

**Sector**

Cross-Cutting Policies

**Strategy/Policy**

MEPA Review

**Methodology and Data Sources for GHG Emission Reduction Calculation**

$$M_n = \sum_{i=2008}^n Z_i$$

where:

Symbol	Value	Unit	Description	Data Source & Assumption
$M_n$	(calculated)	MMTCO <sub>2</sub> e	CO <sub>2</sub> e committed to be mitigated in year n	(see below)
$Z_i$	(depends on calendar year i)	MMTCO <sub>2</sub> e	Committed CO <sub>2</sub> e savings for calendar year i from development projects that are finished with the MEPA review process that year	Committed CO <sub>2</sub> e savings are reported to the MEPA office during the review process, but are not independently verified.  Assumed that CO <sub>2</sub> e reduction assessment methodology is standard across all projects, following <a href="#">emissions quantification guidelines from MEPA GHG Emissions Policy and Protocol</a> .

**Sector**

Cross-Cutting Policies

**Strategy/Policy**

Leading By Example

**Methodology and Data Sources for GHG Emission Reduction Calculation**

$$\begin{aligned}
 M_n = & \left\{ \frac{[(Z_{baseline,elec} \times A_{baseline,elec}) - (Z_{n,elec} \times A_{n,elec})] + [(Z_{baseline,elec} \times A_{baseline,elec}) - (Z_{n+1,elec} \times A_{n+1,elec})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,E85} \times A_{baseline,E85}) - (Z_{n,E85} \times A_{n,E85})] + [(Z_{baseline,E85} \times A_{baseline,E85}) - (Z_{n+1,E85} \times A_{n+1,E85})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,CNG} \times A_{baseline,CNG}) - (Z_{n,CNG} \times A_{n,CNG})] + [(Z_{baseline,CNG} \times A_{baseline,CNG}) - (Z_{n+1,CNG} \times A_{n+1,CNG})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,coal} \times A_{coal}) - (Z_{n,coal} \times A_{coal})] + [(Z_{baseline,coal} \times A_{coal}) - (Z_{n+1,coal} \times A_{coal})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,LNG} \times A_{LNG}) - (Z_{n,LNG} \times A_{LNG})] + [(Z_{baseline,LNG} \times A_{LNG}) - (Z_{n+1,LNG} \times A_{LNG})]}{2} \right\} + \left\{ \frac{[(Z_{baseline,NG} \times A_{NG}) - (Z_{n,NG} \times A_{NG})] + [(Z_{baseline,NG} \times A_{NG}) - (Z_{n+1,NG} \times A_{NG})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,oil} \times A_{oil}) - (Z_{n,oil} \times A_{oil})] + [(Z_{baseline,oil} \times A_{oil}) - (Z_{n+1,oil} \times A_{oil})]}{2} \right\} + \left\{ \frac{[(Z_{baseline,oil6} \times A_{oil6}) - (Z_{n,oil6} \times A_{oil6})] + [(Z_{baseline,oil6} \times A_{oil6}) - (Z_{n+1,oil6} \times A_{oil6})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,propane} \times A_{propane}) - (Z_{n,propane} \times A_{propane})] + [(Z_{baseline,propane} \times A_{propane}) - (Z_{n+1,propane} \times A_{propane})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,propaneV} \times A_{baseline,propaneV}) - (Z_{n,propaneV} \times A_{n,propaneV})] + [(Z_{baseline,propaneV} \times A_{baseline,propaneV}) - (Z_{n+1,propaneV} \times A_{n+1,propaneV})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,dieselV} \times A_{baseline,dieselV}) - (Z_{n,dieselV} \times A_{n,dieselV})] + [(Z_{baseline,dieselV} \times A_{baseline,dieselV}) - (Z_{n+1,dieselV} \times A_{n+1,dieselV})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,gas} \times A_{baseline,gas}) - (Z_{n,gas} \times A_{n,gas})] + [(Z_{baseline,gas} \times A_{baseline,gas}) - (Z_{n+1,gas} \times A_{n+1,gas})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,jet} \times A_{baseline,jet}) - (Z_{n,jet} \times A_{n,jet})] + [(Z_{baseline,jet} \times A_{baseline,jet}) - (Z_{n+1,jet} \times A_{n+1,jet})]}{2} \right\} + \\
 & \left\{ \frac{[(Z_{baseline,steam} \times A_{steam}) - (Z_{n,steam} \times A_{steam})] + [(Z_{baseline,steam} \times A_{steam}) - (Z_{n+1,steam} \times A_{steam})]}{2} \right\}
 \end{aligned}$$

where:

Symbol	Value	Unit	Description	Data Source & Assumption
$M_n$	(calculated)	MMTCO <sub>2</sub> e	CO <sub>2</sub> e mitigated in calendar year n	Energy usage at state agencies are tracked and reported in fiscal years. Energy reduction in each fiscal year is calculated by subtracting an energy usage in that fiscal year from the baseline year usage of that energy source. To estimate energy reduction in a calendar year, we average the energy

Symbol	Value	Unit	Description	Data Source & Assumption
				reduction in the 2 consecutive fiscal years that overlap that calendar year: $CY2013 = \frac{FY2013 + FY2014}{2}$ Assumed a standard calculation methodology across state facilities for their reported energy usages. See more data sources and assumptions below.
$Z_{baseline,elec}$	1,159,395,016.35638 in grid electricity; 0 in electricity for EVs	kWh	Baseline grid electricity usage in fiscal years 2002-2004, including grid electricity for electric vehicles (EVs)	Baseline energy usage is the average energy usage in the 2002, 2003, and 2004 fiscal years in order to buffer annual differences influenced by weather patterns, electricity demands, etc.
$Z_{baseline,E85}$	0	gallon	Baseline Ethanol-85 (E85) usage in fiscal years 2002-2004	
$Z_{baseline,CNG}$	473,371.116666667	gallon	Baseline compressed natural gas (CNG) usage in fiscal years 2002-2004	
$Z_{baseline,coal}$	35,865	ton	Baseline bituminous coal usage in fiscal years 2002-2004	
$Z_{baseline,LNG}$	363,063	gallon	Baseline liquefied natural gas (LNG) usage in fiscal years 2002-2004 for other uses, not for vehicles	
$Z_{baseline,NG}$	36,902,444.4580497	therm	Baseline natural gas (NG) in fiscal years 2002-2004	
$Z_{baseline,oil}$	4,622,499.19447549 in oil #2; 3,194,762.36729034 in oil #4; 22,682.5737837187 in diesel for buildings; 15,250.5543209877 in diesel for other uses	gallon	Baseline usage of oil #2, #4, and diesel for buildings and other uses in fiscal years 2002-2004	
$Z_{baseline,oil6}$	1,5411,334.8122043 for buildings and 397,105.333333333 for other uses	gallon	Baseline oil #6 usage in fiscal years 2002-2004 for buildings and other uses	
$Z_{baseline,propane}$	362,292.139505542	gallon	Baseline propane usage in fiscal years 2002-2004 for buildings	
$Z_{baseline,propane V}$	1,112.66666666667	gallon	Baseline propane usage in fiscal years 2002-2004 for vehicles	

Symbol	Value	Unit	Description	Data Source & Assumption
$Z_{baseline,dieselV}$	1,187,452.56531619	gallon	Baseline diesel usage in fiscal years 2002-2004 for vehicles	
$Z_{baseline,gas}$	36,902,444.4580497	gallon	Baseline gasoline usage in fiscal years 2002-2004	
$Z_{baseline,jet}$	0	gallon	Baseline jet fuel usage in fiscal years 2002-2004	
$Z_{baseline,steam}$	55,372.24	Mlb	Baseline purchased steam usage in fiscal years 2002-2004	
$Z_{i,elec}$	(depends on fiscal year i)	kWh	Reported energy usage in the fiscal year i	Energy usage data as reported to DOER's Leading by Example (LBE) program each fiscal year.
$Z_{i,E85}$		gallon		
$Z_{i,CNG}$		gallon		
$Z_{i,coal}$		ton		
$Z_{i,LNG}$		gallon		
$Z_{i,NG}$		therm		
$Z_{i,oil}$		gallon		
$Z_{i,oil6}$		gallon		
$Z_{i,propane}$		gallon		
$Z_{i,propaneV}$		gallon		
$Z_{i,dieselV}$		gallon		
$Z_{i,gas}$		gallon		
$Z_{i,jet}$		gallon		
$Z_{i,steam}$		Mlb		
$A_{baseline,elec}$ and $A_{i,elec}$	(depends on fiscal year i)	MMT $CO_2$ e/kWh	Multiplier to convert energy use into $CO_2$ e emissions	Used the following emission factors, which was calculated by MassDEP based on the GHG Inventory: 5.52263916319E-10 for baseline fiscal year, 5.52748873256E-10 for FY2005, 5.22483376484E-10 for FY2006, 4.97245882701E-10 for FY2007, 4.83098771023E-10 for FY2008, 4.48893931660E-10 for Fy2009, 4.35519984627E-10 for FY2010, 4.07582961500E-10 for FY2011.
$A_{baseline,E85}$ and $A_{i,E85}$	(depends on fiscal year i)	MMT $CO_2$ e/gallon	Multiplier to convert energy use into $CO_2$ e emissions	Used the following $CO_2$ emission factors: 1.33977175648357E-9 for E85, 6.90233911750794E-9 for CNG, 5.73902230016094E-9 for propane,
$A_{baseline,CNG}$ and $A_{i,CNG}$	(depends on fiscal year i)	MMT $CO_2$ e/gallon		

Symbol	Value	Unit	Description	Data Source & Assumption
$A_{baseline,propaneV}$ and $A_{i,propaneV}$	(depends on fiscal year i)	MMTCO <sub>2</sub> e/gallon		<p>1.01482711405285E-8 for diesel, 8.90848235094669E-9 for gasoline, 9.5683699324983E-9 for jet fuel, PLUS the following percentages of additional transportation GHG emissions from N<sub>2</sub>O and CH<sub>4</sub>: 3.33246432682395% for baseline fiscal year, 2.90262823400433% for FY2005, 2.67795982260269% for FY2006, 2.35106676976239% for FY2007, 2.12044779337411% for FY2008, 1.9096468540002% for FY2009, 1.9096468540002% for FY2010, 1.9096468540002% for FY2011 (tentative).</p> <p>Source of CO<sub>2</sub> emission factor for CNG only: <a href="http://www.theclimateregistry.org/downloads/2013/01/2013-Climate-Registry-Default-Emissions-Factors.pdf">http://www.theclimateregistry.org/downloads/2013/01/2013-Climate-Registry-Default-Emissions-Factors.pdf</a>; 1 Gallon Gasoline Equivalent (GGE) = 126.67 SCF</p> <p>Source of CO<sub>2</sub> emission factor for other energy sources: <a href="http://www.eia.gov/oiaf/1605/coefficients.html">http://www.eia.gov/oiaf/1605/coefficients.html</a></p> <p>The percentage of non-CO<sub>2</sub> emission is calculated based GHG inventory data.</p>
$A_{baseline,dieselV}$ and $A_{i,dieselV}$	(depends on fiscal year i)	MMTCO <sub>2</sub> e/gallon		
$A_{baseline,gas}$ and $A_{i,gas}$	(depends on fiscal year i)	MMTCO <sub>2</sub> e/gallon		
$A_{baseline,jet}$ and $A_{i,jet}$	(depends on fiscal year i)	MMTCO <sub>2</sub> e/gallon		
$A_{coal}$	1.9012087649568E-6	MMTCO <sub>2</sub> e/ton	Multiplier to convert energy use into CO <sub>2</sub> e emissions	Source: <a href="http://www.eia.gov/oiaf/1605/coefficients.html">http://www.eia.gov/oiaf/1605/coefficients.html</a>
$A_{LNG}$	4.45924032381843E-9	MMTCO <sub>2</sub> e/gallon		Source: <a href="http://www.theclimateregistry.org/downloads/2013/01/2013-Climate-Registry-Default-Emissions-Factors.pdf">http://www.theclimateregistry.org/downloads/2013/01/2013-Climate-Registry-Default-Emissions-Factors.pdf</a> ; 1 Gallon Gasoline Equiv. = 126.67 SCF
$A_{NG}$	5.3190974E-9	MMTCO <sub>2</sub> e/therm		Source: <a href="http://www.energystar.gov/ia/business/evaluate_performance/Emissions_Supporting_Doc.pdf">http://www.energystar.gov/ia/business/evaluate_performance/Emissions_Supporting_Doc.pdf</a>
$A_{oil}$	1.02013677E-8	MMTCO <sub>2</sub> e/gallon		
$A_{oil6}$	1.18555802E-8	MMTCO <sub>2</sub> e/gallon		
$A_{propane}$	5.797229E-9	MMTCO <sub>2</sub> e/gallon		
$A_{steam}$	9.42502435E-8	MMTCO <sub>2</sub> e/Mlb		Emission factor based on the average of Boston & Cambridge calculated data from the LBE program.

## Sector

Cross-Cutting Policies

## Strategy/Policy

Green Communities

## Methodology and Data Sources for GHG Emission Reduction Calculation

$$\begin{aligned} M_n = & \left\{ [(Z_{baseline,elec} \times A_{baseline,elec}) - (Z_{n,elec} \times A_{n,elec})] \right. \\ & + \frac{[(Z_{baseline,elec} \times A_{baseline,elec}) - (Z_{i,elec} \times A_{i,elec})] + [(Z_{baseline,elec} \times A_{baseline,elec}) - (Z_{i+1,elec} \times A_{i+1,elec})]}{2} \left. \right\} \\ & + \left\{ [(Z_{baseline,NG} \times A_{NG}) - (Z_{n,NG} \times A_{NG})] + \frac{[(Z_{baseline,NG} \times A_{NG}) - (Z_{i,NG} \times A_{NG})] + [(Z_{baseline,NG} \times A_{NG}) - (Z_{i+1,NG} \times A_{NG})]}{2} \right\} \\ & + \left\{ [(Z_{baseline,oil} \times A_{oil}) - (Z_{n,oil} \times A_{oil})] + \frac{[(Z_{baseline,oil} \times A_{oil}) - (Z_{i,oil} \times A_{oil})] + [(Z_{baseline,oil} \times A_{oil}) - (Z_{i+1,oil} \times A_{oil})]}{2} \right\} \\ & + \left\{ [(Z_{baseline,propane} \times A_{propane}) - (Z_{n,propane} \times A_{propane})] \right. \\ & + \frac{[(Z_{baseline,propane} \times A_{propane}) - (Z_{i,propane} \times A_{propane})] + [(Z_{baseline,propane} \times A_{propane}) - (Z_{i+1,propane} \times A_{propane})]}{2} \left. \right\} \\ & + \left\{ [(Z_{baseline,B20} \times A_{baseline,B20}) - (Z_{n,B20} \times A_{n,B20})] \right. \\ & + \frac{[(Z_{baseline,B20} \times A_{baseline,B20}) - (Z_{i,B20} \times A_{i,B20})] + [(Z_{baseline,B20} \times A_{baseline,B20}) - (Z_{i+1,B20} \times A_{i+1,B20})]}{2} \left. \right\} \\ & + \left\{ [(Z_{baseline,diesel} \times A_{baseline,diesel}) - (Z_{n,diesel} \times A_{n,diesel})] \right. \\ & + \frac{[(Z_{baseline,diesel} \times A_{baseline,diesel}) - (Z_{i,diesel} \times A_{i,diesel})] + [(Z_{baseline,diesel} \times A_{baseline,diesel}) - (Z_{i+1,diesel} \times A_{i+1,diesel})]}{2} \left. \right\} \\ & + \left\{ [(Z_{baseline,gas} \times A_{baseline,gas}) - (Z_{n,gas} \times A_{n,gas})] \right. \\ & + \frac{[(Z_{baseline,gas} \times A_{baseline,gas}) - (Z_{i,gas} \times A_{i,gas})] + [(Z_{baseline,gas} \times A_{baseline,gas}) - (Z_{i+1,gas} \times A_{i+1,gas})]}{2} \left. \right\} \\ & + \left\{ [(Z_{baseline,propane} \times A_{propane}) - (Z_{n,propane} \times A_{propane})] \right. \\ & + \frac{[(Z_{baseline,propane} \times A_{propane}) - (Z_{i,propane} \times A_{propane})] + [(Z_{baseline,propane} \times A_{propane}) - (Z_{i+1,propane} \times A_{propane})]}{2} \left. \right\} \end{aligned}$$

where:

Symbol	Value	Unit	Description	Data Source & Assumption
$M_n$	(calculated)	MMTCO <sub>2e</sub>	CO <sub>2e</sub> mitigated in calendar year n	<p>Green Communities (GCs) report their energy usage each year, with some reporting in calendar year and some reporting in fiscal year. Many GCs have yet to report their energy usage each year. Energy reduction in each calendar (or fiscal) year is calculated by subtracting the energy usage in that calendar (or fiscal) year from the energy usage in the baseline year, which is usually the first reporting year. To estimate the total annual energy reduction by all reporting GCs, the energy reduction of GCs reporting in calendar years is combined with the 2-year averaged energy reduction of GCs reporting in fiscal years; Averaging the energy reduction of 2 consecutive fiscal years provides estimation of the energy reduction for the overlapping calendar year:</p> $CY2013 = \frac{FY2013 + FY2014}{2}$ <p>Assumed a standard calculation methodology across Green Communities for their reported energy usages. See more data sources and assumptions below.</p>
$Z_{baseline,elec}$ and $Z_{n,elec}$	(depends on calendar year n)	kWh	Grid electricity usage in the calendar baseline year and the calendar year n	As reported to the Green Communities program in the annual report.
$Z_{baseline,NG}$ and $Z_{n,NG}$	(depends on calendar year n)	therm	Natural gas usage in the calendar baseline year and the calendar year n	
$Z_{baseline,oil}$ and $Z_{n,oil}$	(depends on calendar year n)	gallon	Oil usage in the calendar baseline year and the calendar year n	
$Z_{baseline,propane}$ and $Z_{n,propane}$	(depends on calendar year n)	gallon	Propane usage in the calendar baseline year and the calendar year n	
$Z_{baseline,B20}$ and $Z_{n,B20}$	(depends on calendar year n)	gallon	B20 biodiesel usage in the calendar baseline year and the calendar year n	

Symbol	Value	Unit	Description	Data Source & Assumption		
$Z_{baseline,diesel}$ and $Z_{n,diesel}$	(depends on calendar year n)	gallon	Diesel usage in the calendar baseline year and the calendar year n			
$Z_{baseline,gas}$ and $Z_{n,gas}$	(depends on calendar year n)	gallon	Gasoline usage in the calendar baseline year and the calendar year n			
$Z_{baseline,steam}$ and $Z_{n,steam}$	(depends on calendar year n)	Mlb	Steam usage in the calendar baseline year and the calendar year n			
$Z_{baseline,elec}$ and $Z_{i,elec}$	(depends on fiscal year i)	kWh	Energy usage in the fiscal baseline year and the fiscal year i	As reported in the annual report to the Green Communities program.		
$Z_{baseline,NG}$ and $Z_{i,NG}$	(depends on fiscal year i)	therm				
$Z_{baseline,oil}$ and $Z_{i,oil}$	(depends on fiscal year i)	gallon				
$Z_{baseline,propane}$ and $Z_{i,propane}$	(depends on fiscal year i)	gallon				
$Z_{baseline,B20}$ and $Z_{i,B20}$	(depends on fiscal year i)	gallon				
$Z_{baseline,diesel}$ and $Z_{i,diesel}$	(depends on fiscal year i)	gallon				
$Z_{baseline,gas}$ and $Z_{i,gas}$	(depends on fiscal year i)	gallon				
$Z_{baseline,steam}$ and $Z_{i,steam}$	(depends on fiscal year i)	Mlb				
$A_{baseline,elec}$ and $A_{n,elec}$ and $A_{i,elec}$	(depends on years n and i)	MMTCO <sub>2</sub> e/kWh			Multiplier to convert energy usage into CO <sub>2</sub> e emissions	Used the following emission factors, which was calculated by MassDEP based on the GHG Inventory: 4.63682524548E-10 for CY2008, 4.34105338772E-10 for CY2009, 4.36934630483E-10 for CY2010, 3.78231292517E-10 for CY2011, 4.97245882701E-10 for FY2007,

Symbol	Value	Unit	Description	Data Source & Assumption
				4.83098771023E-10 for FY2008, 4.48893931660E-10 for FY2009, 4.35519984627E-10 for FY2010, 4.07582961500E-10 for FY2011.
$A_{NG}$	5.3190974E-9	MMTCO <sub>2</sub> e/therm	Multiplier to convert energy usage into CO <sub>2</sub> e emissions	Source: <a href="http://www.energystar.gov/ia/business/evaluate_performance/Emissions_Supporting_Doc.pdf">http://www.energystar.gov/ia/business/evaluate_performance/Emissions_Supporting_Doc.pdf</a>  Used emission factor of oil #2/diesel and #4 for buildings. Used emission factor of propane for buildings (assumed none used for vehicles).
$A_{oil}$	1.02013677E-8	MMTCO <sub>2</sub> e/gallon		
$A_{propane}$	5.797229E-9	MMTCO <sub>2</sub> e/gallon		
$A_{baseline,B20}$ and $A_{n,B20}$ and $A_{i,B20}$	(depends on years n and i)	MMTCO <sub>2</sub> e/gallon	Multiplier to convert energy usage into CO <sub>2</sub> e emissions	Used the following emission factors: 8.1186169124228E-9 for B20 biodiesel, 1.01482711405285E-8 for diesel (assumed for vehicles only), 8.90848235094669E-9 for gasoline, PLUS the following percentages of additional transportation GHG emissions from N <sub>2</sub> O and CH <sub>4</sub> : 2.20848561896436% for CY2008, 2.02422260380359% for CY2009, 1.79559063434078% for CY2010, 1.79559063434078% for CY2011 (tentative), 2.35106676976239% for FY2007, 2.12044779337411% for FY2008, 1.9096468540002% for FY2009, 1.9096468540002% for FY2010, 1.9096468540002% for FY2011 (tentative).  Source of CO <sub>2</sub> emission factors: <a href="http://www.eia.gov/oiaf/1605/coefficients.html">http://www.eia.gov/oiaf/1605/coefficients.html</a> The percentage of non-CO <sub>2</sub> emission is calculated based GHG inventory data.
$A_{baseline,diesel}$ and $A_{n,diesel}$ and $A_{i,diesel}$	(depends on years n and i)	MMTCO <sub>2</sub> e/gallon		
$A_{baseline,gas}$ and $A_{n,gas}$ and $A_{i,gas}$	(depends on years n and i)	MMTCO <sub>2</sub> e/gallon		
$A_{steam}$	9.42502435E-8	MMTCO <sub>2</sub> e/Mlb	Multiplier to convert energy usage into CO <sub>2</sub> e emissions	Emission factor based on the average of Boston & Cambridge calculated data from the LBE program.