5.11 Energy

This section defines energy and explains why it is important to the project. It analyzes the energy consumption by the project alternatives within the study area, both during construction of the highway and during operation of the highway, and proposes mitigation measures to offset any potential adverse effects.

Since the Supplemental Draft EIS was published in August 2014, additional analyses and content review have been performed for many of the resources discussed in this document. These updates, along with changes resulting from the comments received on the Supplemental Draft EIS, have been incorporated into this Final EIS. In this section, the updates include the following items:

- The study area for Energy matches the study area for Air Quality because the analysis is closely related. Since the Air Quality study area changed, the Energy study area was revised to match.
- The construction energy consumption factor was revised to reflect 2015 dollars.
- Construction costs were updated to reflect the cost of the revised alternatives.
- The operational energy factors were updated based on the new Air Quality analysis.

5.11.1 What is energy and why is it important to this project?

There are two types of energy consumption which are measured in British thermal units (Btu): operational energy and construction energy. A single Btu is approximately equal to the energy output from burning one wooden match, and one million Btu equals about 8 gallons of vehicle gasoline. In terms of the energy consumption from a single vehicle or even the daily capacity of vehicles traveling on a highway, in this case I-70, one individual Btu is insignificant. In 2008, the United States used a total of more than 99 quadrillion Btu of energy (Environment and Ecology, 2015).

During the construction of the project, energy will be expended through the use of liquid or gaseous fuels, petroleum products, and electricity to operate machinery, transport materials, mix and pour concrete, and perform many other work tasks. On a highway such as I-70, large amounts of energy are consumed every day through the

Construction Energy

Energy used during construction of the proposed project, including manufacturing of materials, operation and servicing of equipment, and other construction tasks.

Operational Energy

Energy consumed during the operation of the vehicle mix using the existing (2010) and newly constructed roadway (2035) system.

operation of the highway facilities and the operation of the many vehicles using the corridor.

Energy impacts are important to this project because energy is closely related to air quality and greenhouse gases. It should be considered throughout the planning, design, development, construction, and use of a transportation project such as I-70 East.

5.11.2 What study area and methodology were used to analyze energy impacts?

The study area used for evaluating operational energy consumption is based on the air quality study area. It is a large geographic area that encompasses the corridor, surrounding neighborhoods, and localized hotspot areas that are focused on an intersection or interchange. The study area is based on the air quality study area because the analysis is closely related. Fuel consumption to create energy in turn creates emissions that affect the quality of air. Using the larger area provides a better understanding of traffic flow to and from the project corridor and vehicle mix using the highway from the surrounding areas.

Construction energy consumption is calculated from the construction costs of each alternative because construction activities will be confined to the construction limits along the corridor.

Exhibit 5.11-1 shows two elements: the study area for calculating estimated operational energy consumption, and the combined construction limits of the evaluated alternatives for calculating construction energy expenditure.

Energy consumption is calculated for the construction period and during the highway operation design year of 2035. Energy consumption during construction includes manufacturing and movement of construction materials, operation and servicing of equipment, and many other construction-related work tasks.

Energy consumption rates developed by the California Department of Transportation in their Energy and Transportation Systems report (Caltrans, 1983) were applied in this analysis. This report, although dated, is widely used in estimating energy consumed during the construction of highway facilities. It correlates energy consumption during construction with the project cost in 1977 dollars.

Exhibit 5.11-1 Study Area for Energy Resources

Using the construction energy consumption rate for an urban freeway and adjusting from 1977 to 2015 dollars using the Consumer Price Index Inflation Calculator from the U.S. Department of Labor, Bureau of Labor Statistics, yields a figure of approximately 6,997 Btu consumed for every $1 of construction cost (in 2015 dollars). This energy consumption rate is multiplied by the construction cost estimate for each of the project alternatives to arrive at the estimates of energy consumed during construction.

Operational energy consumption is calculated by multiplying VMT from the DRCOG Compass model by an energy consumption factor from EPA's MOVES model. The MOVES model inputs include, but are not limited to, fuel specifications, vehicle inspection/maintenance program parameters, fleet characteristics, and meteorological data. This is done for every roadway segment in the study area based on traffic volume, congested speed, vehicle type (mix), and fuel type (i.e., gas, diesel). The energy consumption values then are summed across all roads in the study area to obtain an alternative's total operational energy value in joules per day. The joules were converted to Btu for consistency across the study.

Congested Speed Variable

Because average vehicle speeds change by time period and fuel consumption rates vary by speed, the addition of the congested speed variable in the analysis allows for a more meaningful comparison of energy consumption among alternatives.

5.11.3 What are the existing conditions for energy consumption?

The year 2010 is defined as the base year for existing conditions because the VMT and speed data are available from the DRCOG Compass model for that year.

In the Denver metropolitan area, the primary sources of energy are hydrocarbons, including petroleum (gasoline/diesel), natural gas, and electricity. Automobiles, commercial trucks, buses, and rail vehicles are the major ground transportation energy consumers. Energy also is consumed for the construction and maintenance of transportation facilities.

I-70 currently operates as a six-lane freeway, so there is a considerable amount of energy consumed from the operation of vehicles along the corridor. The existing operational conditions can be characterized as heavy traffic congestion in the peak periods compounded by an outdated geometric design and aging structure and pavement.

The existing operational energy consumption in the study area was estimated by using the outputs from the DRCOG Compass model (2010) and the MOVES consumption factors. The models produce an output in total joules consumed per day. The total joules were converted to daily Btu, for a total of 53.3 billion Btu consumed per day.

5.11.4 How do the project alternatives potentially affect energy consumption?

The energy consumed during construction and operation will differ among each of the alternatives in the 2035 project analysis year. This subsection presents the energy estimates for construction and operation for each of the alternatives.

Energy consumed during construction

Construction energy consumption is affected by the varying efforts to build any of the alternatives, including ease of construction, length of construction, and materials used during construction. In this manner, construction energy is closely connected with the estimated construction cost (excluding engineering, design, and right-of-way costs) of each alternative discussed in the methodology section.

Exhibit 5.11-2 details construction costs and energy consumption during construction for each project alternative, based on the present consumer pricing index. The No-Action Alternative yields a lower estimated energy consumption because of the comparatively low construction cost. Each build alternative will consume energy in the range of 6,018 billion to 7,698 billion Btu over the course of construction. The Revised Viaduct Alternative is estimated to consume approximately one billion Btu less than the Partial Cover Lowered Alternative. In terms of energy consumption over the course of the projected five-year construction term, this is not a substantial difference.

Exhibit 5.11-2 Construction Costs and Energy Consumption During Construction

Alternative/Option	General-Purpose Lanes Option		Managed Lanes Option	
	Construction Cost (millions of 2015 dollars)	Energy Consumption (Btu in billions)	Construction Cost (millions of 2015 dollars)	Energy Consumption (Btu in billions)
No-Action Alternative	$340	2,380	N/A	—
Revised Viaduct Alternative	$860	6,018	$950	6,648
Partial Cover Lowered Alternative	$1,010	7,068	$1,100	7,698

Calculations based on $1 spent on construction = 6,997 Btu (2015 Consumer Pricing Index)
Note: Construction costs do not include right of way, engineering, or design.

Energy consumed during operation

Each alternative influences operational energy consumption by its ability to relieve traffic congestion. Generally, higher operational speeds—or less traffic congestion—equates to less energy consumed on a per vehicle-mile basis.

Exhibit 5.11-3 presents the energy consumption estimates for on-road vehicles in the study area. The 2010 existing conditions estimate is included for reference.

Exhibit 5.11-3 Operational Energy Consumption Per Day (2035)

Alternative / Option	Energy Consumption (billion Btu per day)
Existing Conditions (2010)	53.3
No-Action	68.0
Revised Viaduct, General-Purpose Lanes Option	70.9
Revised Viaduct, Managed Lanes Option	70.4
Partial Cover Lowered, General-Purpose Lanes Option	71.3
Partial Cover Lowered, Managed Lanes Option	70.0

Based on **Exhibit 5.11-3**, the estimated daily operational energy consumption for the current corridor is expected to increase by approximately 14.7 billion Btu daily from 2010 to 2035. Although transportation trends show that fuel efficiencies are improving, the estimates are heavily influenced by the anticipated increase in demand along the corridor through the study year 2035.

The model estimates that each alternative will expend similar amounts of energy within a range of 3.3 billion Btu per day. In terms of energy consumption, the range between alternatives is relatively low. This includes the No-Action Alternative, which has slightly lower operational energy consumption as compared to the other build alternatives because the alternative proposes fewer lanes.

The data show that the managed lanes option will have slightly less energy expenditure than with general-purpose lanes. The managed lanes option has the potential to increase carpooling through benefits to motorists traveling with multiple passengers. Additionally, the option will attract motorists to use the managed lanes, removing congestion from the general-purpose lanes. The increased flow is projected to lead to lower energy consumption.

5.11.5 How are the negative effects from the project alternatives mitigated for energy?

Construction contracts are a primary tool for implementing CDOT's commitment to environmental stewardship. CDOT's *Environmental Stewardship Guide* (CDOT, 2003) explains and documents CDOT's environmental ethic and the policies and procedures CDOT uses in carrying out that ethic. CDOT commits to work with designers, contractors, and suppliers to implement environmental sustainability policies as infrastructure is designed and constructed. Where appropriate, energy conservation measures in accordance with CDOT's *Lighting Design Guide* (CDOT, 2006)—including energy-efficient electrical systems, lighting, and mechanical equipment—will be implemented.

The Partial Cover Lowered Alternative will have additional operational consumption from the usage of ventilation fans, lighting, and other various amenities for the proposed cover. Energy-efficient options for these facilities will be explored to provide mitigation for the additional energy consumed.

In addition, to minimize the use of energy during the construction period, the following mitigation measures will be used during construction:

- Limit idling of construction equipment
- Encourage employee carpooling and vanpooling for construction workers
- Encourage use of closest material sources
- Locate construction staging areas close to work sites, while situating them as far away as possible from residential uses
- Encourage use of cleaner and more fuel-efficient construction vehicles (for example, low sulfur fuel, biodiesel, or hybrid technologies)
- Encourage use of alternative fuels and asphalt binders
- Implement traffic management schemes that minimize delays and idling

Exhibit 5.11-4 lists the impacts and mitigations associated with energy.

Exhibit 5.11-4 Summary of Energy Impacts and Mitigations

Alternative/Option	Impacts and/or Benefits	Mitigation Measures Applicable to All Alternatives
No-Action Alternative	• 68 billion Btu consumed per day • 2,380 billion Btu consumed during construction	• Limit idling of construction equipment • Encourage employee carpooling and vanpooling for construction workers • Encourage use of closest material sources • Locate construction staging areas close to work sites, while situating them as far away as possible from residential uses • Encourage use of cleaner and more fuel-efficient construction vehicles (for example, low sulfur fuel, biodiesel, or hybrid technologies) • Encourage the use of alternative fuels and asphalt binders • Implement traffic management schemes that minimize delays and idling • Implement energy conservation measures where appropriate, such as energy-efficient electrical system specifications, lighting, mechanical equipment, and building insulation in accordance with CDOT's Lighting Design Guide (CDOT, 2006) • Encourage energy-efficient options for the cover facilities (Partial Cover Lowered Alternative only)
Revised Viaduct Alternative, General-Purpose Lanes Option	• 70.9 billion Btu consumed per day • 6,018 billion Btu consumed during construction	
Revised Viaduct Alternative, Managed Lanes Option	• 70.4 billion Btu consumed per day • 6,648 billion Btu consumed during construction	
Partial Cover Lowered Alternative, General-Purpose Lanes Option	• 71.3 billion Btu consumed per day • 7,068 billion Btu consumed during construction	
Partial Cover Lowered Alternative, Managed Lanes Option	• 70.0 billion Btu consumed per day • 7,698 billion Btu consumed during construction	

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