3.17 ENERGY

During the construction and operation of any transportation system or project, energy is consumed for uses ranging from petroleum consumption for heavy equipment to electricity for street lights. Energy is used during construction to manufacture and transport materials and to operate construction machinery. Energy is used during project operation in the form of fuel consumed by vehicles using the transportation facilities and a small amount of electrical energy for signals, lighting, and maintenance. Vehicle fuel consumption depends on the vehicle miles traveled (VMT) and travel conditions, including vehicle type, speed of travel, roadway grade, and pavement type. For any given vehicle, speed is the most important factor affecting fuel consumption.

This section analyzes future corridor transportation system energy consumption, measured in British thermal units (Btu), and energy that would be required to construct the Build Alternatives. The energy-consuming regional and corridor transportation system consists of passenger automobiles, trucks, and buses. The energy calculations are based on the regional travel demand model projections prepared by the Pueblo Area Council of Governments for 2035 (PACOG, 2008). This section does not measure the energy used by manufacturing and maintenance activities for transportation facilities. Potential changes to future greenhouse gas emissions are discussed in **Section 3.23 Cumulative Impacts**.

3.17.1 Affected Environment

3.17.1.1 Assumptions

Energy sources for transportation in the Pueblo region are primarily petroleum fuels for automobiles, trucks, and buses. Estimates of VMT were determined from the travel demand modeling (PACOG, 2008) to represent regional conditions and from the traffic operational analysis for corridor conditions (CH2M HILL, 2005a; 2011b). Due to the modest amount of VMT occurring via buses and the fact that transit services are the same for all of the alternatives, representative bus VMT was assumed (less than one-tenth of 1 percent of total VMT). Existing regional truck percentages (3.5 percent of total traffic) and average corridor truck percentages (7 percent of total traffic) were applied to total VMT to represent truck VMT. Energy consumed during construction was estimated based on the amount of road lane miles constructed on grade and on structure.

3.17.1.2 Methodology

Energy consumption for the No Action Alternative and Build Alternatives was estimated by determining and comparing the energy consumed during construction and daily operation of each alternative using criteria developed by the U.S. Department of Energy Oak Ridge National Laboratory (Davis and McFarlin, 1993). The regional and corridor VMT estimates were separated into automobile miles, heavy truck miles, and bus miles. The energy consumed during operation for each motorized mode was calculated based on the following criteria:

- ❖ 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)

The amount of energy required to construct one lane mile of roadway on bridge structure (elevated) is nearly ten times greater than for one lane mile of roadway constructed at grade. The energy consumed during construction for each alternative was based on the following criteria:

- ❖ One surface road lane mile = 13,885 million Btu(s)
- ❖ One elevated road lane mile(bridge or structure) = 130,739 million Btu(s)

3.17.2 Environmental Consequences

In the construction and operation of any transportation system, energy is consumed for uses ranging from petroleum consumption for heavy equipment to electricity for street lights. All of the alternatives have the potential to affect environmental resources not regulated at the federal, state, or local levels, including energy use. Such impacts can include the consumption of natural resources such as fossil fuels and raw materials like gravel.

Energy consumption for the Build Alternatives is dependent on the VMT, construction of the roadway, and operation of the roadway. **Exhibit 3.17-1** presents VMT within the I-25 corridor during the PM peak hour. The PM peak hour was determined to be most representative of peak-hour corridor conditions and has been used throughout the resource evaluation. **Exhibit 3.17-2** presents the estimated daily VMT by alternative for the 2035 planning year in the entire Pueblo region.

For the Existing I-25 Alternative and the Modified I-25 Alternative (Preferred Alternative), PM peak-hour corridor VMT (and consequently energy use) would be higher than for the No Action Alternative; however, on a daily basis, the difference in transportation energy use between all the alternatives would be negligible. The Modified I-25 Alternative (Preferred Alternative) would require 15.5 percent more energy to construct (295,000 million more Btu[s]) than the Existing I-25 Alternative due to the higher total lane miles and elevated structure lane miles.

Applying the per-mile estimates for energy use by mode, **Exhibit 3.17-3** presents the total energy use for VMT within the I-25 corridor during the PM peak hour. **Exhibit 3.17-4** presents the estimated daily Btu(s) by alternative for the 2035 planning year in the entire Pueblo region.

Recognizing that energy has already been expended to construct and modify the existing corridor and that energy would continue to be expended for maintenance, the existing condition serves as a baseline to represent the No Action Alternative.

The Existing I-25 Alternative would include construction of both surface and elevated roadways. The total at-grade lane miles would be approximately 73.68, which includes mainline I-25 (40.53 lane miles), ramps (11.01 lane miles), and local roads (22.14 lane miles). The Existing I-25 Alternative would also include 6.70 lane miles of elevated roadway (structure), for a total of 80.38 lane miles.

The Modified I-25 Alternative (Preferred Alternative) would include construction of both surface and elevated roadways. The total at-grade lane miles would be approximately 82.12, which includes mainline I-25 (40.80 lane miles), ramps (9.84 lane miles), and local roads (31.48 lane miles). The Modified I-25 Alternative (Preferred Alternative) would also include 8.06 lane miles of elevated roadway (structure). With 90.18 total lane miles, the Modified I-25 Alternative (Preferred Alternative) would have 9.8 more lane miles than the Existing I-25 Alternative (80.38 total lane miles).

Impacts of the alternatives on energy use are described in detail by alternative in the following subsections.

EXHIBIT 3.17-1
2035 Daily Vehicle Miles Traveled in the I-25 Corridor

Alternative	Automobile VMT	Truck VMT	Bus VMT	Total VMT
No Action Alternative	681,100	2,400	300	683,800
Existing I-25 Alternative	715,100	2,500	300	717,900
Modified I-25 Alternative (Preferred Alternative)	736,500	2,600	300	739,400

Source: CH2M HILL, 2005a; 2010h; 2011b.

I-25 = Interstate 25 VMT = vehicle miles traveled

EXHIBIT 3.17-2
2035 Daily Vehicle Miles Traveled in the Pueblo Area Council of Governments Planning Region

Alternative	Automobile VMT	Truck VMT	Bus VMT	Total VMT
No Action Alternative	4,167,800	14,600	2,100	4,184,500
Existing I-25 Alternative	4,165,100	14,600	2,100	4,181,800
Modified I-25 Alternative (Preferred Alternative)	4,170,200	14,700	2,100	4,187,000

Source: CH2M HILL, 2005a; 2010h; 2011b.

I-25 = Interstate 25 VMT = vehicle miles traveled

EXHIBIT 3.17-3
Peak-Hour Transportation Energy Consumption in the I-25 Corridor (PM Peak)

Alternative	Millions of Btu(s) Consumed
No Action Alternative	4,312
Existing I-25 Alternative	4,526
Modified I-25 Alternative (Preferred Alternative)	4,662

Source: Davis and McFarlin, 1993.
Btu = British thermal unit I-25 = Interstate 25 NA = not applicable

EXHIBIT 3.17-4
Daily Transportation Energy Consumption in the Pueblo Area Council of Governments Planning Region

Alternative	Millions of Btu(s) Consumed
No Action Alternative	26,387
Existing I-25 Alternative	26,370
Modified I-25 Alternative (Preferred Alternative)	26,402

Source: Davis and McFarlin, 1993.
Btu = British thermal unit I-25 = Interstate 25 NA = not applicable

3.17.2.1 No Action Alternative

Under the No Action Alternative, energy would continue to be expended for automobile, truck, and bus transportation. Energy has already been expended to construct and modify the existing I-25 corridor and would continue to be expended for maintenance.

3.17.2.2 Build Alternatives

Existing I-25 Alternative

The Existing I-25 Alternative would result in similar daily regional VMT and resulting energy use as the No Action Alternative and slightly higher PM peak-hour VMT and energy consumption in the corridor. The peak-hour energy used in the corridor would be less than for the Modified I-25 Alternative (Preferred Alternative), but still 5 percent higher than for the No Action Alternative. This may be partially explained by the increased mobility in the corridor due to the additional east-west connectivity, but not as much mobility as the Modified I-25 Alternative (Preferred Alternative), which would also have improved north-south routes.

The Existing I-25 Alternative would have less total lane miles, less at-grade lane miles, and less lane miles on structure than the Modified I-25 Alternative (Preferred Alternative). The 80.38 total lane miles would require 1,899,000 million Btu(s) to construct.

Modified I-25 Alternative (Preferred Alternative)

On a daily basis, the expected regional VMT and resulting energy consumption of the Modified I-25 Alternative (Preferred Alternative) would be similar to the No Action Alternative. The higher PM peak-hour VMT and energy consumption suggest that, while there is considerable variability on a segment-by-segment basis, more vehicles would utilize the corridor in the PM peak hour under the Modified I-25 Alternative (Preferred Alternative) than under the No Action Alternative. This may be explained by the reduction in peak-hour congestion resulting from the increase in corridor capacity and improved mobility provided by the additional east-west and north-south routes.

The Modified I-25 Alternative (Preferred Alternative) would have 9.8 more total lane miles and 1.36 more elevated lane miles than the Existing I-25 Alternative, and would require 2,194,000 million Btu(s) to construct. Based on these estimates, the amount of energy used during the construction of new road lane miles on grade and on structure for each of the Build Alternatives was determined and is presented in **Exhibit 3.17-5**.

EXHIBIT 3.17-5
Energy Consumption for the Construction of the Build Alternatives

Alternative	Type of Construction	Lane Miles	Millions of Btu(s) per lane mile	Millions of Btu(s) Consumed
No Action Alternative	At grade (Surface) Elevated (Structure) Total	NA NA NA	NA NA NA	0 0 0
Existing I-25 Alternative	At grade (Surface) Elevated (Structure) Total	73.68 6.70 80.38	13,885 130,739 NA	1,023,000 876,000 1,899,000
Modified I-25 Alternative (Preferred Alternative)	At grade (Surface) Elevated (Structure) Total	82.12 8.06 90.18	13,885 130,739 NA	1,140,200 1,053,800 2,194,000

Source: Davis and McFarlin, 1993.
Btu = British thermal unit I-25 = Interstate 25 NA = not applicable

3.17.3 Mitigation

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.

To the extent practicable, CDOT will implement sustainability practices into the project planning, construction, and maintenance to minimize impacts and reduce energy use.