(0)*	143,880*(1)*
Temporary MSE walls (square feet)	–	50,000*(0)*	50,000*(0)*	38,000*(1)*	0*(0)*
Total for all structures (square feet)		806,704*(0)*	1,050,281*(1)*	398,195*(0)*	619,000*(1)*
PCC lane-miles	75.83*(0)*	86.34*(0)*	89.75 *(1)*	29.34*(0)*	48.13*(1)*
AC lane-miles	17.76*(0)*	20.57*(0)*	25.36((*1)*	0.98*(0)*	9.03*(1)*
Total Points	***0***	***8***	***8***	***6***	***11***

Source: John Thomson, personal communication, 2009.

Note: Construction cost estimate sheets are located in Appendix A of the *Interstate 80/Interstate 680/State Route 12 Energy Technical Report.*

Environmental Consequences

Increased Consumption of Direct Energy

Direct energy consumption for each alternative would result from motor vehicle travel through the project area. This analysis compares traffic data summarized in the FTOR for the proposed project and inferred future energy consumption from the relationship between traffic conditions and fuel consumption.

Both build alternatives would result in increased VMT, reduced hours of delay, and increased motor vehicle speed over no-project conditions. Increased VMT would result from increased motor vehicle trips traveling a greater distance over the project area. Increased vehicle speeds would increase travel flow and reduce congestion, which may result in reduced fuel consumption. The optimal fuel efficiency varies by vehicle, but generally the lowest fuel economy is in the 0–25 mph range, and the optimal range is 45–55 mph, with a steady decline in efficiency occurring as speeds exceed 55 mph. Under 2035 Alternative B and C full-build conditions, a.m. peak hour vehicle speeds increase to the optimal range for fuel efficiency (52.4 mph for Alternative B; 48.9 mph for Alternative B, Phase 1; 52.7 mph for Alternative C; 44.2 mph for Alternative C, Phase 1), a condition that would increase fuel efficiency when compared to no-project a.m. average speeds (41.8 mph). Improved traffic flow would reduce the vehicle hours of delay for all build scenarios (except 2015 Alternative C, Phase 1), a condition that might reduce fuel use as lower traffic speeds (0–25 mph) result in poor fuel economy. It is unknown to what extent drivers bypass the existing interchange and use alternate and potentially longer-distance traffic routes because of existing traffic conditions. The inability to capture these VMTs in the analysis likely has the greatest affect on the No-Build Alternative where delay hours are highest.

Implementation of either build alternative would relieve traffic congestion by reducing vehicle hours of delay and increasing network speeds, while increasing total VMT through the project area. However, none of the build alternatives are expected to result in an inefficient, wasteful, or unnecessary consumption of energy.

Increase Consumption of Indirect Energy

Indirect energy consumption would result from project construction and maintenance. Construction of the proposed project would result in the consumption of energy to prepare the project site, manufacture and deliver construction materials to the project site, and construct the roadway interchange and associated structures. This increased fossil fuel consumption from project construction is not expected to have an appreciable impact on energy resources.

Based on the qualitative comparison, Alternative C would result in more AC pavement, more bridge structures (both PCC and rebar), slightly more barriers and guardrails, and would have a longer project distance. Based on the qualitative comparison, Alternative B would require more PCC pavement, more lighting, more traffic signals, more ramp meters, more striping, and more sidewalks, curbs, and gutters. For the fundable first phase scenarios, Alternative C, Phase 1 will require more PCC bridge structures, rebar structures, AC pavements, and roadway base aggregate materials than Alternative B, Phase 1. The construction of any of the proposed build

alternatives would be a necessary component of the project and a one-time expenditure of energy. This one-time expenditure of energy would provide for energy benefits in the long run because reduced congestion and improved traffic flow through the interchange might result in reduced direct energy consumption. Based on the qualitative analysis, Alternative C was determined to be the most preferable alternative.

Implementation of the proposed project would result in an increase in indirect energy consumption relative to the No-Build Alternative due to project construction and maintenance. However, the associated construction and maintenance of the build alternatives are not expected to result in an inefficient, wasteful, or unnecessary consumption of energy.

Avoidance, Minimization, and/or Mitigation Measures

For the proposed project alternatives, an adverse impact on energy consumption would occur if a project alternative results in wasteful, inefficient, or unnecessary consumption of energy. The increase in energy consumption associated with any of the build alternatives is not expected to result in an inefficient, wasteful, or unnecessary consumption of energy. Mitigation of any impacts on energy is largely beyond the authority of STA, MTC, and the Department, and unimplementable on a project-specific basis. Because the build alternatives would not result in wasteful or excessive use of energy, avoidance, minimization, and mitigation measures would not be necessary.