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# 4.21 ENERGY

## INTRODUCTION

Energy is consumed by equipment during the construction of a roadway and is also consumed by vehicles using the roadway after construction is complete. Petroleum (fossil fuel) is the most common energy source used to power construction equipment as well as vehicles using the regional transportation system. This section analyzes the energy required to construct each of the build alternatives and the energy consumption associated with the regional transportation system in 2030. Energy consumption is measured in British Thermal Units (BTUs). The regional transportation system consists of passenger automobiles, trucks, and buses using the roadway network. The energy calculations are based on the regional travel demand model projections prepared by the DRCOG. No public concerns regarding energy were expressed through the public involvement process.

## 4.21.1 AFFECTED ENVIRONMENT

Greenhouse gas emissions from transportation sources are directly related to energy consumption and primarily result from the combustions of fossil fuels in vehicles. These emissions are normally presented as the total carbon dioxide ($CO_2$) equivalent released, and take into account the global warming potential of each chemical species emitted from a source. For example, combustion sources emit small amounts of nitrous oxide ($N_2O$), which has a global warming potential 310 times that of $CO_2$. Each ton of $N_2O$ emitted would be equivalent to 310 tons of $CO_2$. All greenhouse gas emissions presented in this section are presented as $CO_2$ equivalent.

## 4.21.2 ENVIRONMENTAL CONSEQUENCES

Energy would be consumed during the construction of any build alternative and the operation of the No Action Alternative and each of the build alternatives. The energy consumption and greenhouse gas emissions for the No Action Alternative and each of the build alternatives are evaluated and compared based on the following assumptions:

- The forecast year is 2030.
- Daily VMT data is estimated from the DRCOG regional travel demand model (see **Table 4.21-1**).
- The study area consists of the regional transportation network modeled for air quality and travel demand purposes.
- Regional energy consumption in BTUs is based on estimated changes in vehicle miles traveled per the Federal Transit Administration's (FTA) document, *Reporting Instructions for the Section 5309 New Starts Criteria* (New Starts Criteria (FTA, 2001)).
- The greenhouse gas emissions are calculated from the BTU estimates developed from the energy consumption estimate multiplied by standard tons of $CO_2$/million BTU conversion factors, provided in the FTA's *Reporting Instructions for the Section 5309 New Starts Criteria* (FTA, 2001).

*Table 4.21-1 2030 Daily VMT in the Northwest Corridor Study Area by Alternative*

| Alternative | Total Daily VMT (Auto, Truck, and Bus)* |
|---|---|
| No Action | 12,376,000 |
| Freeway Alternative | 13,152,000 |
| Tollway Alternative | 13,026,000 |
| Regional Arterial Alternative | 12,744,000 |
| Combined Alternative (Recommended Alternative) | 12,905,000 |

Note: *Daily VMT calculations for each category compiled by Felsburg, Holt & Ullevig.

*Source: Felsburg, Holt & Ullevig Traffic Forecasting, 2005 and 2006.*

### 4.21.2.1 CONSTRUCTION

The No Action Alternative would require minimal amounts of energy since upcoming construction would consist only of basic roadway maintenance.

All of the build alternatives would require energy for construction. The amount of energy is generally proportionate to the amount of highway construction included in the alternative. There is also a correlation between the absolute cost of an alternative and the amount of energy required for construction. The Freeway Alternative, Tollway Alternative, Regional Arterial Alternative, and Combined Alternative (Recommended Alternative) would require 1,909,898 BTUs, 1,814,231 BTUs, 1,436,429 BTUs, and 1,659,951 BTUs, respectively, for construction (see **Table 4.21-2**).

*Table 4.21-2 Energy Consumption for Construction*

| Alternative | Type of Construction | Lane Miles | Million BTUs per Lane Mile | BTUs Consumed |
|---|---|---|---|---|
| Freeway Alternative | Surface Roadway[1] | 94.05 | 13,885 | 1,305,884 |
| | Elevated Roadway[2] | 4.62 | 130,739 | 604,014 |
| | **Total Roadway** | **98.67** | **N/A** | **1,909,898** |
| Tollway Alternative | Surface Roadway[1] | 87.16 | 13,885 | 1,210,217 |
| | Elevated Roadway[2] | 4.62 | 130,739 | 604,014 |
| | **Total Roadway** | **91.78** | **N/A** | **1,814,231** |
| Regional Arterial Alternative | Surface Roadway[1] | 103.45 | 13,885 | 1,436,429 |
| | Elevated Roadway[2] | N/A | N/A | N/A |
| | **Total Roadway** | **103.45** | **N/A** | **1,436,429** |
| Combined Alternative (Recommended Alternative) | Surface Roadway[1] | 19.55 | 13,885 | 1,659,951 |
| | Elevated Roadway[2] | N/A | 130,739 | N/A |
| | **Total Roadway** | **19.55** | **N/A** | **1,659,951** |

Note: [1]Surface roadway = 13,885 million BTUs/lane mile.
[2]Elevated roadway = 130,739 million BTUs/lane mile.

*Source: FTA 2001.*

### 4.21.2.2 OPERATIONS

The No Action Alternative would induce less energy than all of the build alternatives. The build alternatives would all induce greater energy consumption than the No Action Alternative because of the added capacity on the roadway system resulting in a higher VMT. The Freeway Alternative would have the greatest increase in energy consumption, followed by the Tollway Alternative, Combined Alternative (Recommended Alternative), and Regional Arterial Alternative (see **Table 4.21-3)**. The same trends are found for $CO_2$ production with each of the build alternatives producing more $CO_2$ than the No Action Alternative. The Freeway Alternative would have the greatest increase in $CO_2$ production, followed by the Tollway Alternative, Combined Alternative (Recommended Alternative), and Regional Arterial Alternative. $CO_2$ production was estimated by multiplying the daily energy consumed by $CO_2$ conversion factors taken from the New Starts Criteria (FTA, 2001). The total regional daily VMT was assumed to be 92 percent automobiles, 4 percent heavy trucks, and 4 percent buses (see **Table 4.21-4**).

***Table 4.21-3 Energy Consumption by Alternative (Daily BTUs)***

| Alternative | BTUs Consumed (billion) | Difference from No Action (x 1,000,000) | Percent | Greater than No Action |
|---|---|---|---|---|
| No Action | 102.5 | N/A | N/A | N/A |
| Freeway Alternative | 108.9 | 6,427 | +5.9 | Yes |
| Tollway Alternative | 107.8 | 5,384 | +4.9 | Yes |
| Regional Arterial Alternative | 105.5 | 3,048 | +2.9 | Yes |
| Combined Alternative (Recommended Alternative) | 106.9 | 4,381 | +4.3 | Yes |

*Source:* *FTA 2001.*
*Felsburg, Holt & Ullevig Traffic Forecasting, 2005 and 2006.*

***Table 4.21-4 Daily $CO_2$ Production by Alternative***

| Alternative | $CO_2$ Produced (Tons)* | Difference from No Action | Percent | Greater than No Action |
|---|---|---|---|---|
| No Action | 7,914 | N/A | N/A | N/A |
| Freeway Alternative | 8,410 | 496 | +5.9 | Yes |
| Tollway Alternative | 8,329 | 415 | +4.9 | Yes |
| Regional Arterial Alternative | 8,149 | 235 | +2.9 | Yes |
| Combined Alternative (Recommended Alternative) | 8,252 | 338 | +4.3 | Yes |

Notes: C $O_2$ Conversion Factors
Passenger vehicle = 0.0765.
Heavy duty vehicle (trucks) = 0.0788.
Diesel buses = 0.0788.

*$CO_2$ Produced: All greenhouse gas emissions in the study area are presented as $CO_2$ equivalents.

*Source:* *FTA 2001.*

### 4.21.3 INDIRECT IMPACTS

Under the No Action Alternative and all build alternatives, the population in the study area is anticipated to increase over 30 percent. This increase would result in additional energy demands for construction of new homes, gasoline for automobiles, and natural gas and electricity for utilities. The additional energy demand is anticipated to be directly proportionate to the increase in population, as land development occurs.

### 4.21.4 SUGGESTED MITIGATION

This section presents proposed mitigation measures to address the impacts discussed in this section (see **Table 4.21-5**).

***Table 4.21-5 Proposed Mitigation Measures***

| Impact | Impact Type | Mitigation Measures for all Build Alternatives |
|---|---|---|
| Use of Energy Resources During Construction | Construction | The No Action Alternative and all of the build alternatives may affect environmental resources not regulated at the federal, state, or local levels. Such impacts could include the consumption of natural resources such as fossil fuels and raw materials like gravel. The alternative selected may also affect social resources like landfill capacity. In most cases, such impacts cannot be quantified and cannot be avoided entirely. It is recognized that these impacts should be minimized to the extent possible. Sustainable practices incorporated into the project planning, construction, and maintenance could minimize impacts. This may include such practices as: natural resource conservation, waste minimization, materials reuse, minimal use of native virgin materials, conservation and efficient use of water and energy, air pollution prevention, preference for "green" purchasing including recycled and minimally-processed items, and preference for locally-available resources. The incorporation of proven materials that are longer-lasting and require less maintenance is encouraged on projects when use of such materials is consistent with meeting the objective of providing a safe and efficient transportation system. Alternative materials and practices should meet the performance goals of construction specifications, demonstrate legitimate expenditure of public funds, and comply with all other applicable laws and regulations. |
| Increases in Daily VMT | Operations | Mitigation of energy consumption for the operation of the regional transportation system focuses on reduction in daily VMT, which can be achieved through the successful implementation of transit oriented development (TOD). Local land use and zoning incentives to improve the success of TOD would be the most effective mitigation. A commitment from local jurisdictions within the study area would be required to make TOD a priority. Wetlands and vegetation along the roadway could be beneficial in the sequestration of $CO_2$ produced by vehicles. Mitigation for wetland impacts and vegetation impacts are provided for this project (see **Section 4.9** and **4.11**) |

*Source: FTA 2001.*

## 4.21.5 SUMMARY

The added roadway capacity associated with all of the build alternatives would attract vehicles from other regions in the Denver metropolitan area, resulting in higher energy consumption within the study area. This could decrease energy consumption in surrounding regional areas.

The results of this analysis show that no build alternative would perform better than the No Action Alternative regarding energy consumption. The Regional Arterial Alternative would perform the best of the build alternatives regarding energy consumption and would consume 2.9 percent more energy than the No Action Alternative. The Combined Alternative (Recommended Alternative), the Tollway Alternative, and the Freeway Alternative would consume 4.3 percent, 4.9 percent, and 5.9 percent more energy than the No Action Alternative, respectively (see **Table 4.21-6**).

### *Table 4.21-6 Summary of Impacts by Alternative*

| Alternative | Daily Energy Consumption (BTUs consumed in billions) | Energy Consumption for Construction (BTUs) | Daily $CO_2$ Produced (Tons) |
|---|---|---|---|
| No Action Alternative | 102.5 | 0 | 7,914 |
| Freeway Alternative | 108.9 | 1,909,898 | 8,410 |
| Tollway Alternative | 107.8 | 1,814,231 | 8,329 |
| Regional Arterial Alternative | 105.5 | 1,436,429 | 8,149 |
| Combined Alternative (Recommended Alternative) | 106.9 | 1,659,951 | 8,252 |

*Source: FTA 2001.*
*Felsburg, Holt & Ullevig Traffic Forecasting, 2005 and 2006.*

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