CMAQ EMISSIONS CALCULATOR TOOLKIT

The purpose of the Congestion Mitigation and Air Quality Improvement Program Emissions Calculator Toolkit (CMAQ Toolkit) is to provide users a standardized approach to estimating emission reductions from the implementation of a CMAQ-funded project. The CMAQ Toolkit uses emission rates for highway vehicles based on default-scale[1] runs of the Motor Vehicle Emission Simulator (MOVES) as well as other data sources. For each tool in the toolkit, the inputs and methodology are described in user guides along with some example cases. Emission estimates from the CMAQ Toolkit are not intended to meet specific requirements for State Implementation Plans (SIPs) or transportation conformity analyses. Information regarding the development of default emission rates and guidance on incorporating user-supplied emission rates can be found in the accompanying documentation of the emissions data.

Diesel Idle Reduction Tool

This tool allows users to calculate emissions benefits from the application of idle reduction methods to diesel long-haul truck operations in their area.[2]

Techniques to reduce long-duration truck idling may include behavioral change induced by driver education and incentives to reduce idling, State or local anti-idling laws, and idle reduction technology. The term "idle reduction technology" refers to devices that enable diesel engine operators to refrain from long-duration idling of the main propulsion engine (referred to as “extended idle”) by using an alternative power source. Any project that promotes engine-off idling or expands the use of auxiliary power units (APU – diesel and battery), direct-fired heaters, or truck stop electrification (TSE) may be modeled in this tool.

This document is organized into three sections – User Guide, Tool Methodology, and Examples – to aid the user in understanding and interpreting results from the calculator. The User Guide directs the user on how to properly input values into the tool, and provides definitions of both user inputs and tool outputs. The Tool Methodology section outlines the steps taken by the tool to calculate emission reductions, as well as any assumptions incorporated into the tool. This section also describes the equations used within the tool to calculate emission benefits. The Examples section provides instructive examples of how to use the tool for different types of analysis. Descriptions of each idle reduction technique are provided in the appendix.

[1] Default-scale in MOVES3 refers to national-scale, the terminology used in previous versions of MOVES.
[2] The most current version of Diesel Idle Reduction tool is dated July 2022.

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USER GUIDE

This section describes each user input and tool output, as well as the emissions reductions report, error messages, and other assumptions present in the tool.

User Inputs

The Diesel Idle Reduction Tool interface contains a series of questions to guide the user in properly inputting information for emission reductions calculations in a step-by-step process. The inputs for this tool should be specific to the vehicles that will use an idle reduction technique(s) included in the tool. The user-defined inputs for this tool are described in Table 1.

Table 1. User Inputs

Item	User Input	Units	Description
(1)	Project evaluation year	-----	Use the drop-down menu to choose a year between 2018 and 2040.
(2)	Activity type and Annual Activity	Hours or Number of Vehicles	Use the radio buttons to select an activity type: operating hours or number of trucks. Then enter the annual activity quantity in the input cell below the radio buttons.
(3a)	Idle reduction method	-----	Use the check boxes above the table to select the types of hotelling associated with the project.
(3b)	Hotelling activity distribution	-----	Enter the annual operating hours or number of trucks for the idle reduction method(s).
--	*Optional Activity Calculator*		*The Activity Calculator may be used to generate activity by model year group as input to Question 3b, based on MOVES national defaults. See National Default Activity below and Example 1.*
(4)	Annualization	Days	Use the radio buttons to indicate whether to use the default annualization (365 days) or enter your own value.

Vehicle Type: The Diesel Idle Reduction Tool considers a single vehicle type: combination long-haul truck (sourceTypeID 62).

Fuel Type: The fuel type is diesel (fuelTypeID 2).

Activity Type: Users may choose to enter activity as 'operating hours' or 'number of trucks.' The tool automatically converts either input to hotelling hours based on federal regulations on daily operating

hours and rest periods for long-haul trucks (see Activity Equations). If activity is provided in terms of operating hours, values should be given for the entire fleet, not per truck.

Hotelling Hours: MOVES defines "hotelling" as any long period of time that drivers spend in their vehicles during mandated rests[3] while making long distance deliveries by tractor/trailer combination heavy-duty trucks. Hotelling hours account for (1) use of the truck engine (extended idling) and (2) use of idle reduction methods, such as APUs, to power air conditioning, heat, and other vehicle accessories.

Operating Hours: Operating hours account for the time a driver spends driving on the road. These are the number of hours of main engine operation, as opposed to hotelling or rest periods.

Hotelling Operating Mode: The hotelling operating mode refers to the time spent in extended idle or using an idle reduction method. Before project implementation, 100% of hotelling activity is assigned to extended idle.

Model Year Group: The user may enter activity for up to six model year groups: 2006 or earlier, 2007-2009, 2010-2012, 2013-2020, 2021-2023, 2024-2050. These groups are based on emission rate designations in the EPA's Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (Phase 2).[4,5]

National Default Activity: If annual activity data (operating hours or truck population) by model year group is not readily available, the Activity Calculator to the right of Question 2 may be used to determine activity based on national defaults from MOVES3. See the Emissions Data Documentation for further detail.

Enter total annual activity in Question 2 and click the "Calculate Default Activity Distribution" button to generate default activity by model year group. These values may be entered (or copied and pasted) under the desired hotelling operating mode(s) in Question 3. See Example 1 for an example of how to use the Activity Calculator.

Idle Reduction Method: The tool allows users to select up to five different idle reduction methods: diesel APU, battery APU, direct-fired heater, truck stop electrification (TSE), and engine-off idling. See the Appendix for descriptions of each idle reduction method.

MOVE3 was used to derive emission rates for two hotelling operating modes: Extended Idle Hours (activityType 3) and Hotelling Diesel Auxiliary (activityType 13). Emission rates for other activity types were derived from the U.S. Environmental Protection Agency (EPA) and Argonne National Laboratory sources, including the Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool. See Emission Rates Sources and the Emissions Data Documentation for more detail.

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[3] Federal regulations require that drivers spend at least 8 hours of rest after each 10 hours of driving. See the Federal Motor Carrier Safety Administration's Interstate Truck Driver's Guide to Hours of Service.
[4] 40 CFR Parts 9, 22, 85, 86, 600, 1033, 1036, 1037, 1039, 1042, 1043, 1065, 1066, and 1068; 49 CFR Parts 523, 534, 535, and 538: https://www.gpo.gov/fdsys/pkg/FR-2016-10-25/pdf/2016-21203.pdf
[5] EPA's Motor Vehicle Emission Simulator (MOVES): https://www.epa.gov/moves

Annualization: The default annualization (number of days each year the project is active) for the tool is 365 days. Annual emissions are divided by the annualization period to output emissions reductions in units of kg/day. Users may enter their own annualization based on project-specific criteria.

Calculating Output: Once the input parameters are entered, click the 'Calculate Output' button to generate your results. Emission results will not automatically update: if any changes are made to the input parameters, this button must be clicked again to calculate updated emission reductions. If you would like to return to default settings and clear input values, click on the 'Reset to Default Values' button.

Comparing Idle Reduction Methods: To compare the emission benefits from different idle reduction methods, the tool may be run multiple times using equivalent inputs. The evaluation year, activity, and annualization should be held constant; only the selected idle reduction method in Question 3 should change. The number of operating hours or trucks must be the same across model year groups to ensure accurate comparison.

Tool Outputs

Total Hotelling Hours, Number of Hours Operated, and Total Vehicle Miles Travelled (VMT) are provided as outputs for the entire truck fleet. See Activity Equations for details of methodology.

The emission benefits are derived from the decrease in the amount of daily emissions resulting replacement of extended idling with one or more idle reduction methods. Some methods may result in an increase rather than a decrease in emissions compared with the base case scenario (100% extended idle), yielding a net emissions disbenefit. For example, newer truck models may have lower particulate matter emissions when compared with APUs (see Example 2: Diesel and Battery APU Program).

Emission reductions are calculated for five pollutants – CO, $PM_{2.5}$, PM_{10}, NOx, and VOC – in kilograms/year, and then divided by 365 days (or a user-defined number of working days) to generate the CMAQ daily emission reductions reporting in kilograms per day. Reductions in Carbon Dioxide (CO_2) Total Energy Consumption (TEC) and Carbon Dioxide Equivalents ($CO2_e$) are also reported for idle reduction strategy activity types. See the Emissions Data Documentation for detail.

Error Messages

The error message that the user may encounter in this tool, the reason for the error message, and the solution is listed in Table 2 below:

Table 2. Error Messages

Error Message	Reason for Error	Solution
ERROR: The value you entered is not a valid project evaluation year.	Invalid input for project evaluation year.	Input a year between 2018 and 2040 by using the pull-down menu.

Error Message	Reason for Error	Solution
WARNING: You must enter the annual activity quantity in the Annual Activity input above. Note that the activity must be greater than zero.	Annual Activity quantity has not been entered, or is less than zero.	Input a numerical annual activity quantity in the activity input cell that is greater than zero.
WARNING: You must select at least one hotelling activity type and fill in the table.	Incomplete information provided for hotelling activity distribution.	Select activity types and populate table.
WARNING: Please enter a project evaluation year to use the Activity Calculator.	No input provided for project evaluation year.	Input a year between 2018 and 2040 by using the pull-down menu.
WARNING: Please enter total annual activity to use the Activity Calculator. Note that the	Missing input for the Activity Calculator.	Input total annual activity as operating hours or number of trucks.
WARNING: Please enter a value for the number of days per year the project will operate, or choose the default value.	Missing input for the annualization.	Input a number of days between 1 and 365.

Once you correct any errors, please press 'Calculate Output' to recalculate the results.

TOOL METHODOLOGY

Emissions Equations

The equations below summarize how the Diesel Idle Reduction Tool calculates emissions changes. The change in emissions is the difference between the emissions from baseline idling and the emissions from alternative idling methods and strategies. Emission reductions, reported in kilograms per day of the diesel idle reduction project, are calculated for a given pollutant as follows:

$$\Delta Emissions = Base\ Idling\ Emissions - Idle\ Reduction\ Project\ Emissions \qquad (1)$$

Baseline Idling Emissions: before idle reduction project; 100% extended idle (engine-on idling)

Alternative Idling Emissions: after idle reduction project; user-defined combination of idle reduction methods (diesel APU, battery APU, direct-fired heater, TSE, engine-off) and extended idle[6]

When calculating the change in emissions from baseline idling to alternative idling, users must supply the type(s) of hotelling activity adopted in the alternative case. The tool automatically converts user activity inputs (operating hours or population) to number of hotelling hours. The change in emissions is calculated as:

[6] Users may choose to include extended idle as part of their emissions reductions calculation, to account for some fraction of hotelling activity still using extended idle after project implementation.

$$\Delta\text{Emissions} = \sum_{m \in M} e_{ext\ idle_m} * t_{ext\ idle} - \sum_{m \in M} (e_{diesel\ APU} \cdot t_{diesel\ APU} + e_{bat\ APU} \cdot t_{bat\ APU} + e_{heater} \cdot t_{heater} + e_{TSE} \cdot t_{TSE} + e_{eng\ off} \cdot t_{eng\ off}) \quad (2)$$

where:

$m \in M$ = a specific model year group *m* in the tool's complete set of model year groups *M*,

$e_{ext\ idle}$ = extended idle emission rate (all emission rates in units of g/hour of hotelling time),
$e_{diesel\ APU}$ = diesel APU emission rate,
$e_{bat\ APU}$ = battery APU emission rate,
e_{heater} = direct-fired heater emission rate,
e_{TSE} = TSE emission rate,
$e_{engine\ off}$ = engine off emission rate

$t_{ext\ idle}$ = base case; total hotelling activity (hours) across all model years (assumed to be 100% extended idle),
$t_{diesel\ APU}$ = hotelling hours of all vehicles using diesel APUs within a specified model year group after project,
$t_{bat\ APU}$ = hotelling hours of all vehicles using battery APUs within a specified model year group after project,
t_{heater}= hotelling hours of all vehicles using direct-fired heaters within a specified model year group after project,
t_{TSE}= hotelling hours of all vehicles using TSE within a specified model year group after project,
$t_{eng\ off}$ = hotelling hours of all vehicles using engine-off idling within a specified model year group after project,

Note that annual emission reductions are converted to daily emission reductions by dividing the yearly emissions by the number of days per year that the diesel idle reduction program is active. The default annualization in the tool is 365 days, but the user can also enter their own value.

Activity Equations

The 'time' terms in Equation 2 are derived from user inputs to the module. Users are given the option to provide annual activity in terms of either operating hours or number of trucks. Vehicle hotelling hours are calculated based on federal law limiting long-haul truck drives to ten operating hours followed by a mandated eight-hour rest period (i.e., eight hotelling hours). [7]

If activity is provided in terms of operating hours:

[7] 49 CFR Parts 385, 390, 395: https://www.federalregister.gov/documents/2003/04/28/03-9971/hours-of-service-of-drivers-driver-rest-and-sleep-for-safe-operations

$$Hotelling\ Hours = Operating\ Hours\ x \frac{8\ Hotelling\ Hours}{10\ Operating\ Hours} \quad (3)$$

If activity is provided in terms of number of trucks:

$$Hotelling\ Hours = Number\ of\ Trucks\ \times\ Annualization\ in\ Days \times 8 \frac{Hotelling\ Hours}{Day} \quad (4)$$

Total Vehicle Miles Travelled is provided as an additional output and calculated using a conversion factor from the EPA. The conversion factor of 0.0072 hours/mile is based on a national default hotelling rate developed for MOVES3.[8]

$$Hotelling\ Hours = VMT \times 0.0072\ \frac{Hotelling\ Hours}{Mile} \quad (5)$$

Emission Rates Sources

Emission rates data for the six model year groups (2006 or earlier, 2007-2009, 2010-2012, and 2013-2020, 2021-2023, 2024-2050) were derived from runs of the MOVES3 model and Argonne National Laboratory. In the case of battery APUs, complete data were not available from these three sources, so an alternative method based on fuel consumption values from AFLEET 2020 was developed to calculate emission rates (see Emissions Data Documentation).

The section below summarizes data sources used for each hotelling activity type. See the Emissions Data Documentation for tables that provide emission rates for each hoteling type, model year group, and pollutant, as well as additional details on data sources.

Extended idle: emission rates (all pollutants) were derived from runs of MOVES3.

Diesel APUs: similar to extended idle, emission rates (all pollutants) were derived from MOVES3 runs.

Direct-fired heater: emission rates (all pollutants) were obtained from Argonne National Laboratory study of idle reduction methods.[9] As the study did not report emission rates for $PM_{2.5}$, this tool conservatively assumes that $PM_{2.5}$ emissions are equivalent to PM_{10} emissions.

Battery APUs: fuel consumption[10] was used as a surrogate to calculate emission rates for battery APUs, as rates for all pollutants were not available in MOVES or Argonne data sources. See the Emissions Data Documentation for a detailed description of the calculation method.

[8] U.S. EPA. Population and Activity of On-road Vehicles in MOVES3. Population and Activity of Onroad Vehicles in MOVES3 (EPA-420-R-21-012, April 2021)

[9] Gaines, L and Burnham, A. (2016). Emissions from idling heavy-duty trucks and idling-reduction equipment. 2016 Transportation Research Board Annual Meeting, January 10-14, Washington, DC.

[10] Fuel consumption values were obtained from AFLEET 2020.

TSE and Engine-Off Idling: emission rates for these two idle reduction methods were assumed to be zero. Upstream emissions from electricity used for TSE is not considered in this tool.

EXAMPLES

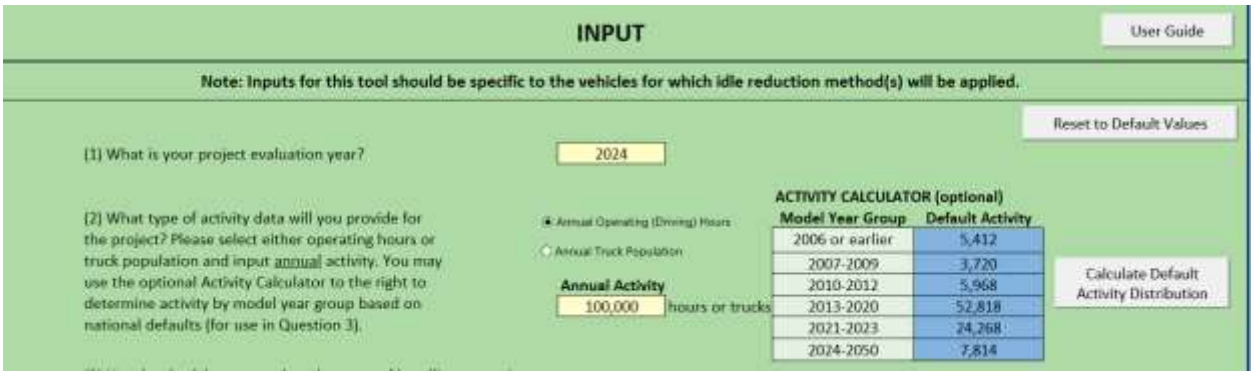
Example 1: Engine-Off Idling

A state is encouraging drivers to use engine-off idling (rather than extended idling with the main engine on) for short rest periods,[11] leading to a reduction in extended idling hours. In this example, a project is estimated to replace up to 80,000 hotelling hours with engine-off idling across the truck fleet.

In the tool, the user would select the following inputs, shown in the images below:

Question 1: Project Evaluation Year: 2024
Question 2: Type of Activity: Operating Hours
Annual Activity: 100,000 hours[12]

Click the 'Calculate Default Activity Distribution' button to generate a distribution based on national MOVES defaults.



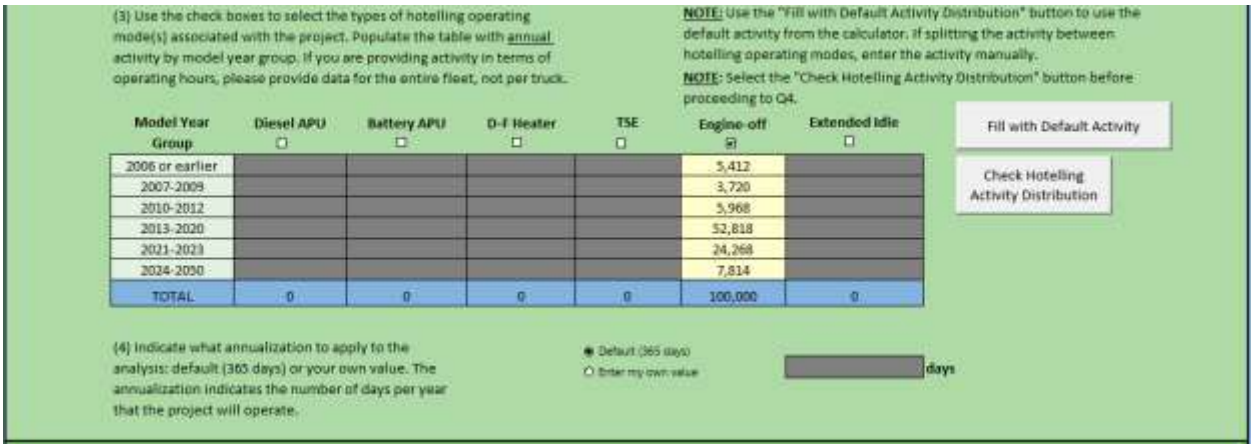
Question 3: Hotelling Activity Type – Engine-off
Enter or copy and paste values from Activity Calculator:
Model Year Group 2006 or Earlier Activity: 5,412
Model Year Group 2007-2009 Activity: 3,720
Model Year Group 2010-2012 Activity: 5,968
Model Year Group 2013-2020 Activity: 52,818
Model Year Group 2021-2023 Activity: 24,268
Model Year Group 2024-2050 Activity: 7,814

After populating the table in question 3, click the 'Check Hotelling Activity Distribution' button to confirm that the table has been completed properly.

Question 4: Annualization: Default (365 days)

[11] Educating drivers and operators about the impacts and adverse effects of long-duration idling can help change their behavior. See https://www.epa.gov/verified-diesel-tech/learn-about-idling-reduction-methods-irts-trucks-and-school-buses. Some states and cities (e.g., Sacramento, CA) have also enacted anti-idling laws with strict idling limits (e.g., 5 minutes) and fines for violations.

[12] 100,000 operating hours translates to 80,000 hotelling hours, using the federal mandate of 8 hours rest for every 10 hours driving as a basis.



(3) Use the check boxes to select the types of hotelling operating mode(s) associated with the project. Populate the table with annual activity by model year group. If you are providing activity in terms of operating hours, please provide data for the entire fleet, not per truck.

NOTE: Use the "Fill with Default Activity Distribution" button to use the default activity from the calculator. If splitting the activity between hotelling operating modes, enter the activity manually.

NOTE: Select the "Check Hotelling Activity Distribution" button before proceeding to Q4.

Fill with Default Activity

Check Hotelling Activity Distribution

Model Year Group	Diesel APU ☐	Battery APU ☐	D-F Heater ☐	TSE ☐	Engine-off ☑	Extended Idle ☐
2006 or earlier					5,412	
2007-2009					3,720	
2010-2012					5,968	
2013-2020					52,818	
2021-2023					24,268	
2024-2050					7,814	
TOTAL	0	0	0	0	100,000	0

(4) Indicate what annualization to apply to the analysis: default (365 days) or your own value. The annualization indicates the number of days per year that the project will operate.

◉ Default (365 days)
○ Enter my own value

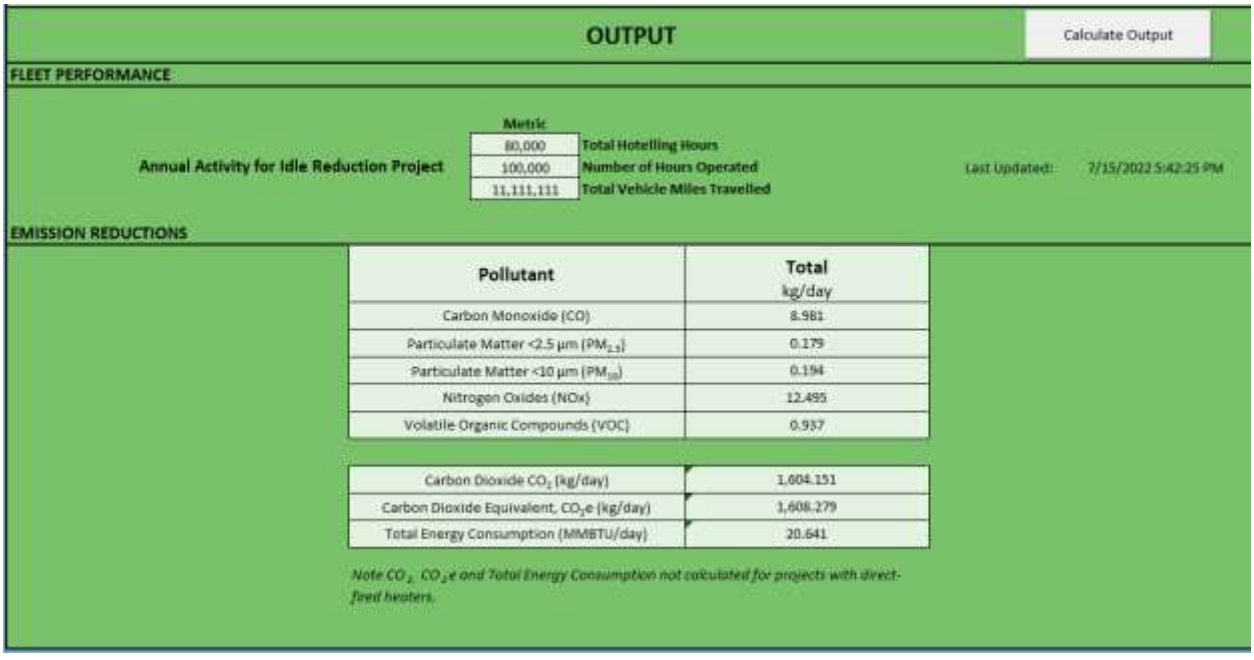
days

Once the inputs are entered, select the 'Calculate Output' button to estimate emission reductions for the project, as shown below.

The estimated annual activity as a result of the project is:

Total Hotelling Hours: 80,000
Number of Hours Operated: 100,000
Total Vehicle Miles Travelled: 11,111,111

Note that VMT and number of hours operated are "N/A" in the case of engine-off projects. Engine-off idling is assumed to only be practicable during short rest periods, rather than the full hotelling period (8 hours) mandated for every 10 hours of operation.



OUTPUT

Calculate Output

FLEET PERFORMANCE

	Metric	
Annual Activity for Idle Reduction Project	80,000	Total Hotelling Hours
	100,000	Number of Hours Operated
	11,111,111	Total Vehicle Miles Travelled

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EMISSION REDUCTIONS

Pollutant	Total kg/day
Carbon Monoxide (CO)	8.981
Particulate Matter <2.5 µm ($PM_{2.5}$)	0.179
Particulate Matter <10 µm (PM_{10})	0.194
Nitrogen Oxides (NOx)	12.495
Volatile Organic Compounds (VOC)	0.937

Carbon Dioxide CO_2 (kg/day)	1,604.151
Carbon Dioxide Equivalent, CO_2e (kg/day)	1,608.279
Total Energy Consumption (MMBTU/day)	20.641

Note CO_2, CO_2e and Total Energy Consumption not calculated for projects with direct-fired heaters.

The estimated emissions reductions are:

CO: 8.981 kg/day
$PM_{2.5}$: 0.179 kg/day
PM_{10}: 0.194 kg/day
NOx: 12.495 kg/day
VOC: 0.937 kg/day

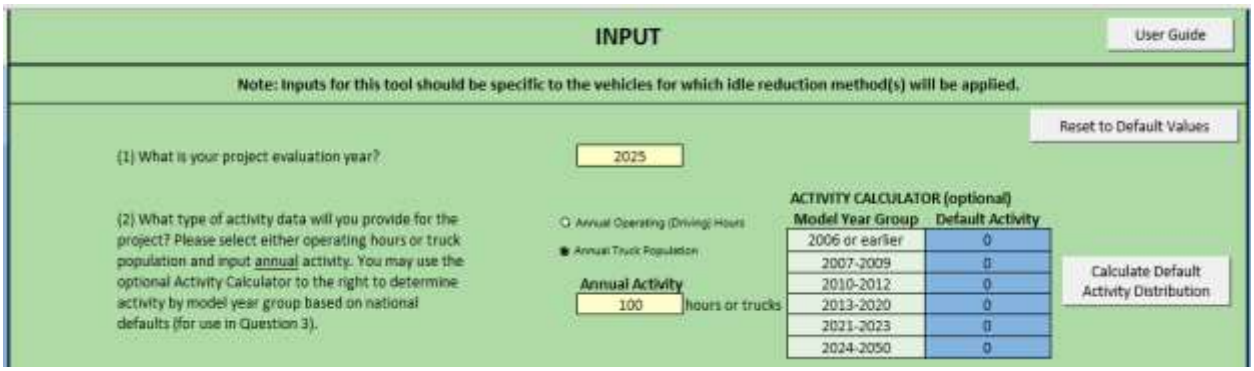
CO_2: 1,604.151 kg/day
CO_2e: 1,608.279 kg/day
TEC: 20.641 MMBTU/day

Example 2: Diesel and Battery APU Program

A state has implemented a diesel and battery APU program. CMAQ funds are being used to retrofit existing vehicles with APUs, as well as install the technology on new vehicles. The program encourages installation of battery APUs in particular, due to their lack of particulate exhaust emissions. [13]

In the tool, the user would select the following inputs, shown in the images below:

Question 1: Project Evaluation Year: 2025
Question 2: Type of Activity: Annual Truck Population (manually enter activity, without using the Activity Calculator)
Annual Activity: 100 trucks



Question 3: Hotelling Activity Types – Diesel APU and Battery APU
Model Year Group 2013-2020 Activity

- Diesel APU: 80
- Battery APU: 10

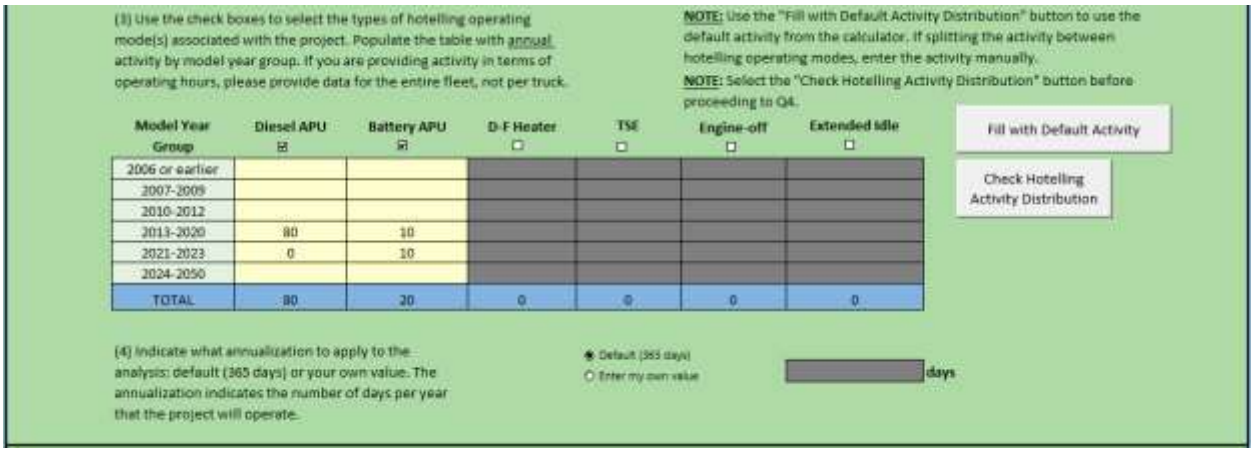
Model Year Group 2021-2023 Activity

- Diesel APU: 0
- Battery APU: 10

After populating the table in question 3, click the 'Check Hotelling Activity Distribution' button to confirm that the table has been completed properly.

[13] Battery APUs emissions are based on the additional fuel required to charge the battery during normal engine operation. Unlike diesel APUs, there are no direct exhaust emissions from battery APUs.

Question 4: Annualization: Default (365 days)



(3) Use the check boxes to select the types of hotelling operating mode(s) associated with the project. Populate the table with annual activity by model year group. If you are providing activity in terms of operating hours, please provide data for the entire fleet, not per truck.

NOTE: Use the "Fill with Default Activity Distribution" button to use the default activity from the calculator. If splitting the activity between hotelling operating modes, enter the activity manually.

NOTE: Select the "Check Hotelling Activity Distribution" button before proceeding to Q4.

Model Year Group	Diesel APU ☑	Battery APU ☑	D-F Heater ☐	TSE ☐	Engine-off ☐	Extended Idle ☐
2006 or earlier						
2007-2009						
2010-2012						
2013-2020	80	10				
2021-2023	0	10				
2024-2050						
TOTAL	80	20	0	0	0	0

Fill with Default Activity

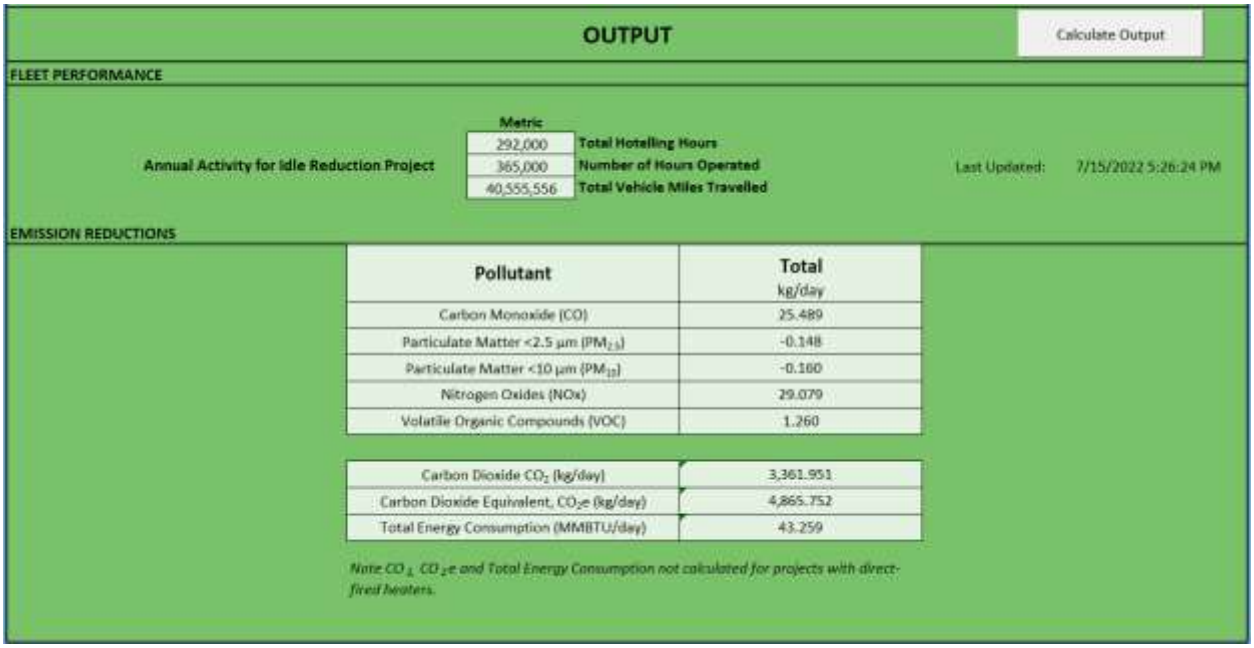
Check Hotelling Activity Distribution

(4) Indicate what annualization to apply to the analysis: default (365 days) or your own value. The annualization indicates the number of days per year that the project will operate.

◉ Default (365 days)
○ Enter my own value

days

Once the inputs are entered, select 'Calculate Output' to estimate emission reductions for the project, as shown below. Note that PM and VOC emission reductions are negative, which indicates a disbenefit. These results may be attributed to newer model year trucks (model years 2013 and later) having lower emission rates than diesel APUs, due to stricter controls on truck exhaust emissions. [14]



OUTPUT

Calculate Output

FLEET PERFORMANCE

Annual Activity for Idle Reduction Project	Metric	
	292,000	Total Hotelling Hours
	365,000	Number of Hours Operated
	40,555,556	Total Vehicle Miles Travelled

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EMISSION REDUCTIONS

Pollutant	Total kg/day
Carbon Monoxide (CO)	25.489
Particulate Matter <2.5 μm ($PM_{2.5}$)	-0.148
Particulate Matter <10 μm (PM_{10})	-0.160
Nitrogen Oxides (NOx)	29.079
Volatile Organic Compounds (VOC)	1.260

Carbon Dioxide CO_2 (kg/day)	3,361.951
Carbon Dioxide Equivalent, CO_2e (kg/day)	4,865.752
Total Energy Consumption (MMBTU/day)	43.259

Note CO_2, CO_2e and Total Energy Consumption not calculated for projects with direct-fired heaters.

The estimated annual activity as a result of the project is:

Total Hotelling Hours: 292,000

[14] Model year trucks 2013 and later must meet a PM emission standard of 0.02 g/hr during extended idle periods. This standard is lower than those for diesel APUs for model years 2007-2023. Federal regulations will require use of a diesel particulate filter for diesel APUs beginning in 2024. See the Emissions Data Documentation for more information.

Number of Hours Operated: 365,000
Total Vehicle Miles Travelled: 40,555,556

The estimated emissions reductions are:

CO: 25.489 kg/day
$PM_{2.5}$: -0.148 kg/day
PM_{10}: -0.160 kg/day
NOx: 29.079 kg/day
VOC: 1.260 kg/day

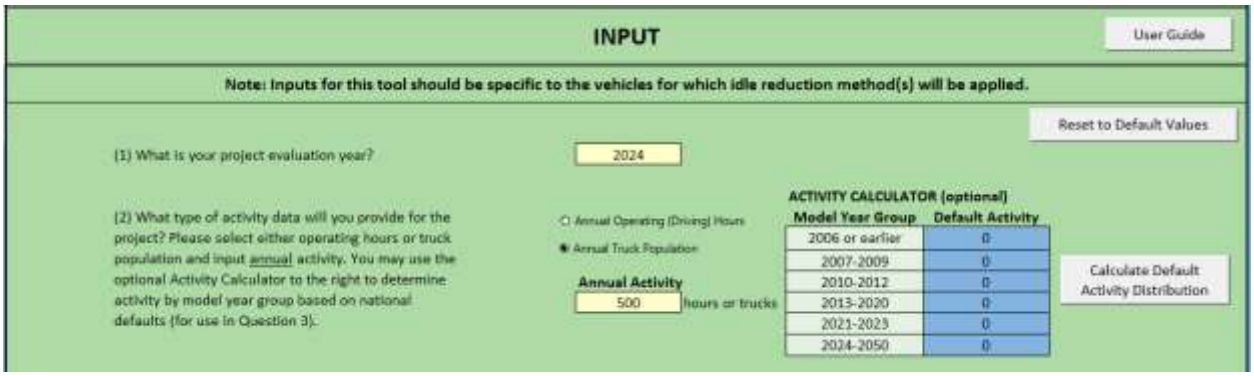
CO_2: 3,361.951 kg/day
CO_2e: 4,865.752 kg/day
TEC: 43.259 MMBTU/day

Example 3: TSE Infrastructure

A state has expanded TSE infrastructure by installing 500 new parking spaces across four sites. Overhead structures at each parking space will deliver electricity, heat, air conditioning, and other amenities. The parking spaces will result in re-allocation of hotelling activity from extended idle to TSE. The project is assumed to be active 300 days out of the year.

In the tool, the user would select the following inputs, shown in the images below:

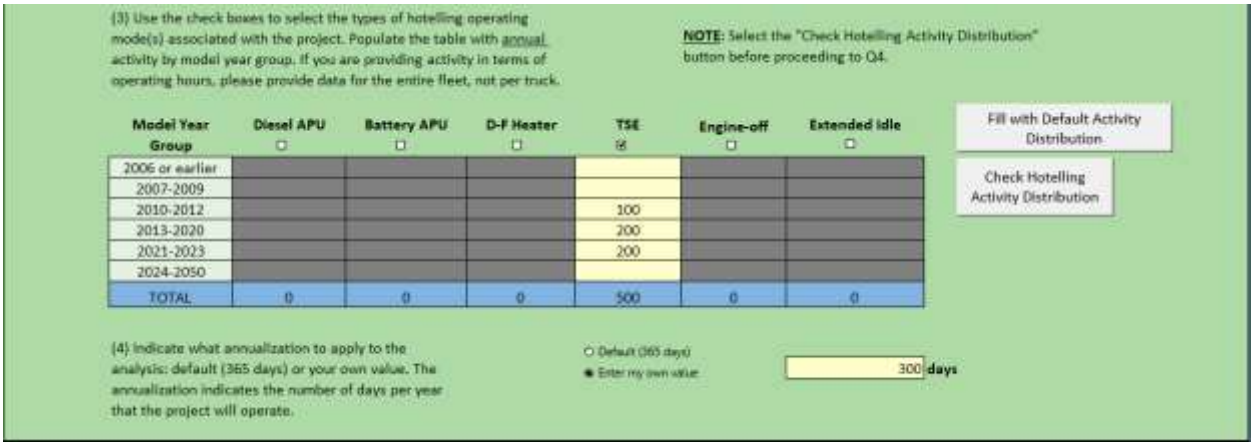
Question 1: Project Evaluation Year: 2024
Question 2: Type of Activity: Annual Truck Population (manually enter activity, without use of Activity Calculator)
Annual Activity: 500 trucks

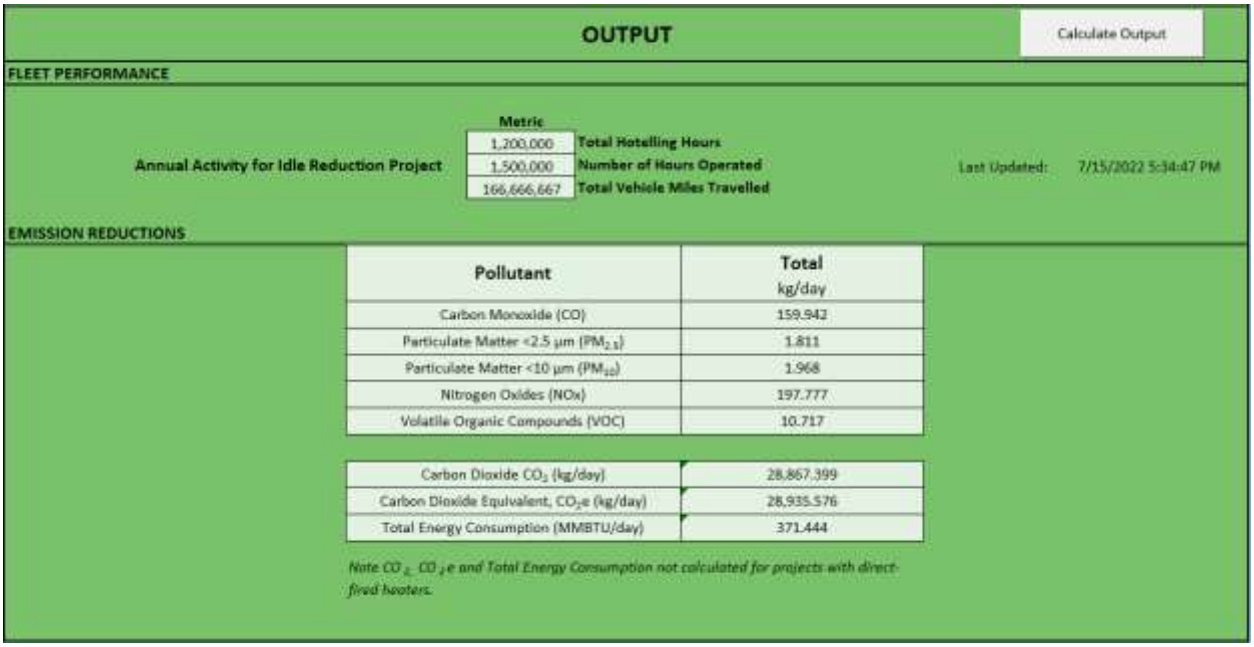


Question 3: Hotelling Activity Type – TSE
Model Year Group 2010-2012 Activity: 100
Model Year Group 2013-2020 Activity: 200
Model Year Group 2021-2023 Activity: 200

After populating the table in question 3, click the 'Check Hotelling Activity Distribution' button to confirm that the table has been completed properly.

Question 4: Annualization: 300 days





OUTPUT

Calculate Output

FLEET PERFORMANCE

Annual Activity for Idle Reduction Project	Metric	
	1,200,000	Total Hotelling Hours
	1,500,000	Number of Hours Operated
	166,666,667	Total Vehicle Miles Travelled

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EMISSION REDUCTIONS

Pollutant	Total kg/day
Carbon Monoxide (CO)	159.942
Particulate Matter <2.5 µm ($PM_{2.5}$)	1.811
Particulate Matter <10 µm (PM_{10})	1.968
Nitrogen Oxides (NOx)	197.777
Volatile Organic Compounds (VOC)	10.717

Carbon Dioxide CO_2 (kg/day)	28,867.399
Carbon Dioxide Equivalent, CO_2e (kg/day)	28,935.576
Total Energy Consumption (MMBTU/day)	371.444

Note CO_2, CO_2e and Total Energy Consumption not calculated for projects with direct-fired heaters.

The estimated annual activity as a result of the project is:

Total Hotelling Hours: 1,200,000
Number of Hours Operated: 1,500,000
Total Vehicle Miles Travelled: 166,666,667

The estimated emissions reductions for all five pollutants are:

CO: 159.942 kg/day
$PM_{2.5}$: 1.811 kg/day
PM_{10}: 1.968 kg/day
NOx: 197.777 kg/day
VOC: 10.717 kg/day

CO_2: 28,867.399 kg/day
$CO2_2e$: 28,935.576 kg/day
TEC: 371.444 MMBTU/day

Appendix – Definitions

Hotelling

Hotelling refers to the time long-haul trucks spend parked during rest periods in all modes (i.e., engine idle, idle reduction technology, engine off). Federal regulations restrict long-haul truck drivers to ten operating hours followed by a mandated eight-hour rest period (hotelling hours).

Extended Idle

Extended idle refers to idling of the main truck engine(s) during hotelling periods. The Diesel Idle Reduction tool was designed to calculate the emissions benefits from projects which replace extended idling with one or more idle reduction methods.

Engine-off Idling

State and local anti-idling laws and other incentives can encourage engine-off idling in place of extended idling (engine power). For example, some cities restrict the length and location of truck idling.

Although not directly considered in this tool, automatic engine idling systems can help to reduce extended idling by turning the main diesel engine on and off as required for heating and cooling during rest periods. These systems use the onboard climate systems and start the engine only to maintain temperature. Automatic engine idling systems can also keep the engine warm in cold conditions, and charge the batteries.

Diesel Auxiliary Power Unit

Diesel auxiliary power units (APUs) run on a dedicated diesel fuel supply and provide drivers with on-board power for climate control and electrical devices. Some diesel APUs may also provide engine warming and truck battery charging. Regulations in some States, such as California, require diesel APUs to be equipped with a diesel particulate filter (DPF) to reduce emissions of particulate matter. The EPA's Heavy Duty Greenhouse Gas Rule (Phase 2)[15] will also require use of a DPF by 2024, to meet a PM10 emission standard of 0.02 g/hr.

Battery Auxiliary Power Unit (Electric APU)

Battery APUs charge using the main engine's alternator while the truck is operating. When the engine is off, energy stored within the battery APU is used to power the truck's climate control and electrical systems. The battery pack in most electric APU units is sized to provide at least 10-hours of runtime.

Direct-Fired Heater (Fuel-Operated Heaters)

Direct-fired heaters are small devices powered by drawing fuel from the vehicle's fuel tank or a separate reserve tank to supply warm air to the driver's sleeper compartment. They provide heat only and can be used in conjunction with cooling systems depending upon cab comfort needs.

[15] Final Rule for Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles - Phase 2: https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-greenhouse-gas-emissions-and-fuel-efficiency

Truck Stop Electrification (Electrified Parking Spaces / Shore Power)

Truck stop electrification (TSE), also referred to as electrified parking spaces (EPS) or shore power, allows trucks equipped with electrical converter plugins to power on-board climate control equipment and other accessories without needing to run their main engines.