ENERGY ANALYSIS TECHNICAL MEMO

INSTRUCTIONS:

1. Do not use this outline for complex and/or large-scale projects with potentially substantial energy impacts.
2. Please refer to the SER, Volume 1, Chapter 13, and the Energy Analysis Report Decision Tree to:
   * Determine the need for a separate Energy Analysis Report (or Technical Memo)
   * Determine whether the required assessment is QUALITATIVE or QUANTITATIVE
3. For Caltrans staff, use the current Caltrans Memorandum template and include the following information:
   * Address memo to the District Branch Chief of Environmental Analysis

Attention to: Project Generalist

From: Environmental Engineering Branch Chief and the Energy Analyst

* + Provide date
  + Provide project information in the “File” section of the memo:
    - EA Number
    - District-County-Route-Start postmiles (PM)/End PM
    - Project Nickname (e.g., SR 82 Roadway Rehabilitation)
  + Provide Subject: Energy Analysis Technical Memo

1. For Non-Caltrans preparers (i.e., consultants, local agencies), use a letter format and provide:
   * Information listed above
   * An approval signature line for Caltrans
2. Change the font color of the boilerplate language (shown in red) to black and remove examples (shown in purple) and instructions (shown in blue) when memo is finalized.

# INTRODUCTION

(NOTE: The following text is boilerplate language)

The National Environmental Policy Act (NEPA) (42 U.S. Code Part 4332) requires the identification of all potentially significant impacts on the environment, including impacts on energy resources. Guidance for evaluating energy impacts of transportation projects subject to NEPA is outlined in FHWA's Technical Advisory T 6640.8A (Technical Advisory). The Technical Advisory energy analysis requirement applies to projects for which an Environmental Impact Statement (EIS) is prepared. The Technical Advisory indicates that documentation should discuss energy requirements for construction and operation, and the overall conservation potential for each of the project alternatives. The relationship of the project alternatives to applicable state or regional energy plan should also be documented. Additional conservation measures, such as use of high-occupancy vehicle incentives and other measures to improve traffic flow should also be identified.

Other measures to improve energy efficiency in the transportation sector have been implemented at the federal level. In recent years, the United States Environmental Protection Agency (U.S. EPA) and the National Highway Traffic Safety Administration (NHTSA) issued Final Rules governing Corporate Average Fuel Economy (CAFE) standards and other improvements to fuel economy to new vehicles.

On December 28, 2018, the Governor's Office of Planning and Research and the California Natural Resources Agency updated the California Environmental Quality Act (CEQA) Guidelines to require that an environmental document include an analysis of a project's potential for significant environmental effects resulting from wasteful, inefficient, or unnecessary use of energy; or wasteful use of energy resources (Guidelines § 15126.2(b)). The Initial Study/Negative Declaration/Mitigated Negative Declaration (IS/ND/MND) or Environmental Impact Report shall describe feasible measures which could minimize inefficient and unnecessary consumption of energy (Guidelines § 15126.4) and examples of energy conservation measures are provided in the Guidelines Appendix F.

Assembly Bill (AB) 32 codified the 2020 greenhouse gas (GHG) emissions reduction goals outlined in Executive Order (EO) S-3-05. Senate Bill 32 codified the GHG reduction targets established in EO B-30-15 to achieve a mid-range goal of 40 percent below 1990 levels by 2030. The California Air Resources Board (ARB) is required to create a scoping plan and implement rules to achieve “real, quantifiable, cost-effective reductions of greenhouse gases.” The law requires ARB to adopt rules and regulations to achieve the maximum technologically feasible and cost-effective GHG reductions. Energy use and efficiency are important considerations for achieving state goals to reduce greenhouse gas emissions.

# PROJECT DESCRIPTION

Instruction:

Provide brief description of the project and the alternatives. (Do not provide a very detailed discussion since this will already be in other reports and in the environmental document).

Example:

The project proposes to rehabilitate the roadway and sidewalks, improve safety and visibility, remedy drainage issues and upgrade curb ramps to be ADA compliant along El Camino Real (State Route 82, PM 12.3/15.9) in the City of Burlingame, San Mateo County. The Build alternatives are listed below:

Alternative 1 - Roadway rehabilitation and infrastructure upgrade.

Alternative 2 - Roadway rehabilitation and infrastructure upgrade with underground utilities.

Instruction:

Provide brief discussion why analysis is required for the project.

Example of a non-capacity increasing and non-congestion relief project:

The proposed project is not expected to increase vehicle capacity, nor expected to result in substantial energy use, therefore a qualitative energy analysis will be used to comply with CEQA and will be included in the NEPA document. This technical memo will analyze energy use during construction (quantitative), during operation (qualitative) and maintenance (qualitative).

# AFFECTED ENVIRONMENT

Instruction:

This section should include a description of existing conditions in the project area that affect energy usage. For example, what are the existing traffic conditions? What mix of vehicles is currently using the facility (particularly if the project is expected to substantially change the vehicle mix)? Are there existing traffic management system (TMS) elements in place? What is the condition of the existing pavement surface? A poor driving surface can contribute to an increase in fuel consumption. Is there existing highway lighting and what type is it?

Example:

The project area is located within a relatively urbanized environment, and the surrounding landscape includes mixed residential and commercial development. State Route 82 is a signalized major thoroughfare that connects several downtown areas and communities in San Mateo County. There are various roadside advisory, warning and regulatory signs, light poles and luminaries along SR 82 within the project limits.

The Pavement Condition Survey for the project area has an overall condition rating of poor with moderate alligator cracking and very poor ride quality throughout. The current condition of the pavement contributes to higher energy consumption, i.e., shorter intervals between maintenance.

# STUDY METHODS

(NOTE: The following text is boilerplate language)

Activities that consume energy also contribute to other related impacts. Greenhouse gas emissions, for example, are linked to energy consumption. In transportation, carbon dioxide (CO2) is the primary GHG pollutant due to its abundance when compared with other vehicle emitted GHGs, including methane (CH4), nitrous oxide (N20), hydrofluorocarbon (HFC), and black carbon (BC).

Therefore, direct energy consumption can be quantified by using an approved version of the emissions modeling tool CT-EMFAC or EMFAC and construction energy consumption can be estimated using the Caltrans Construction Emission Tool (CAL-CET), or the CalEEMod emissions model. If energy consumption is not quantified in the emissions modeling tool used, gasoline and diesel consumption can be estimated from CO2 using U.S. EPA’s GHG equivalencies formulas for diesel and gasoline[[1]](#footnote-1).

Instruction:

Describe the modeling tools used to quantify energy consumption. Make sure to indicate which approved version of modeling tool was used as appropriate. Show estimates or data/information used in comparisons for qualitative analysis. Since construction GHG analysis is required for all projects, construction energy consumption may have already been quantified.

Example:

To assess gasoline and diesel consumed by construction equipment and vehicles, CAL-CET was used to estimate CO2 emissions of workers' vehicles and equipment. U.S. EPA’s GHG equivalencies formulas were used to convert CO2 to fuel volumes. This is shown in Table 1 below.

# ENVIRONMENTAL CONSEQUENCES

Instruction:

* This section presents the results of the energy analysis (of each Build alternative) and discloses potential energy effects. Results can be shown in gallons of fuel or kilowatt-hour of electricity, etc., or BTU.

BTU Conversions by Project Energy Type

|  |  |  |
| --- | --- | --- |
| Energy Type | Energy Unit | Equivalent BTU |
| Electricity | kWh | 3,412 |
| Gasoline | gallon | 120,214 |
| Diesel | gallon | 137,381 |

Source: EIA 2023c

* This section should also include any energy-saving or conservation measures specifically incorporated into the design of the project. Refer to CEQA Guidelines, Appendix F.
* This section should also discuss any avoidance, minimization, and/or mitigation measures. Control measures to reduce GHG are applicable unless control is carbon sequestration by vegetation.

## SHORT TERM (CONSTRUCTION) ANALYSIS

Example: A quantitative analysis is shown below:

**Table 1: Construction Equipment/Vehicles Fuel Consumption**

|  |  |  |
| --- | --- | --- |
| **ALL BUILD ALTERNATIVES** | **FUEL CONSUMPTION**  **DIESEL (gallons)** | **FUEL CONSUMPTION**  **GASOLINE (gallons)** |
| ANNUAL | 39,282.20 | 1,347.58 |
| PROJECT TOTAL | 117,846.60 | 4,042.74 |

Note: The project Build alternatives have the same activities with small differences in construction energy consumption.

The No Build Alternative will not involve construction and therefore will not result in construction energy consumption.

For the Build Alternative, there will be different phases in construction and energy use will be dependent on construction equipment being used per activity, but the average annual consumption will be approximately the same for the 3-year project span. From Table 1, for a construction duration of 36 months, the estimated total diesel consumption is 117,846.60 gallons and total gasoline consumption is 4,042.74 gallons.

Because construction activities are short-term, the increase of consumption within the project area will also be short-term. The use of construction best management practices will minimize energy consumption from construction activities, including but not limited to:

1. Limit idling of vehicles and equipment.
2. Using solar-powered equipment, if feasible (example - signal boards).
3. Use of tier 4 equipment.
4. Regular vehicle and equipment maintenance.
5. If feasible, recycle non-hazardous waste and excess materials to reduce disposal offsite.

In addition, with innovations such as longer pavement lives, improvement in traffic management, and changes in materials, energy consumption can be offset to some degree by longer intervals between maintenance and rehabilitation activities, and other project features discussed below.

## LONG TERM (OPERATIONS) ANALYSIS

Example 1: A project with no capacity increase nor congestion reduction, qualitative analysis is shown below: In this example, maintenance (indirect) is included in the discussion.

The project proposes to rehabilitate the roadway and will not increase capacity nor relieve congestion. As such, this project will not result in changes in traffic volumes, vehicle mix, or any other factor that would cause an increase in energy consumption of the project from that of the No-Build Alternative.

All the build alternatives have project features that can reduce energy consumption, namely:

1. Sidewalk (width, profile and cross slope), curb (ramp slope, landing and detectable warning surface) and crosswalk (profile and cross slope) will be corrected. Accessible pedestrian signals (APS) and timers will be installed. These features will promote pedestrian access.
2. Rehabilitation of pavement and improvement in traffic management will lengthen intervals between maintenance activities. Energy used on maintenance of SR 82 for both build alternatives will be lesser than the no-build alternative.

Example 2: A capacity increasing project and quantitative analysis is shown below:

To assess fuel consumed by construction equipment and vehicles, CT-EMFAC2017 was used to estimate fuel consumption. This is shown in Table 2 below.

**Table 2: Annual Fuel Consumption (Direct Energy)**

| **Scenario/ Analysis Year** | **Energy Consumption Gasoline**  **(gallons)** | **Energy Consumption Diesel**  **(gallons)** | **Energy Consumption Electricity**  **(kWh)** | **Energy Consumption XXX**  **(units)** | **Total Energy Consumption**  **(in 100,000 BTU)** | **Change from Base Year**  **(in 100,000 BTU)** | **Change from No Build**  **(in 100,000 BTU)** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Base Year 2017 |  |  |  |  |  |  |  |
| Opening Year 2025 |  |  |  |  |  |  |  |
| * No Build |  |  |  |  |  |  |  |
| * Alternative 1 |  |  |  |  |  |  |  |
| * Alternative 2 |  |  |  |  |  |  |  |
| Design Year 2045 |  |  |  |  |  |  |  |
| * No Build |  |  |  |  |  |  |  |
| * Alternative 1 |  |  |  |  |  |  |  |
| * Alternative 2 |  |  |  |  |  |  |  |

Note: Energy content of 120,214 BTU per gallon of gasoline, 137,381 BTU per gallon of diesel, and 3,412 BTU per kWh was used based on the conversion factors listed at: <https://www.eia.gov/energyexplained/units-and-calculators/british-thermal-units.php>, date accessed 01/29/24.

Instruction:

1. BTU conversion factors above are from <https://www.eia.gov/energyexplained/units-and-calculators/british-thermal-units.php> based on 2022 consumption. Refer to the link during energy analysis preparation and use the most current BTU conversion factors.
2. Results can be shown in gallons/kWh or BTU. Units like gallon or kWh are easily understood by the public during public review, however, converting to BTU makes comparisons easier. The table above converted gallons & kWh to BTU for ease of comparison.
3. If renewable energy (i.e., solar) will be used, include in the analyses. Use of renewable energy is a means to achieve energy conservation.

# CONCLUSIONS

Instruction:

Summarize the construction (short-term) and operations/maintenance (long-term) impacts. Do not provide discussion of significance determination. Summarize analyses results and conclusions reached.

These relevant conclusions will be used for NEPA and CEQA discussion in the environmental document.

1. <https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references> [↑](#footnote-ref-1)