OPTION 1H
TRUCK STOP ELECTRIFICATION

Summary

This option assumes implementation of an incentive-based or regulatory strategy intended to reduce idling by medium- and heavy-duty vehicles. For this analysis, on-road medium- and heavy-duty vehicles are defined as vehicles weighing greater than 14,000 pounds gross vehicle weight.

Idling by trucks in the medium- and heavy-duty vehicle classes consumes about 1 billion gallons of diesel fuel annually in the United States.[1] In California, nearly 200 million gallons of diesel fuel are wasted by vehicles in this class but especially heavy trucks from extended idling. It is estimated that long-haul trucks idle their engines 8 hours a day on average. The California Air Resources Board estimates that about 68,000 trucks with sleeping compartments operate in California and engage in extended duration idling.[2] Extended duration idling pollutes the air and wastes fuel. Driven by public policy goals and business motivations to reduce air pollution and fuel consumption, several strategies and technologies are being implemented to reduce heavy-duty truck idling in California. Recently, the California Air Resources Board and several agencies, including municipalities have adopted regulations to limit truck idling to no more than 5 minutes.[3]

Two categories of technologies are being pursued to reduce truck idling. On-board technologies rely on the integration of electric appliances and other equipment onto truck platforms to take advantage of plug-in at truck stops. For this analysis, on-board technologies also include the electrification of transport refrigeration units (TRUs).[4] Off-board technologies rely on an infrastructure that offers conditioned air and other amenities such as internet access from a truss and air conditioning units over the parking spaces.

These technology offerings are likely to impact petroleum demand in California in varying degrees. In the near-term (one to five years), truck idling reduction technologies are likely to reduce California's on-road diesel demand by about 1 percent. In the mid-term (five to twelve years) or by 2010, truck idling reduction is projected to reduce California's on-road diesel demand by 2 to 3 percent. In the long-term (12 or more years) or by 2025 idling reduction technologies are likely to reduce California's on-road diesel demand by seven to ten percent or 62 million to 300 million gallons of the state's on-road diesel demand.

Scenarios Description

Two scenarios are considered for this analysis. A Business-As-Usual (BAU) scenario assumes modest penetration of on-board and off-board truck idling reduction technologies of 2 percent per year and modest fixed infrastructure deployment annually.[5] The aggressive case assumes a penetration of 10 percent annually and a robust fixed infrastructure deployment.

BAU Scenario

This scenario assumes that no significant integration of on-board truck idling reduction occurs in the immediate future (one to five years from now). Today's high incremental cost ($7,000 to $12,000)[6] for the on-board technology is a barrier to moderate adoption of the technology in significant numbers in the market place. Off-board technology idling reduction infrastructure is deployed at 250 spaces per year through 2025.

Aggressive Scenario

This scenario assumes that all heavy vehicles eligible for the combination of on-board technology and off-board technology are taking advantage of their availability. Both technologies are deployed as described later in the methodology. The scenario assumes that the combination of fuel savings, volume production, and incentives that eliminate or reduce the incremental cost to end-users spur the adaptation of the technology in suitable applications. Research indicates that the incremental cost of the on-board idling reduction technologies is likely to drop by 60 to 80 percent by the 2017 to 2025 timeframe when a mature market for this product is expected to develop. Similarly, developers project the cost of off-board idling reduction infrastructure technologies will drop by 50 percent within five to seven years to $7,500 to $8,500 per parking space.[7] Original equipment manufacturers will offer electric and on-board truck idling reduction technologies on all new product offerings in compliance with applicable regulations.[8] These factors make it possible that over 90 percent of the eligible truck parking spaces at California truck stops will feature a combination of on-board and off-board truck idling reduction infrastructure by 2025.

Methodology

This analysis used two approaches to estimate the potential petroleum reduction from reduced truck idling and the derivative costs and benefits. Results of both approaches are combined.

The first approach estimates petroleum savings from electrifying about 10,000 commercial truck parking spaces at California truck stops based on the deployment of the off-board infrastructure.

For the first approach, staff assumed a truck parking space utilization of 70 percent over a 24-hour period and 1 gallon per hour[9] of avoided diesel fuel due to reduced idling. The BAU Scenario assumes 250 new parking spaces are electrified each year. By 2025, 6,000 truck parking spaces feature the off-board infrastructure. The Aggressive Scenario assumes 1,000 new parking spaces are electrified each year from 2005 through 2015 when 10,000 spaces are electrified. The electrified spaces are held constant through 2025.

The second approach estimates petroleum savings from the use of on-board technologies in the 68,000 trucks equipped with sleeper compartments operating in California. On-board technologies rely on the availability and the integration of electric appliances on board the truck. Petroleum reduction from this approach derives from the widespread integration of electric appliances onto truck platforms and the availability of electrical outlets at truck stops for plug-in operation.

For the second approach, staff assumed on-board electric technologies are integrated and enter the market at the rate of 2 percent per year of the 68,000 trucks in California with sleeper compartments. Staff further assumed that the plug-in infrastructure is deployed at 250[10] truck parking spaces annually through 2025. Space utilization of 70 percent over a 24 hour period and 1 gal per hour of avoided diesel fuel due to reduced idling are the same as for the off-board infrastructure. The BAU Scenario assumes 250 new parking spaces are electrified each year. By 2025, 6000 truck parking spaces feature the off-board infrastructure. The Aggressive Scenario assumed on-board electric technologies are integrated and enter the market at the rate of 10 percent per year of the 68,000 trucks in California with sleeper compartments.

The combination of the two approaches provides the basis for the petroleum reduction projections, benefits, and costs, where applicable.

Technology Status

Off-board technologies provide heating, ventilation, heating, and air conditioning (HVAC) and electricity to trucks which connect to delivery hoses connected to a truss structure over truck parking spaces. Drivers turn off their engines and connect the hose to the truck cab using a $10 template. Drivers pay an hourly fee ($1.25 to $1.50) for time connected and services provided. With nearly 1,000 truck parking spaces at commercial truck stops featuring this system, off-board technologies are in the semi-commercial deployment stage.

On-board technologies integrate electric appliances on trucks. Trucks equipped with electrical appliances are able, for a fee, to connect to electrical outlets at truck stops. On-board technology packages also feature energy storage devices (batteries) to support reduced idling away from truck stops. On-board technologies are in the development stage.

Key Input Parameters and Values

The key inputs for this option are the incremental cost of truck idling reduction technologies compared to the conventional diesel engine platform. Several industry and government sources, including Argonne National Laboratory, estimate the incremental cost for on-board truck idling reduction technology ranges between $7,000 to $12,000.[11, 12, 13] The dominant developer of off-board idling reduction technology reports per space infrastructure cost of $12,000 to $15,000.[14] Staff assumes this cost drops by half by the year 2015 due to economies of scale, volume production, and learning curve effects. Another key input in the analysis is the reduction in fuel used from the implementation of the idling reduction technology.[15]

This analysis amortizes the incremental cost, where applicable, over the fuel consumed during the useful life of the vehicle and application. This treatment reduces the cost savings to the consumer or end-user of the technology. Similarly, maintenance cost items are applied on a per gallon basis. We assume that the maintenance cost for the off-board idling reduction technology is absorbed by the infrastructure developer and service provider. We assume that the maintenance cost for the on-board truck idling reduction technology is borne by the truck operator. For this analysis, the benefit to the consumer is adjusted by subtracting this cost from the annual cost savings to the consumer arising from the truck idling reduction technology.

Results

The impacts of the truck idling reduction option are summarized in Tables 1-4. The results in the tables are for the BAU and Aggressive scenarios used to characterize the possible futures this option provides under three fuel price levels. A low fuel price of $1.85[16] and a high fuel price of $2.18[17] are used.

Table 1. Petroleum Reduction and Benefits for Truck Stop Electrification for Low Fuel Price and 5 Percent Discount Rate

Efficiency Option or Scenario	Displacement in 2025, billion gallon gasoline equivalent	Reduction from Base Case Demand, percent	Highest Cumulative Benefit or Change, Present Value, 2005-2025, 5% discount rate, Billion $2005				
			A	B	C	D	A+B+C+D
			Direct Non-Environmental Benefit	Change in Government Revenue	Direct Environmental Net Benefit	External Cost of Petroleum Dependency	Direct Net Benefit
Business-As-Usual	0.06	0.30	0.4	(0.06)	0.06	0.03	0.37
Aggressive	0.35	1.7	2.4	(0.28)	0.26	0.14	2.52

Table 2. Petroleum Reduction and Benefits for Truck Stop Electrification for Low Fuel Price and 12 Percent Discount Rate

Efficiency Option or Scenario	Displacement in 2025, billion gallon gasoline equivalent	Reduction from Base Case Demand, percent	Highest Cumulative Benefit or Change, Present Value, 2005-2025, 12% discount rate, Billion $2005				
			A	B	C	D	A+B+C+D
			Direct Non-Environmental Benefit	Change in Government Revenue	Direct Environmental Net Benefit	External Cost of Petroleum Dependency	Direct Net Benefit
Business-As-Usual	0.06	0.3	0.13	(0.03)	0.06	0.03	0.19
Aggressive	0.35	1.7	0.59	(0.11)	0.26	0.14	0.88

Table 3. Petroleum Reduction and Benefits for Truck Stop Electrification for High Fuel Price and 5 Percent Discount Rate

Efficiency Option or Scenario	Displacement in 2025, billion gallon gasoline equivalent	Reduction from Base Case Demand, percent	Highest Cumulative Benefit or Change, Present Value, 2005-2025, 5% discount rate, Billion $2005				
			A	B	C	D	A+B+C+D
			Direct Non-Environmental Benefit	Change in Government Revenue	Direct Environmental Net Benefit	External Cost of Petroleum Dependency	Direct Net Benefit
Business-As-Usual	0.06	0.3	0.52	(0.06)	0.06	0.03	0.49
Aggressive	0.35	1.7	2.4	(0.28)	0.26	0.14	2.52

Table 4. Petroleum Reduction and Benefits for Truck Stop Electrification for High Fuel Price and 12 Percent Discount Rate

Efficiency Option or Scenario	Displacement in 2025, billion gallon gasoline equivalent	Reduction from Base Case Demand, percent	Highest Cumulative Benefit or Change, Present Value, 2005-2025, 12% discount rate, Billion $2005				
			A	B	C	D	A+B+C+D
			Direct Non-Environmental Benefit	Change in Government Revenue	Direct Environmental Net Benefit	External Cost of Petroleum Dependency	Direct Net Benefit
Business-As-Usual	0.06	0.3	0.2	(0.03)	0.06	0.03	0.26
Aggressive	0.35	1.7	0.9	(0.11)	0.26	0.14	1.19

For the BAU Scenario, truck idling reduction using a combination of on-board and off-board idling reduction technologies reduces California's on-road diesel demand by 62 million gallons or about 0.3 percent in 2025.

Net-Direct benefits to the state under this scenario and a 5 percent discount rate and low fuel price of $1.82 per gallon are estimated to be $0.37 billion in 2025. Net-Direct benefits to the state under this scenario and a 12 percent discount rate and low fuel price of $1.82 per gallon are estimated to be $0.19 billion in 2025.

Net-Direct benefits to the state under this scenario and a 5 percent discount rate and high fuel price of $2.18 per gallon are estimated to be $0.49 billion in 2025. Net-Direct benefits to the state under this scenario and a 12 percent discount rate and low fuel price of $2.18 per gallon are estimated to be $0.26 billion in 2025.

Aggressive Scenario

For the Aggressive Scenario, truck idling reduction using a combination of on-board and off-board idling reduction technologies reduces California's on-road diesel demand by 300 million gallons or about 10 percent in 2025.

Net-Direct benefits to the state under this scenario and a 5 percent discount rate and low fuel price of $1.82 per gallon are estimated to be $2.52 billion in 2025. Net-Direct benefits to the state under this scenario and a 12 percent discount rate and low fuel price of $1.82 per gallon are estimated to be $0.88 billion in 2025.

Net-Direct benefits to the state under this scenario and a 5 percent discount rate and high fuel price of $2.18 per gallon are estimated to be $2.52 billion in 2025. Net-Direct benefits to the state under this scenario and a 12 percent discount rate and high fuel price of $2.18 per gallon are estimated to be $1.19 billion in 2025.

Key Drivers and Uncertainties

The following key drivers and uncertainties are identified and known to affect this option.

- Potential cost savings from integrating truck idling reduction technologies
- Cost to replace new battery or other energy storage device maintenance for on-board systems
- Market acceptance of on-board technologies
- Market acceptance of off-board technologies
- Durability and reliability
- Manufacturer field support and warranty

Endnotes

[1] Stodoldky, F., Gaines, L., Ayas, A. “Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks” Argonne National Laboratory. ANL/ESD-43. June 2000.

[2] “Initial Statement of Reasons: Public Hearing to Consider the Adoption of Heavy-duty Vehicle Idling Emission Reduction Requirements:, California Air Resources Board, December 5, 2003.

[3] Ibid.

[4] Transportation Refrigeration Units are devices used to cool high-value or perishable items being transported. These devices operate on small auxiliary diesel engines. Replacing them with electric units would eliminate pollution associated with their operation and save fuel.

[5] Calculated historical penetration rate of selected technologies onto vehicle platforms. Ward’s Automotive.

[6] “Idling Reduction Technologies for Heavy Duty Trucks: Technology Introduction Plan”, Idaho National Engineering and Environmental Laboratory, May 13, 2004

[7] Bob Wilson, IdleAire Technologies, October 2004 - Personal Communication.

[8] “Initial Statement of Reasons: Public Hearing to Consider the Adoption of Heavy-duty Vehicle Idling Emission Reduction Requirements”, California Air Resources Board, December 5, 2003.

[9] Argonne National Laboratory, U.S. EPA estimate that the average heavy-duty truck consumes about 1 gallon per hour of engine idling.

[10] 250 spaces is the historical rate at which the dominant developer has deployed the idling reduction infrastructure in California under a combination of incentives and funding initiatives.

[11] “Initial Statement of Reasons: Public Hearing to Consider the Adoption of Heavy-duty Vehicle Idling Emission Reduction Requirements”, California Air Resources Board, December 5, 2003.

[12] Stodolsky, F., Gaines, L., Ayas, A. “Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks” Argonne National Laboratory. ANL/ESD-43. June 2000.

[13] “Briefing on Electric Transportation Technologies”, California Electric Transportation Coalition, August 2004.

[14] Ibid.

[15] Analysis of the Truck Inventory and Use Survey from the Truck Size and Weight Perspective for Trucks with Four-Axles or Less.

[16] “Summary of Retail Price Scenarios for 2025, California Energy Commission Staff, February 24, 2005.

[17] Ibid.