CONGESTION MITIGATION AND AIR QUALITY (CMAQ) IMPROVEMENT PROGRAM

Cost-Effectiveness Tables Development and Methodology

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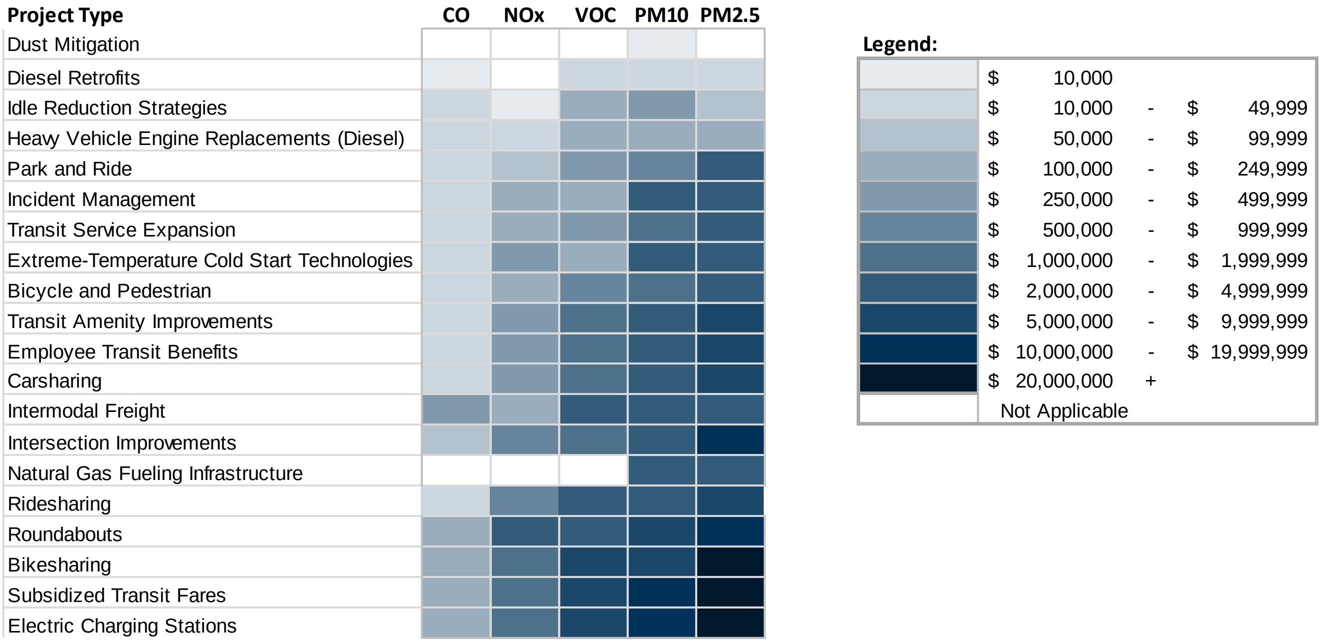

Figure 1. Median Cost-Effectiveness Estimates (Dollars per Ton of Pollutant Reduced).

The analysis yielded a broad range of cost-effectiveness estimates, represented in terms of dollars per ton of pollutant reduced. The most critical findings relate to project types that indicate particularly strong or weak cost-effectiveness, for either individual pollutants or across the range of pollutants.

Project Types with Strong Cost-Effectiveness

Table 1 summarizes the best-performing project types by pollutant, based upon the distributions of cost-effectiveness measures evaluated at the median:

Table 1. Project Types with Strongest Estimated Cost-Effectiveness.

Project Type	Pollutants with Most Cost-Effective Reduction
Idle Reduction Strategies	All pollutants
Heavy-Duty Vehicle Engine Replacements	NOx, VOCs, PM_{10}, $PM_{2.5}$
Diesel Retrofits (DOCs, DPFs)	CO, PM_{10}, $PM_{2.5}$ and VOCs
Transit Service Expansion	NOx, VOCs, CO
Park and Ride	NOx, VOCs, CO
Extreme-Temperature Cold Start	CO and VOCs
Incident Management	CO and VOCs
Intermodal Freight	NOx
Dust Mitigation	PM_{10}

Idle Reduction Strategies

This section reviews the analysis of idle reduction strategies (IR), including idle reduction strategies projects. These projects center on the use of technologies to provide power to heavy-duty trucks when the vehicles are not in motion. By providing means to power heavy-duty trucks that do not rely on idling, IR can support shifts to lower-emission energy consumption by heavy-duty trucks. Additionally, IR reduces localized community and driver exposure to diesel engine emissions. Also, plug-in idle reduction strategies may enable refrigerated trailers to plug in rather than operating a small non-road engine.

Key IR technologies include auxiliary power units (APUs), overhead ducting systems (chiefly, IdleAire) and plug-in electric power and heating and cooling systems (e.g., Shorepower). The set of available project information centered on plug-in systems and IdleAire projects; each of these project sub-types were included in the analysis.

In the analysis, the effects of IR projects were investigated at the heavy-vehicle-fleet-average level for combinations of heavy vehicle model years and road types. The central emission information for the analysis came from MOVES model runs, which reported emission rates for vehicles at idle (in grams per hour), by model year (weighted by the share of vehicles in operation within each model year) and road type. In all, 101 IR scenarios were analyzed.

The steps required to conduct the analysis of IR projects involving plug-in systems include:

- Generate per-hour emission rates for $PM_{2.5}$, PM_{10}, NOx, VOC and CO in MOVES2010b for each model year and road type in the analysis;
- Identify estimates of annual vehicle use (idling hours) for vehicles;
- Identify estimates of the technological effectiveness of IR technologies;
- Identify estimates of IR use (percentage of time facilities are used, or hours of idling reduced per day per unit);
- Identify estimates of project lifetimes; and
- Identify estimates of project costs.

The MOVES runs yielded estimates of emission rates (in grams per hour) for each of the pollutants in the study, by model year and road type, using national-average travel profiles. The estimated annual impacts on pollutants were identified by multiplying the estimated effectiveness of IR technology (e.g., a 60-percent reduction in NOx emissions at idle per device per hour) by the number of idling hours reduced per year and the per-hour emission rates for vehicles at idle.

Lower- and upper-bound values for device utilization rates (15 percent and 60 percent per hour), impact of idling activity (reduction of 25 percent of hoteling and reduction of 100 percent of hoteling) and project costs ($4,500 and $11,500 per space) were used to identify lower- and upper-bound cost-effectiveness estimates. A constant, 15-year project lifetime was assumed.

To estimate individual cost-effectiveness for each model year/road type combination in the analysis, the estimated cost for a given project was divided by the sum of estimated annual emission impacts across project lifetimes. Each estimated annual emission impact was identified as the product of the estimated change in a given emission rate (i.e., with the use of idle reduction versus without) and the assumed annual volume of idling activities for vehicles. This yields a value of dollars per gram of pollutant abated over the project lifetime, which can then be converted to dollars per ton abated.

The analysis of IR projects involving IdleAire was conducted primarily using outputs from the DEQ, and included the following steps:

- Identify the vehicle type toward which the IR strategy would be applied (e.g., Class 8 long-haul truck);

- Identify the model year for the vehicle (endpoints of 1995 and 2010 were selected for the analysis);

- Identify estimates of annual vehicle use (hoteling hours) for vehicles, with the DEQ default values applied;

- Identify estimates of the technological effectiveness of IR technologies, with the DEQ default values applied;

- Identify estimates of IR use (percentage of time facilities are used, or hours of idling reduced per day per unit), with the DEQ default values applied;

- Identify estimates of project lifetimes, with the DEQ default values applied; and

- Identify estimates of project costs.

Sample Analytical Scenario: Idle Reduction Strategy (IdleAire)

As an illustrative example, consider the use of an IdleAire device by model year 2000 heavy-duty trucks traveling on urban unrestricted (i.e., highway) roads.

In this scenario, we assume the following details:

- The effective fleet-average emission rates for MY2000 heavy-duty trucks for travel on urban unrestricted roads are 109.7 grams per hour for NOx, and 6.096 grams per hour for $PM_{2.5}$;
- the IdleAire device is utilized 60 percent of the time (i.e., 60 percent occupancy rate);
- the IdleAire device reduces 100 percent of idling activity, with no offsetting emissions;
- the facility is used 365 days per year;
- the service life of the technology is 15 years; and
- the cost of the project is $11,500 per electrified space.

Step One: Shifting MY2000 heavy-duty trucks using the facility from 100 percent idling to 40 percent idling (i.e., using the facility 60 percent of the time) would lead to the following annual reductions in emissions of NOx and $PM_{2.5}$:

Table 18. Sample Calculation of Annual Emission Impacts of an Idle Reduction Project (Model Year 2000 Fleet-Average Heavy-Duty Vehicle with IdleAire Technology, Urban Unrestricted Roads).

Pollutant	Emission Reduction from Idle Reduction Strategy (IR)	Baseline Idle Emission Rate (grams/hour)	Daily Idling Activity Affected (hours)	Daily Reduction in Emissions from IR (grams)	*Annual Reduction in Emissions from IR (grams)*
NOx	100%	109.7	14.4	1,580	*576,583*
$PM_{2.5}$	100%	6.096		87.8	*32,041*

Step Two: Each of the estimated annual emission impacts is multiplied by the project lifetime to identify project-level emission impacts:

Table 19. Sample Calculation of Total Emission Impacts of an Idle Reduction Project (Model Year 2000 Fleet-Average Heavy-Duty Vehicle with Plug-In Technology, Urban Unrestricted Roads).

Pollutant	Annual Reduction in Emissions from IR (grams)	Project Lifetime (years)	Total Reduction in Emissions from IR (grams)	*Total Reduction in Emissions from IR (tons)*
NOx	576,583	15	8,648,748	*9.534*
$PM_{2.5}$	32,041		480,609	*0.530*

Step Three: The project cost is divided by the estimated project-level emission impacts to yield cost-effectiveness estimates:

Table 20. Sample Calculation of Cost-Effectiveness Estimates for an Idle ReductionProject (Model Year 2000 Fleet-Average Heavy-Duty Vehicle with Plug-In Technology, Urban Unrestricted Roads).

Pollutant	**Total Reduction in Emission from IR (tons)**	**Project Cost**	***Cost-Effectiveness (dollars per ton)***
NOx	9.534	$11,500	*$1,206*
$PM_{2.5}$	0.530		*$21,707*

Summary Cost-Effectiveness Estimates: Idle Reduction Strategies

The median cost-effectiveness estimates for the range of scenarios for idle reduction strategies are presented in Table 21 below:

Table 21. Median Cost-Effectiveness Estimates (Dollars per Ton) – Idle Reduction Projects.

Pollutant	**Cost-Effectiveness**
$PM_{2.5}$	$76,342
PM_{10}	$51,139
CO	$20,724
NOX	$2,040
VOCs	$122,587