Procedure: CalcEmissions

File: CalcEmissions\_RH2\_2020-03-27.sql

# Introduction

The CalcEmissions procedure is a Transact-SQL (T-SQL) script which is saved to instances of the Cost Effectiveness Tool (CET) database. The procedure has three formal parameters, no outputs, and updates two tables as a side-effect. The intended purpose of CalcEmissions is to apply standardized emissions rates for three criterion pollutants to a user’s input energy efficiency measures and calculate each measure’s emissions reductions. Within the context of the CET, which is run as a stack of numerous procedures, saved tables, and saved queries, the tables changed due to the side-effects of CalcEmissions are included in the overall feedback to users.

## Parameters:

The following table identifies each of the parameters specified for the CalcEmissions procedure. The syntax for execution is EXEC [ProcedureName] [Parameter1Name]=[Parameter1Value] []Parameter2Name]=[Parameter2Value]

|  |  |  |
| --- | --- | --- |
| **Name** | **Data Type** | **Description** |
| @JobID | INT | A numeric identifier for a particular instance of calling the CalcEmissions. The CET stack generates a sequential number each time it is run, which is passed to CalcEmissions. The value of @JobID is used to delete existing rows in the table OutputEmissions, and is written into the JobID column of new rows.  Default Value: -1 |
| @MEBens | FLOAT | A number which is added to the Net-to-Gross Ratio (NTGR) to adjust calculated net savings. The number represents unaccountable savings attributed to the Energy Efficiency Portfolio’s effects on the broader market. California State Policy currently sets the value to 0.05. The value is used in calculating net emissions reductions, which are based on net energy savings values.  Default Value: Null  Note: If @MEBens is null, CalcEmissions uses the value of the MarketEffectBens column of the table CETJobs with the ID matching the value of @JobID if a value exists, and 0 otherwise. |
| @AVCVersion | VARCHAR(255) | The name of the version of the Avoided Cost Calculator which is to be used as the source of emissions rate data. Though input as a string, the versions are typically named according to the year in which the Avoided Cost Calculator was published, e.g., ’2018’.  Default Value: Null  Note: If the value of @AVCVersion does not match an entry in the Settingsvw stored query, CalcEmissions may remove but will not add new rows to the OutputEmissions table. |

## Data Sources:

|  |  |  |
| --- | --- | --- |
| **Database Object** | **Operations** | **Description** |
| CETJobs | Read | A table containing a log of previous executions of RunCET. CETJobs stores the time of execution, and certain inputs and outputs. CalcEmissions reads only from the ID and MarketEffectBens columns of CETJobs. |
| E3EmissionsSourcevw | Read | Source data for electric energy emissions rates. |
| E3CombustionTypevw | Read | Source data for natural gas energy emissions rates. |
| Settingsvw | Read | Source data for Avoided Cost Calculator metadata used in matching emissions rates in E3EmissionsSourcevw to measures in InputEmissions. |
| InputMeasurevw | Read | A saved query or view which passes the contents of the InputMeasure table with additional filters, trivial calculations, and renamed fields. User inputs are stored to InputMeasure for use in the CET stack generally and by CalcEmissions specifically. |

## Outputs:

None

## Side Effects:

|  |  |  |
| --- | --- | --- |
| **Affected Object** | **Operations** | **Description** |
| OutputEmissions | Delete Rows  Append Rows | A pre-defined table containing the results from previous executions of CalcEmissions. The table includes the value of @JobID and identifying information from of InputMeasure, along with the results of the calculations in CalcEmissions. |
| SavedEmissions | Delete Rows | A pre-defined table containing data copied from OutputEmissions. CalcEmissions deletes rows with values in the JobID column matching the value of the parameter @JobID, but does not make any additions. |

# Calculation Methodology

CalcEmissions calculates the following values, which are appended to the OutputEmissions table, based on equations presented later in this document:

| **Column Name** | **Description** | **Equation Number** |
| --- | --- | --- |
| NetElecCO2 | CO2 Emissions Reductions based on the first year of each input measure’s net electric savings. | 1 |
| NetGasCO2 | CO2 Emissions Reductions based on the first year of each input measure’s net natural gas savings. | 2 |
| GrossElecCO2 | CO2 Emissions Reductions based on the first year of each input measure’s gross electric savings. | 3 |
| GrossGasCO2 | CO2 Emissions Reductions based on the first year of each input measure’s gross natural gas savings. | 4 |
| NetElecCO2Lifecycle | CO2 Emissions Reductions based on each input measure’s net electric savings throughout the measure’s lifecycle. | 5 |
| NetGasCO2Lifecycle | CO2 Emissions Reductions based on each input measure’s net natural gas savings throughout the measure’s lifecycle. | 6 |
| GrossElecCO2Lifecycle | CO2 Emissions Reductions based on each input measure’s gross electric savings throughout the measure’s lifecycle. | 7 |
| GrossGasCO2Lifecycle | CO2 Emissions Reductions based on each input measure’s gross natural gas savings throughout the measure’s lifecycle. | 8 |
| NetElecNOx | CO2 Emissions Reductions based on the first year of each input measure’s net electric savings. | 9 |
| NetGasNOx | CO2 Emissions Reductions based on the first year of each input measure’s net natural gas savings. | 10 |
| GrossElecNOx | CO2 Emissions Reductions based on the first year of each input measure’s gross electric savings. | 11 |
| GrossGasNOX | CO2 Emissions Reductions based on the first year of each input measure’s gross natural gas savings. | 12 |
| NetElecNOxLifecycle | CO2 Emissions Reductions based on each input measure’s net electric savings throughout the measure’s lifecycle. | 13 |
| NetGasNOxLifecycle | CO2 Emissions Reductions based on each input measure’s net natural gas savings throughout the measure’s lifecycle. | 14 |
| GrossElecNOxLifecycle | CO2 Emissions Reductions based on the first year of each input measure’s net electric savings. | 15 |
| GrossGasNOxLifecycle | CO2 Emissions Reductions based on the first year of each input measure’s net natural gas savings. | 16 |
| NetPM10 | CO2 Emissions Reductions based on the first year of each input measure’s net electric savings. | 17 |
| GrossPM10 | CO2 Emissions Reductions based on the first year of each input measure’s gross electric savings. | 18 |
| NetPM10Lifecycle | CO2 Emissions Reductions based on each input measure’s net electric savings throughout the measure’s lifecycle. | 19 |
| GrossPM10Lifecycle | CO2 Emissions Reductions based on each input measure’s gross electric savings throughout the measure’s lifecycle. | 20 |

These columns provide combinations four selectors: Savings Type {Net | Gross}; Fuel Source {Elec | Gas}; Timeframe {First Year | Lifecycle}; and Criterion Pollutant {CO2 | NOx | PM10}, excepting that PM10 is only calculated based on electric savings. The following table shows how the OutputEmissions columns are organized by selector, and again identifies the corresponding equations, presented later in this document.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Fuel Source** | |
|  |  | Electric | Natural Gas |
| **Criterion Pollutant** | CO2 | |  |  |  |  | | --- | --- | --- | --- | |  |  | **Savings Type** | | |  |  | Net | Gross | | **Timeframe** | First Year | [1](#_Net_First_Year) | [3](#_Gross_First_Year) | | Lifecycle | [5](#_Net_Lifecycle_Electric) | [7](#_Gross_Lifecycle_Electric) | | |  |  |  |  | | --- | --- | --- | --- | |  |  | **Savings Type** | | |  |  | Net | Gross | | Timeframe | First Year | [2](#_Net_First_Year_1) | [4](#_Gross_First_Year_1) | | Lifecycle | [6](#_Net_Lifecycle_Natural) | [8](#_Gross_Lifecycle_Natural) | |
| NOx | |  |  |  |  | | --- | --- | --- | --- | |  |  | **Savings Type** | | |  |  | Net | Gross | | **Timeframe** | First Year | [9](#_Net_First_Year_3) | [11](#_Gross_First_Year_2) | | Lifecycle | [13](#_Net_Lifecycle_Electric_1) | [15](#_Gross_Lifecycle_Electric_1) | | |  |  |  |  | | --- | --- | --- | --- | |  |  | **Savings Type** | | |  |  | Net | Gross | | Timeframe | First Year | [10](#_Net_First_Year_4) | [12](#_Gross_First_Year_3) | | Lifecycle | [14](#_Net_Lifecycle_Natural_1) | [16](#_Gross_Lifecycle_Natural_1) | |
| PM10 | |  |  |  |  | | --- | --- | --- | --- | |  |  | **Savings Type** | | |  |  | Net | Gross | | **Timeframe** | First Year | [17](#_Net_First_Year_2) | [18](#_Gross_First_Year_4) | | Lifecycle | [19](#_Net_Lifecycle_Electric_2) | [20](#_Gross_Lifecycle_Electric_2) | | N/A |

The methodology for calculating emissions is an extension of the methodology presented in the original CET developed by CPUC Energy Division’s contractor Energy and Environmental Economics, Inc. (E3). At the time of the original CET’s publication, emissions reductions were less central to the state’s energy policies, and the level of detail invested in their calculation was accordingly attenuated: emissions rates were reported as one value applicable for a given measure’s entire lifecycle. In more recent years, emissions rate forecasts for CO2 have become more detailed, with varying emissions rates each quarter which can be applied to a measure depending on its installation date and lifetime. Thus, the equations for CO2 emissions are the sum of the products of quarterly emissions rates and annual savings rates applicable to the quarter.

ED staff confirmed with a representative from E3 familiar with the emissions rates data that the CO2 emissions rates are normalized for annual electric savings rates, whereas emissions rates for NOx and PM10 are reported in a manner akin to the original CET: they are not normalized and must be handled differently from CO2. However, the E3EmissionsSourcevw query returns a table structured such that the emissions rates for all three criterion pollutants are reported for every quarter. The equations therefore apply a similar approach to matching each quarter’s savings rates and NOx and PM10 savings rates, but convert the annual savings rates to quarterly savings rates (by simply dividing by four) in order to maintain consistency with the source data.

# Emissions Reductions Formulas

## CO2

The CalcEmissions procedure calculates Carbon Dioxide emissions reductions in units of Tons of CO2. Emissions reductions are calculated based on user input electric and natural gas energy savings, stored CO2 emissions rates for electric and natural gas energy usage, and several energy efficiency measure parameters: Realization Rate, Installation Rate, Net-to-Gross Ratio and Market Effect Benefits, and Remaining and Expected Useful Life. Net and gross annual electric energy savings rate values are evaluated for each quarter throughout the measure’s lifecycle—for single baseline measures, the savings rate is constant throughout; for dual baseline measures (i.e., Accelerated Replacement), the calculations apply the appropriate annual savings rate based on the measure’s Remaining Useful Life. In cases where the Remaining or Expected Useful Life is not divisible evenly into quarters, the applicable quarter’s annual electric energy savings rate is interpolated based on the fraction of the quarter within the first or second baseline, or after. In contrast to the electric calculations, CO2 emissions reductions due to natural gas energy savings are calculated based on a single emission rate for a given input measure, applicable for the measure’s lifecycle. The CO2 emissions rate for a measuer is simply multiplied by the total net or gross natural gas energy savings in Therms for the first year or the measure’s lifecycle.

The emissions rates provided through the saved query E3EmissionsSourcevw are based on hourly electric grid carbon intensity forecasts developed by E3 combined with hourly end-use load shapes. The hourly emissions rates are forecast for every hour through 2049, while there is only one design year (i.e., 8760 values) for each end-use load shape. The hourly end-use load shapes are normalized for annual energy usage, meaning the sum of all 8760 values is exactly one. Each hourly carbon emissions intensity, bearing units of Tons CO2 per kWh, when multiplied by the corresponding End Use Load Shape value, in kWh per annual kWh, results in a value with units of Tons CO2 per annual kWh. These values are then summed throughout each quarter for use in the CET.

The equations for each emissions reduction calculation are presented below. Each equation is applied to a single row in the InputMeasure table. This table contains a unique identifier in the field CET\_ID, copied to the OutputTable. The CET uses the unique identifier to match various procedure results in the final CET outputs.

### Net First Year Electric CO2 Emissions Reduction (NetElecCO2):

Equation

Where

is the net CO2 emissions reductions in tons of CO2 due to electric energy savings in the first year after installation. The CalcEmissions procedure stores the calculated value to the NetElecCO2 field in the table OutputEmissions.

is the calendar quarter-year in which emissions reductions are calculated, starting with being the quarter in which the measure is implemented. The CalcEmissions procedure iterates through values of the Qac field in the output of the stored query E3EmissionsSourcevw, which can be converted to indices based on InputMeasurevw.Qm identifies the quarter in which the measure is installed in the same indexing schema as Qac:

is the number of measures implemented. The CalcEmissions procedure uses the Qty field of the InputMeasurevw for this factor. Values are usually integers, ranging from one and up to many thousands.

is the Net-to-Gross ratio for the energy efficiency measure applicable to electric energy consumption savings, typically determined through evaluation. The CalcEmissions procedure uses the NTGRkWh field of the InputMeasurevw for this factor. Values are typically between 0.5 and 1.0.

is the Market Effects Benefits, typically set by policy. The CalcEmissions procedure uses the MEBens field of the InputMeasurevw for this factor if a value is specified, or the @MEBens parameter input upon calling the procedure. The default value is 0.05.

is the Installation Rate for the energy efficiency measure—the ratio of measures paid for through a program are actually implemented rather than stored indefinitely or abandoned—applicable to electric energy consumption savings, typically determined through evaluation. The CalcEmissions procedure uses the IRkWh field returned by the InputMeasurevw stored procedure for this factor. Values are typically between 0.5 and 1.0.

is the Realization Rate for the energy efficiency measure—the ratio of realized energy savings compared against predicted savings—applicable to electric energy consumption savings, typically determined through evaluation. The CalcEmissions procedure uses the RRkWh field returned by the InputMeasurevw stored query for this factor. Values are typically between 0.5 and 1.0.

is the CO2 Emissions Rate for quarter , normalized for annual electric savings. The CO2 Emissions Rate is provided in units of tons of CO2 per annual kWh savings. Values for are provided for each valid combination of Program Administrator, Target Sector, End Use, and Climate Zone for each quarter from 2017 through 2049 in the CO2 column returned through the E3EmissionsSourcevw stored query.

is the applicable annual electric energy savings rate for the quarter , in kWh per year. is evaluated based on first and second baseline savings rates ( and ), as applicable, and is defined as:

Equation .

Where:

and are the Remaining and Expected Useful Life associated with the measure, expressed in quarters of years. The CalcEmissions procedure uses the values in fields RULq and EULq in the InputMeasurevw stored query for these factors. These values can be integers or fractional values, and typical values range from zero to 72 (i.e., 18 years). The data provided through E3EmissionsSourcevw permit measures with lifecycles fully contained in the 120 quarters from 2017 through 2046, and any quarters occurring outside this window will be counted as contributing zero emissions reductions. and are both assumed to be non-negative, and that

and are the annual electric savings rates in kWh per year for the first and second baselines of the measure’s lifecycle, respectively. For single-baseline measures, is applied for the entirety of their lifecycles, i.e., from the installation quarter through the Expected Useful Life. For dual-baseline measures, is applied from the installation quarter through the Remaining Useful Life, and is applied between the Remaining Useful Life and the Expected Useful Life. The CalcEmissions procedure applies values of the kWh1 and kWh2 fields returned by the saved query InputMeasurevw for these factors.

, , and are scaling factors which weight the baseline annual savings rates according to the amount of time within the given quarter is within either the first or the second baseline. These factors are defined as:

Equation .

### Net First Year Natural Gas CO2 Emissions Reductions (NetGasCO2):

Equation

Where

is the net CO2 emissions reductions in tons of CO2 due to natural gas consumption savings in the first year after installation. The CalcEmissions procedure stores the calculated value to the NetGasCO2 field in the table OutputEmissions.

is as defined for Equation 1.

is the Net-to-Gross ratio for the energy efficiency measure applicable to natural gas consumption savings, typically determined through evaluation. The CalcEmissions procedure uses the NTGRThm field of the InputMeasurevw for this factor. Values are typically between 0.5 and 1.0.

is as defined for Equation 1.

is the Installation Rate for the energy efficiency measure—the ratio of measures paid for through a program are actually implemented rather than stored indefinitely or abandoned—applicable to natural gas consumption savings, typically determined through evaluation. The CalcEmissions procedure uses the IRThm field of the InputMeasurevw for this factor. Values are typically between 0.5 and 1.0.

is the Realization Rate for the energy efficiency measure—the ratio of realized energy savings compared against predicted savings—applicable to natural gas consumption savings, typically determined through evaluation. The CalcEmissions procedure uses the RRThm field of the InputMeasurevw for this factor. Values are typically between 0.5 and 1.0.

is the CO2 Emissions Rate for annual natural gas savings. The CO2 Emissions Rate is provided in units of tons of CO2 per Therm of natural gas savings. Values for are provided for each Program Administrator, and are constant across all quarters. The CalcEmissions procedure uses values from the CO2gas column returned by the Settingsvw stored query as the source for this factor.

is the natural gas savings attributed to the first four quarters after the measure is installed. The value of is evaluated as follows:

Equation .1

Where

and are the first- and second-baseline annual natural gas savings rates in Therms per year.

### Gross First Year Electric CO2 Emissions Reductions (GrossElecCO2):

Equation

Where

is the gross CO2 emissions reductions in tons of CO2 due to electric energy savings in the first year after installation. The CalcEmissions procedure stores the calculated value to the GrossElecCO2 field in the table OutputEmissions.

, , , , , and are as defined for Equation 1.

### Gross First Year Natural Gas CO2 Emissions Reductions (GrossGasCO2):

Equation

Where

is the gross CO2 emissions reductions in tons of CO2 due to natural gas consumption savings in the first year after installation. The CalcEmissions procedure stores the calculated value to the GrossGasCO2 field in the table OutputEmissions.

is as defined for Equation 1.

, , , and are as defined for Equation 2.

### Net Lifecycle Electric CO2 Emissions Reductions (NetElecCO2Lifecycle):

Equation

Where

is the net CO2 emissions reductions in tons of CO2 due to electric energy savings throughout the measure’s lifecycle. The CalcEmissions procedure stores the calculated value to the NetElecCO2Lifecycle field in the table OutputEmissions.

, , , , , , , , and are as defined for Equation 1.

### Net Lifecycle Natural Gas CO2 Emissions Reductions (NetGasCO2Lifecycle):

Equation

Where

is the gross CO2 emissions reductions in tons of CO2 due to natural gas consumption savings throughout the measure’s lifecycle. The CalcEmissions procedure stores the calculated value to the NetGasCO2Lifecycle field in the table OutputEmissions.

and are as defined for Equation 1.

, , , and are as defined for Equation 2.

is the natural gas savings attributed to the measure’s entire lifecycle. The value of is evaluated as follows:

### Gross Lifecycle Electric CO2 Emissions Reductions (GrossElecCO2Lifecycle):

Equation

Where

is the gross CO2 emissions reductions in tons of CO2 due to electric energy savings throughout the measure’s lifecycle. The CalcEmissions procedure stores the calculated value to the NetElecCO2Lifecycle field in the table OutputEmissions.

Other terms are as defined for Equation 1.

### Gross Lifecycle Natural Gas CO2 Emissions Reductions (GrossGasCO2Lifecycle):

Equation

Where

is the gross CO2 emissions reductions in tons of CO2 due to natural gas consumption savings throughout the measure’s lifecycle. The CalcEmissions procedure stores the calculated value to the NetGasCO2Lifecycle field in the table OutputEmissions.

is as defined for Equation 1.

, , and are as defined for Equation 2.

is as defined for Equation 6.

## NOx

The CalcEmissions procedure calculates NOx (i.e., NO2 and NO3) emissions reductions in units of lbs of NOx. Emissions reductions are calcuted based on user input electric and natural gas energy savings, stored NOx emissions rates for electric and natural gas energy usage, and several energy efficiency measure parameters: Realization Rate, Installation Rate, Net-to-Gross Ratio and Market Effects Benefits, and Remaining and Expected Useful Life. Net and gross quarterly electric energy savings rate values are evaluated for each quarter throughout the measure’s lifecycle—for single baseline measures, the savings rate is constant throughout; for dual baseline measures (i.e., Accelerated Replacement), the calculations apply the appropriate annual savings rate based on the measure’s Remaining Useful Life. In cases where the Remaining or Expected Useful Life is not divisible evenly into quarters, the applicable quarter’s quarterly electric energy savings rate is interpolated based on the fraction of the quarter within the first or second baseline, or after. In contrast to the electric calculations, NOx emissions reductions due to natural gas energy savings are calculated based on a single emission rate for a given input measure, applicable for the measure’s lifecycle. The NOx emissions rate for a measure is simply multiplied by the total net or gross natural gas energy savings in Therms for the first year or the measure’s lifecycle.

The equations for each emissions reduction calculation are presented below. Each equation is applied to a single row in the InputMeasure table. This table contains a unique identifier in the field CET\_ID, copied to the OutputTable. The CET uses the unique identifier to match various procedure results in the final CET outputs.

### Net First Year Electric NOx Emissions Reductions (NetElecNOx):

Equation

Where

is the net NOx emissions reductions in lbs of NOx due to electric energy savings in the first year after installation. The CalcEmissions procedure stores the calculated value to the NetElecNOx field in the table OutputEmissions.

, , , , , and are as defined for Equation 1.

is the NOx Emissions Rate for quarter , normalized for quarterly electric savings. The NOx Emissions Rate is provided in units of lbs of NOx per kWh saved during the applicable quarter. Values for are provided for each valid combination of Program Administrator, Target Sector, End Use, and Climate Zone for each quarter from 2017 through 2049 in the NOx column returned through the E3EmissionsSourcevw stored query.

is the applicable quarterly electric energy savings rate for the quarter , in kWh per quarter of a year. is one quarter of the applicable annual electric energy savings rate:

Where

is as defined for Equation 1.

### Net First Year Natural Gas NOx Emissions Reductions (NetGasNOx):

Equation

Where

is the net NOx emissions reductions in lbs of NOx due to natural gas consumption savings in the first year after installation. The CalcEmissions procedure stores the calculated value to the NetGasNOx field in the table OutputEmissions.

and are as defined for Equation 1.

, , , and are as defined for Equation 2.

is the NOx Emissions Rate for annual natural gas savings. The NOx Emissions Rate is provided in units of lbs of NOx per Therm of natural gas savings.

### Gross First Year Electric NOx Emissions Reductions(GrossElecNOx):

Equation

Where

is the net NOx emissions reductions in lbs of NOx due to electric energy savings in the first year after installation. The CalcEmissions procedure stores the calculated value to the GrossElecNOx field in the table OutputEmissions.

, , , and are as defined for Equation 1.

and are as defined for Equation 9.

### Gross First Year Natural Gas NOx Emissions Reductions (GrossGasNOx):

Equation

Where

is the net NOx emissions reductions in tons of NOx due to natural gas consumption savings in the first year after installation. The CalcEmissions procedure stores the calculated value to the GrossGasNOx field in the table OutputEmissions.

and are as defined for Equation 1.

, , , and are as defined for Equation 2.

is as defined for Equation 10.

### Net Lifecycle Electric NOx Emissions Reductions (NetElecNOxLifecycle):

Equation

Where

is the net NOx emissions reductions in lbs of NOx due to electric energy savings throughout the measure’s lifecycle. The CalcEmissions procedure stores the calculated value to the NetElecNOxLifecycle field in the table OutputEmissions.

, , , , , , and are as defined for Equation 1.

and are as defined for Equation 9.

### Net Lifecycle Natural Gas NOx Emissions Reductions (NetGasNOxLifecycle):

Equation

Where

is the net NOx emissions reductions in lbs of NOx due to natural gas consumption savings throughout the measure’s lifecycle. The CalcEmissions procedure stores the calculated value to the NetGasNOxLifecycle field in the table OutputEmissions.

, , , and are as defined for Equation 1.

, , and are as defined for Equation 2.

is as defined for Equation 10.

is as defined for Equation 6.

### Gross Lifecycle Electric NOx Emissions Reductions(GrossElecNOxLifecycle):

Equation

Where

is the gross NOx emissions reductions in lbs of NOx due to electric energy savings throughout the measure’s lifecycle. The CalcEmissions procedure stores the calculated value to the GrossElecNOxLifecycle field in the table OutputEmissions.

, , , , and are as defined for Equation 1.

and are as defined for Equation 9.

### Gross Lifecycle Natural Gas NOx Emissions Reductions (GrossGasNOxLifecycle):

Equation

Where

is the net NOx emissions reductions in lbs of NOx due to natural gas consumption savings throughout the measure’s lifecycle. The CalcEmissions procedure stores the calculated value to the GrossGasNOxLifecycle field in the table OutputEmissions.

, , and are as defined for Equation 1.

, and are as defined for Equation 2.

is as defined for Equation 10.

is as defined for Equation 6.

## NOx

The CalcEmissions procedure calculates 10-micron particulate matter (PM-10) emissions reductions in units of lbs of PM-10. Emissions reductions are calcuted based on user input electric energy savings, stored PM-10 emissions rates for electric energy usage, and several energy efficiency measure parameters: Realization Rate, Installation Rate, Net-to-Gross Ratio and Market Effects Benefits, and Remaining and Expected Useful Life. Net and gross quarterly electric energy savings rate values are evaluated for each quarter throughout the measure’s lifecycle—for single baseline measures, the savings rate is constant throughout; for dual baseline measures (i.e., Accelerated Replacement), the calculations apply the appropriate annual savings rate based on the measure’s Remaining Useful Life. In cases where the Remaining or Expected Useful Life is not divisible evenly into quarters, the applicable quarter’s quarterly electric energy savings rate is interpolated based on the fraction of the quarter within the first or second baseline, or after. PM-10 emissions reductions are not calculated for natural gas energy savings.

The equations for each emissions reduction calculation are presented below. Each equation is applied to a single row in the InputMeasure table. This table contains a unique identifier in the field CET\_ID, copied to the OutputTable. The CET uses the unique identifier to match various procedure results in the final CET outputs.

### Net First Year Electric PM-10 Emissions Reductions (NetElecPM10):

Equation

Where

is the net particulate emissions reductions in lbs of PM-10 due to electric energy savings in the first year after installation. The CalcEmissions procedure stores the calculated value to the NetElecPM10 field in the table OutputEmissions.

, , , , , and are as defined for Equation 1.

is the PM-10 Emissions Rate for quarter , normalized for quarterly electric savings. The PM-10 Emissions Rate is provided in units of lbs of PM-10 per kWh saved during the applicable quarter. Values for are provided for each valid combination of Program Administrator, Target Sector, End Use, and Climate Zone for each quarter from 2017 through 2049 in the PM10 column returned through the E3EmissionsSourcevw stored query.

is as defined in Equation 9.

### Gross First Year Electric PM-10 Emissions Reductions(GrossElecPM10):

Equation

Where

is the gross particulate emissions reductions in lbs of PM-10 due to electric energy savings in the first year after installation. The CalcEmissions procedure stores the calculated value to the GrossElecPM10 field in the table OutputEmissions.

, , , and are as defined for Equation 1.

is as defined in Equation 17.

is as defined in Equation 9.

### Net Lifecycle Electric PM-10 Emissions Reductions (NetElecPM10Lifecycle):

Equation

Where

is the net particulate emissions reductions in lbs of PM-10 due to electric energy savings throughout the measure’s lifecycle. The CalcEmissions procedure stores the calculated value to the NetElecPM10Lifecycle field in the table OutputEmissions.

, , , , , , and are as defined for Equation 1.

is as defined in Equation 17.

is as defined in Equation 9.

### Gross Lifecycle Electric PM-10 Emissions Reductions(GrossElecPM10Lifecycle):

Equation

Where

is the net particulate emissions reductions in lbs of PM-10 due to electric energy savings throughout the measure’s lifecycle. The CalcEmissions procedure stores the calculated value to the NetElecPM10Lifecycle field in the table OutputEmissions.

, , , , and are as defined for Equation 1.

is as defined in Equation 17.

is as defined in Equation 9.