4.19 ENERGY

Summary

Energy is consumed during the construction and operation of transportation projects. It is used during construction to manufacture materials, transport materials, and operate construction machinery. Energy used during project operation includes fuel consumed by vehicles using the project facilities, and a negligible amount of energy for signals, lighting, and maintenance. Fuel consumption depends on the vehicle miles traveled (VMT) and travel conditions, such as vehicle type, speed of travel, roadway grade, and pavement type. For any given vehicle, speed is the most important factor affecting energy consumption.

This section analyzes future corridor transportation system energy consumption for 2035, measured in British thermal units (Btu), and future greenhouse gas emissions, measured by carbon dioxide (CO_2) production. The section also analyzes energy that would be required to construct the build packages. The corridor transportation system consists of passenger automobiles, trucks, and buses, and in the Denver Segment, existing light rail transit (LRT) facilities. The energy calculations and greenhouse gas emission estimates are based on the regional travel demand model projections prepared by the Denver Regional Council of Governments (DRCOG). This section does not measure the energy used by or the greenhouse gas emissions resulting from manufacturing and maintenance activities for transportation facilities.

The results of the local United States Highway 36 (US 36) corridor analysis show that Package 1 would result in the least energy consumption of any of the packages evaluated. Packages 2 and 4 and the Combined Alternative Package (Preferred Alternative) would consume 3.2, 4.5, and 3.5 percent more energy, respectively, than Package 1, due to increases in VMT under the build packages.

The regional analysis of energy consumption and greenhouse gas emissions shows minor increases (up to 0.7 percent) in regional energy usage and greenhouse gases for all three build packages over Package 1, due to slight increases in VMT under the build packages.

Affected Environment

All Segments

Energy sources for transportation are most commonly petroleum fuels for automobiles and trucks and electricity for light rail. Currently, approximately 90 percent of Regional Transportation District (RTD) buses operate on diesel fuel, and 10 percent operate on compressed natural gas. None of the buses operating on US 36 under the build packages being considered in this Final Environmental Impact Statement would use electric power.

Greenhouse gas emissions from transportation sources are directly related to energy consumption and primarily result from the combustion of fossil fuels in vehicle engines. Indirect greenhouse gas emissions resulting from electricity production may also be substantial depending on the mode of transportation considered. To reduce greenhouse gas emissions from transportation sources, effective planning must incorporate modes of transport that use less energy per person per mile traveled or that use energy derived from fuels that have a low carbon content per unit of energy. For example, changing bus fleets from diesel to natural gas can reduce greenhouse gas emissions through the use of a low carbon-intensity fuel. Increasing regional transit ridership can further reduce emissions because transit uses less energy per person per mile traveled than single-occupancy vehicles.

Greenhouse gas emissions are normally presented as the total CO_2 equivalent released, and they take into account the global warming potential of all of the sources of greenhouse gas emissions. For example, combustion sources emit small amounts of nitrous oxide (N_2O), which have a global warming potential 310 times that of CO_2. In terms of CO_2 equivalent, each ton of N_2O emitted would be equivalent to 310 tons of CO_2. All greenhouse gas emissions presented in this study are presented as CO_2 equivalent.

Impact Evaluation

Methodology

This section evaluates the differences in energy consumption and greenhouse gas emissions between Package 1 and each of the build packages, based on the following assumptions:

- The forecast year is the “horizon” year of the long-range planning period, in this case, 2035.
- VMT data are estimated in the DRCOG regional travel demand model and from bus and bus rapid transit (BRT) operating plans within the US 36 corridor.
- The project area consists of the corridor transportation network modeled for air quality and travel demand purposes.
- Energy consumption in Btu(s) is based on estimated changes in VMT as reported in the *Reporting Instructions for the Section 5309 New Starts Criteria* (FTA 2006).
- The greenhouse gas emissions are calculated from the Btu estimates developed for the energy consumption estimate multiplied by standard tons of CO_2/million Btu conversion template, provided in the *Reporting Instructions for the Section 5309 New Starts Criteria* (FTA 2006).

Energy Consumption

The corridor VMT was separated into passenger miles, heavy truck miles, bus miles, and rail miles to account for differences in energy consumption levels.

The Btu(s) consumed by each category of VMT are taken from the Federal Transit Administration (FTA) New Starts program standardized evaluation criteria as follows:

- One passenger vehicle mile = 6,233 Btu(s)
- One heavy-duty vehicle (truck) mile = 22,046 Btu(s)
- One diesel bus mile = 41,655 Btu(s)
- One commuter rail/diesel mile = 95,000 Btu(s)

Table 4.19-1, Daily Vehicle Miles Traveled in the US 36 Corridor (Year 2035), presents the estimated daily VMT by package during the horizon year of 2035. These numbers are multiplied by the Btu consumption factors to estimate energy usage.

Table 4.19-1: Daily Vehicle Miles Traveled in the US 36 Corridor (Year 2035)

Package	Automobile VMT	Truck VMT	Bus VMT	Rail VMT	Total VMT (automobile, truck, bus, and rail)
1	17,314,200	849,900	48,000	3,500	18,215,600
2	17,747,200	875,300	70,400	3,300	18,926,500
4	17,961,400	893,000	68,800	3,300	18,926,500
Combined Alternative Package (Preferred Alternative)	17,823,900	886,600	59,200	3,500	18,217,800

Source: US 36 Mobility Partnership, 2009.

Notes:

Package 2 and Package 4 values have been adjusted to reflect 2035 conditions to provide a direct comparison with Package 1 and the Combined Alternative Package (Preferred Alternative).

N/A = not applicable

VMT = vehicle miles traveled

Greenhouse Gas

CO_2 production, used as a surrogate for greenhouse gas emissions in this analysis, was analyzed on a regional level to estimate greenhouse gas emissions that would occur within the nine-county DRCOG region during the horizon year of 2035. Greenhouse gas emissions were calculated by multiplying the daily regional energy use by the CO_2 conversion factors taken from the FTA New Starts criteria. The conversion factors include:

- Passenger vehicle = 0.0765
- Heavy-duty vehicle (truck) = 0.0788
- Diesel bus = 0.0788
- Commuter rail = 0.0788

These conversion factors are based on existing average greenhouse gas emissions by vehicle type; emissions are expected to decrease in the future due to advancements in vehicle and fuel technology and more stringent emission restrictions. Although approximately 10 percent of RTD's current bus fleet operates on compressed natural gas, which emits fewer greenhouse gases, the analysis used the diesel bus conversion factor for all bus miles traveled.

Comparison of All Packages

Direct Impacts

All Segments

Estimated corridor and regional daily energy consumption are presented in Table 4.19-2, US 36 Corridor Energy Consumption per Day (Year 2035), and Table 4.19-3, Regional Energy Consumption per Day (Year 2035), for Package 1 and each of the build packages.

Table 4.19-2: US 36 Corridor Energy Consumption per Day (Year 2035)

Package	Millions of Btu(s) Consumed per Day	Difference from Package 1 (millions of Btu[s] per day)	Percent Difference	Greater than Package 1?
1	128,989	N/A	N/A	N/A
2	133,16 1	+4,171	+3.2	Yes
4	134,821	+5,831	+4.5	Yes
Combined Alternative Package (Preferred Alternative)	133,440	+4,450	+3.5	Yes

Source: US 36 Mobility Partnership, 2009.
Notes:
+ = plus
Btu = British thermal unit
N/A = not applicable

Table 4.19-3: Regional Energy Consumption per Day (Year 2035)

Package	Millions of Btu(s) Consumed[1] per Day	Difference from Package 1 (millions of Btu[s] per day)	Percent Difference	Greater than Package 1?
1	814,658	N/A	N/A	N/A
2	817,021	+2,363	+0.3	Yes
4	820,598	+5,939	+0.7	Yes
Combined Alternative Package (Preferred Alternative)	818,216	+3,557	+0.4	Yes

Source: US 36 Mobility Partnership, 2009.
Notes:
[1] Totals do not include British thermal units consumed by buses.
+ = plus
Btu = British thermal unit
N/A = not applicable

As shown in Table 4.19-2, US 36 Corridor Energy Consumption per Day (Year 2035), Package 1 would require less energy to operate than any of the build packages. Package 2 and Package 4 and the Combined Alternative Package (Preferred Alternative) would require approximately 3.2, 4.5, and 3.5 percent more energy, respectively, to operate than Package 1. The increased energy use would be due to increases in automobile, truck, and bus VMT under the build packages.

The regional energy analysis, summarized in Table 4.19-3, Regional Energy Consumption per Day (Year 2035), estimates that Package 1 would require 0.3 to 0.7 percent less energy to operate than any of the build packages. The regional increase in energy consumption would result from increases in automobile, truck, and bus VMT under the build packages.

Regional greenhouse gas emissions for Package 2 and Package 4 and the Combined Alternative Package (Preferred Alternative) would increase over Package 1 by 0.3, 0.7, and 0.4 percent, respectively. Other regional projects that are identified in the DRCOG long-range plan (such as FasTracks and other major roadway improvements) are already accounted for in the analysis, as part of Package 1. The emission factors used in the analysis reflect existing average greenhouse gas emissions by vehicle type, and these emissions are expected to decrease in the future due to the addition of newer vehicles with tighter emission controls, cleaner fuels, and more stringent emission restrictions. In addition, RTD has committed to using the cleanest fuels that are reasonable, available, and practical in order to reduce all greenhouse gases. Therefore, the estimated 0.7 percent increase in greenhouse gas emissions represents a worst-case scenario, using future VMT (which is slightly higher than today) with existing greenhouse gas emission factors (which are currently higher than projected in the future). See Table 4.19-4, Regional Carbon Dioxide Production (Year 2035).

Table 4.19-4: Regional Carbon Dioxide Production (Year 2035)

Package	CO_2 Produced (tons per day)	Difference from Package 1 (No Action) (tons per day)	Percent Difference	Greater than Package 1 (No Action)
1	62,547	N/A	N/A	N/A
2	62,730	183	0.3	Yes
4	63,006	459	0.7	Yes
Combined Alternative Package (Preferred Alternative)	62,822	275	0.4	Yes

Source: US 36 Mobility Partnership, 2009.
Notes:
CO_2 = carbon dioxide
N/A = not applicable

Construction

Package 1 would require energy for construction of transit stations and other planned improvements associated with the Northwest Rail Corridor Project.

All of the build packages would require energy for construction. The amount of energy is generally proportionate to the amount of highway construction included in the package. There is also a correlation between the absolute cost of a package and the amount of energy required for construction. As shown in Table 4.19-5, Energy Consumption for Construction, would require approximately 6,590,990 million, 6,623,627 million, and 5,820,826 million Btu(s), respectively. The Combined Alternative Package (Preferred Alternative) would require less energy to construct because it would construct fewer lanes than Package 2 and Package 4 in most locations in the corridor.

Table 4.19-5: Energy Consumption for Construction

Package	Type of Construction	Lane Miles	Millions of Btu(s) per Lane Mile	Millions of Btu(s) Consumed
2	Surface Roadway	389	13,885	5,401,265
	Elevated Roadway	9.1	130,739	1,189,725
			Total	6,590,990
4	Surface Roadway	397	13,885	5,512,345
	Elevated Roadway	8.5	130,739	1,111,282
			Total	6,623,627
Combined Alternative Package (Preferred Alternative)	Surface Roadway	326	13,885	4,526,510
	Elevated Roadway	9.9	130,739	1,294,316
			Total	5,820,826

Source: US 36 Mobility Partnership, 2009.
Note:
Btu = British thermal unit

Indirect Impacts

All Segments

The expected population increase from 2005 to 2035 in the project area under Package 1 would result in additional demand for energy, construction of new homes, gasoline for automobiles, and natural gas and electricity for utilities. The amount of new energy consumption is anticipated to be directly proportionate to new population, just as land can be expected to develop comparably to past trends.

The energy requirements to serve the population increase referred to above under Package 1 would be the same with each of the build packages as well, with the exception that land uses may intensify around a couple of the BRT stations. The effect of the transit supportive development could result in slightly less energy demand with increases in transit and smaller residences and private yards.

Mitigation

All packages may affect environmental resources not regulated at the federal, state, or local levels. Such impacts can include the consumption of natural resources such as fossil fuels and raw materials like gravel. The type of package selected may also affect social resources such as landfill capacity. In most cases, such impacts cannot be quantified and cannot be avoided entirely. These impacts should be minimized to the extent practicable.

As part of its environmental ethic and policy, CDOT encourages its staff, consultants, and contractors to identify opportunities and methods to reduce the impact of projects and programs on environmental resources. This encouragement includes a commitment to allow innovative programs and flexibility in project planning, construction, and maintenance for the use of sustainable processes and materials. This may include such concepts 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.

CDOT encourages the identification and incorporation of proven materials that are longer-lasting and require less maintenance when use of such materials is consistent with CDOT's ability to meet its primary obligations of providing a safe and efficient transportation system. Alternative materials and practices can and must meet the performance goals of CDOT construction specifications, demonstrate legitimate expenditure of public funds, and comply with all other applicable laws and regulations.

Table 4.19-6, Mitigation Measures — Energy, presents proposed mitigation measures for energy resources consumption.

Table 4.19-6: Mitigation Measures — Energy

Impact	Impact Type	Mitigation Measures
Increases in bus VMT	Operations	• RTD's policy on sustainability will be implemented.
Use of energy resources during construction	Construction	• CDOT and RTD sustainable practices will be incorporated into the project planning, construction, and maintenance to minimize impacts.

Source: US 36 Mobility Partnership, 2006.
Notes:
CDOT = Colorado Department of Transportation
RTD = Regional Transportation District
VMT = vehicle miles traveled