

Cleaner and GreenerSM Environment Program Emission Calculation Exercises

Exercise #1: Calculate How Much Pollution is caused by Energy Use at School and at Home

You will need:

- To calculate the pollution caused by your home energy use, you will need a residential utility bill. Either bring your own or ask your students to bring in copies of their families' utility bills.
- To calculate the pollution caused by your school's energy use, you will need a copy of your school's utility bill. Your school's energy or facility manager should be able to provide you with this information.
- Access to the Cleaner and Greener web site.

Using the Cleaner and Greener Web-Based Pollution Calculator

- 1) Visit the Cleaner and Greener web site at www.cleanerandgreener.org/resources/pollution-from-electricity.htm
- 2) Enter the amount of your monthly electricity bill (in U.S. dollars)
- 3) Select your customer type: Residential, Commercial, or Industrial. (Select residential to calculate emissions from your home's energy use, select commercial to calculate emissions from your school's energy use.)
- 4) Select your state.

Once you have entered the above information, your estimated annual electricity usage (kWh) and amount of emissions by pollutant caused as a result will be displayed in a table like the one to the right.

Results:

Your Estimated Annual Electricity Usage (kWh):

(Calculated using the average electric generation emission factors and average electricity rate by customer type for the selected state.)

Your Electricity Usage Causes the Following Pollution Each Year:	
Type of Pollution	Amount of Pollution
Greenhouse Gases (CO ₂)	<input type="text" value="33070"/> Pounds
Volatile Organic Compounds (VOC)	<input type="text" value="1"/> Pounds
Nitrogen Oxides (NO _x)	<input type="text" value="94"/> Pounds
Carbon Monoxide (CO)	<input type="text" value="5"/> Pounds
Sulfur Dioxide (SO ₂)	<input type="text" value="180"/> Pounds
Particulates (PM 10)	<input type="text" value="2"/> Pounds
Toxic Metals Pollution	
Amount of Pollution	
Mercury (Hg)	<input type="text" value="882"/> Milligrams
Cadmium (Cd)	<input type="text" value="33"/> Milligrams
Lead (Pb)	<input type="text" value="1246"/> Milligrams

Exercise #2: Calculate the Pollution Reduction Delivered By Decreasing Energy Use at Your School

You will need:

- Ask your school's facility manager if your school has implemented any energy-saving projects or actions. You will need the Estimated Annual Electricity Reduction in kWh and the Estimated Annual Natural Gas Reduction in therms.
- Access to the Cleaner and Greener web site.

Using the Cleaner and Greener Web-Based Emission Reduction Calculator

- 1) Visit the Cleaner and Greener web site at www.cleanerandgreener.org/resources/emission_reductions.htm
- 2) Enter your school's Estimated Annual Electricity Reduction (kWh)
- 3) Enter your school's Estimated Annual Natural Gas Reduction (therms)
- 4) Select your customer type: Residential, Commercial, or Industrial. (Select commercial to calculate emissions from your school's energy use.)
- 5) Select your state.

Once you have entered the above information, your estimated annual cost savings and amount of emission reductions by pollutant will be displayed in a table. To learn about what these pollutants represent in terms of your health, the environment, and the economy, visit www.cleanerandgreener.org/programs/schools/pollution.htm

Cleaner and GreenerSM Environment Program Advanced Emission Calculation Exercises

Exercise #1: Calculate How Much Pollution is Caused by Energy Use at School or at Home

You will need:

- To calculate the pollution caused by your home energy use, you will need a residential utility bill. Either bring your own or ask your students to bring in copies of their families' utility bills.
- To calculate the pollution caused by your school's energy use, you will need a copy of your school's utility bill. Your school's energy or facility manager should be able to provide you with this information.
- A copy of the Cleaner and Greener Emission Factors and Energy Prices guide. (This guide can be downloaded from the Cleaner and Greener web site or can be ordered by phone at 608-280-0255.)
- A calculator.
- Access to the Cleaner and Greener web site.

Calculations

- 1) Amount of monthly electricity bill (in U.S. dollars): _____
- 2) Circle customer type: Household = Residential School = Commercial Manufacturing = Industrial
- 3) State: _____

Using the Cleaner and Greener Emissions Factors and Energy Prices guide:

- 4) Based on the customer type circled above, look up the average electricity cost for your state in Table 8.

Electricity Cost = _____ \$/kWh

- 5) Calculate your estimated Annual Electricity Usage (kWh)

Calculate your estimated Monthly Electricity Usage (kWh) by dividing your monthly electricity bill in dollars by your state electricity cost in \$/kWh. Then multiply by 12 to calculate your estimated Annual Electricity Usage in kWh.

Annual Electricity Usage (kWh) = $\frac{\text{Electricity bill (\$/month)}}{\text{Electricity cost (\$/kWh)}} * 12 \text{ months}$

- 6) Calculate the pollutant emissions caused by your monthly electricity use. Use the proper emission factors for your state from Table 3. To calculate CO₂ emissions, use the emission factors from Table 2. The same emission factors will be used for both residential and commercial energy use since the emission factors are on a state level average.

Monthly Emissions of Pollutant = $\frac{\text{Annual electricity use (kWh)}}{\text{Annual electricity use}} * \frac{\text{Pollutant Emission Factor (lbs/kWh)}}{\text{Pollutant Emission Factor}}$

Use the general equation above to calculate the monthly emissions for each pollutant:

_____ (kWh) * _____ (lbs/kWh) = _____ lbs Greenhouse Gases (CO₂)
Annual electricity use CO₂ E.F.

_____ (kWh) * _____ (lbs/kWh) = _____ lbs Volatile Organic Compounds (VOC)
Annual electricity use VOC E.F.

_____ (kWh) * _____ (lbs/kWh) = _____ lbs Nitrogen Oxides (NO_x)
Annual electricity use NO_x E.F.

_____ (kWh) * _____ (lbs/kWh) = _____ lbs Carbon Monoxide (CO)
Annual electricity use CO E.F.

_____ (kWh) * _____ (lbs/kWh) = _____ lbs Sulfur Dioxide (SO₂)
Annual electricity use SO₂ E.F.

$$\frac{\text{Annual electricity use}}{\text{Annual electricity use}} \text{ (kWh)} * \frac{\text{PM}_{10} \text{ E.F.}}{\text{PM}_{10} \text{ E.F.}} \text{ (lbs/kWh)} = \text{Annual electricity use} \text{ (kWh)} * \text{PM}_{10} \text{ E.F.} \text{ (lbs/kWh)} = \text{Annual electricity use} * \text{PM}_{10} \text{ E.F.} \text{ lbs Particulates (PM}_{10}\text{)}$$

$$\frac{\text{Annual electricity use}}{\text{Annual electricity use}} \text{ (kWh)} * \frac{\text{Hg E.F.}}{\text{Hg E.F.}} \text{ (lbs/kWh)} = \text{Annual electricity use} \text{ (kWh)} * \text{Hg E.F.} \text{ (lbs/kWh)} = \text{Annual electricity use} * \text{Hg E.F.} \text{ lbs Mercury (Hg)}$$

$$\frac{\text{Annual electricity use}}{\text{Annual electricity use}} \text{ (kWh)} * \frac{\text{Cd E.F.}}{\text{Cd E.F.}} \text{ (lbs/kWh)} = \text{Annual electricity use} \text{ (kWh)} * \text{Cd E.F.} \text{ (lbs/kWh)} = \text{Annual electricity use} * \text{Cd E.F.} \text{ lbs Cadmium (Cd)}$$

$$\frac{\text{Annual electricity use}}{\text{Annual electricity use}} \text{ (kWh)} * \frac{\text{Pb E.F.}}{\text{Pb E.F.}} \text{ (lbs/kWh)} = \text{Annual electricity use} \text{ (kWh)} * \text{Pb E.F.} \text{ (lbs/kWh)} = \text{Annual electricity use} * \text{Pb E.F.} \text{ lbs Lead (Pb)}$$

7) Fill in the table below with the results:

Your Electricity Usage Causes the Following Pollution Each Year:

Type of Pollution	Amount of Pollution (pounds)
Greenhouse Gases (CO ₂)	
Volatile Organic Compounds (VOC)	
Nitrogen Oxides (NO _x)	
Carbon Monoxide (CO)	
Sulfur Dioxide (SO ₂)	
Particulates (PM ₁₀)	
Toxic Metals Pollution	Amount of Pollution (milligrams)
Mercury (Hg)	
Cadmium (Cd)	
Lead (Pb)	

8) Use the Cleaner and Greener Web-Based Pollution Calculator at www.cleanerandgreener.org/resources/pollution-from-electricity.htm to check your results.

Exercise #2: Calculate the Pollution Reduction Delivered By Decreasing Energy Use at Your School

You will need:

- Ask your school's facility manager if your school has implemented any energy-saving projects or actions. You will need an Estimated Annual Electricity Reduction in kWh and an Estimated Annual Natural Gas Reduction in therms.
- A copy of the Cleaner and Greener Emission Factors and Energy Prices guide. (This guide can be downloaded from the Cleaner and Greener web site or can be ordered by phone at 608-280-0255.)
- A calculator
- Access to the Cleaner and Greener web site.

Calculations:

- 1) Estimated **Annual** Electricity Reduction (kWh): _____ (kWh saved)
- 2) Estimated **Annual** Natural Gas Reduction (therms): _____ (therms saved)
(Enter zero if no natural gas use or reductions. Enter increases in natural gas consumption as negative numbers for fuel switching measures. To convert MMBtu to therms, divide by 10.)
- 3) Circle customer type: Household = Residential School = Commercial Manufacturing = Industrial
- 4) State: _____

Using the Cleaner and Greener Emissions Factors and Energy Prices guide:

- 5) Calculate your Estimated Annual Cost Savings using average natural gas and electricity rates by customer type for the selected state from Tables 8 and 10 (make sure to use the proper units):

Estimated Annual Cost Savings (\$) =

$$\left[\frac{\text{Electricity Reduction (kWh)}}{\text{Electricity Price (\$/kWh)}} \right] + \left[\frac{\text{Natural Gas Reduction (therms)}}{\text{Natural Gas Price (\$/therm)}} \right]$$

- 6) Calculate the emission reductions for each pollutant type caused by your school's energy-saving projects.

To calculate the annual amount of pollution reduction from your school's energy savings for each pollutant type, multiply the estimated annual electricity savings in kWh by the electricity emission factor in pounds per kWh. Use the fossil fuel-based electricity generation emission factors for your state from Table 1.

Then multiply the estimated annual natural gas savings in therms by the natural gas emission factor in pounds per kWh. Natural gas emission factors can be found in Table 4.

Add these two figures together to arrive at the amount of pollutant emissions saved in pounds. For the toxic metals (Hg, Cd, and Pb), multiply the amount of Hg, Cd, and Pb in pounds by 453592.4 mg/lb to convert to milligrams. (It only takes very small amounts of toxic metals to cause serious health and environmental damage.)

Pollutant Emissions Saved (pounds)=

$$\left[\frac{\text{KWh Saved (kWh)}}{\text{Electricity E.F. (lbs/kWh)}} \right] + \left[\frac{\text{therms saved (therms)}}{\text{Natural Gas E.F. (lbs/therm)}} \right]$$

Use the general equation above to calculate the emission reductions for each pollutant:

Greenhouse Gas (CO₂) Emissions Saved (pounds) =

$$\left[\frac{\text{KWh Saved (kWh)}}{\text{CO}_2 \text{ Electricity E.F. (lbs/kWh)}} \right] + \left[\frac{\text{therms saved (therms)}}{\text{CO}_2 \text{ Natural Gas E.F. (lbs/therm)}} \right]$$

Volatile Organic Compounds (VOC) Emissions Saved (pounds) =

$$\left[\frac{\text{KWh Saved (kWh)}}{\text{VOC Electricity E.F. (lbs/kWh)}} \right] + \left[\frac{\text{therms saved (therms)}}{\text{VOC Natural Gas E.F. (lbs/therm)}} \right]$$

Nitrogen Oxides (NOx) Emissions Saved (pounds) =

$$\left[\frac{\text{KWh Saved (kWh)}}{\text{NOx Electricity E.F. (lbs/kWh)}} \right] + \left[\frac{\text{therms saved (therms)}}{\text{NOx Natural Gas E.F. (lbs/therm)}} \right]$$

Carbon Monoxide (CO) Emissions Saved (pounds) =

$$\left[\frac{\text{KWh Saved (kWh)}}{\text{CO Electricity E.F. (lbs/kWh)}} \right] + \left[\frac{\text{therms saved (therms)}}{\text{CO Natural Gas E.F. (lbs/therm)}} \right]$$

Sulfur Dioxide (SO₂) Emissions Saved (pounds) =

$$\left[\frac{\text{KWh Saved (kWh)}}{\text{SO}_2 \text{ Electricity E.F. (lbs/kWh)}} \right] + \left[\frac{\text{therms saved (therms)}}{\text{SO}_2 \text{ Natural Gas E.F. (lbs/therm)}} \right]$$

Particulates (PM₁₀) Emissions Saved (pounds) =

$$\left[\frac{\text{KWh Saved (kWh)}}{\text{PM}_{10} \text{ Electricity E.F. (lbs/kWh)}} \right] + \left[\frac{\text{therms saved (therms)}}{\text{PM}_{10} \text{ Natural Gas E.F. (lbs/therm)}} \right]$$

Mercury (Hg) Emissions Saved (pounds) =

$$\left[\frac{\text{KWh Saved}}{\text{KWh}} (\text{kWh}) * \frac{\text{Hg Electricity E.F.}}{\text{lbs/kWh}} (\text{lbs/kWh}) \right] + \left[\frac{\text{therms saved}}{\text{therms}} (\text{therms}) * \frac{\text{Hg Natural Gas E.F.}}{\text{lbs/therm}} (\text{lbs/therm}) \right]$$

Cadmium (Cd) Emissions Saved (pounds) =

$$\left[\frac{\text{KWh Saved}}{\text{KWh}} (\text{kWh}) * \frac{\text{Cd Electricity E.F.}}{\text{lbs/kWh}} (\text{lbs/kWh}) \right] + \left[\frac{\text{therms saved}}{\text{therms}} (\text{therms}) * \frac{\text{Cd Natural Gas E.F.}}{\text{lbs/therm}} (\text{lbs/therm}) \right]$$

Lead (Pb) Emissions Saved (pounds) =

$$\left[\frac{\text{KWh Saved}}{\text{KWh}} (\text{kWh}) * \frac{\text{Pb Electricity E.F.}}{\text{lbs/kWh}} (\text{lbs/kWh}) \right] + \left[\frac{\text{therms saved}}{\text{therms}} (\text{therms}) * \frac{\text{Pb Natural Gas E.F.}}{\text{lbs/therm}} (\text{lbs/therm}) \right]$$

****Multiply the amount of Hg, Cd, and Pb in pounds by 453592.4 mg/lb to convert to milligrams***

7) Fill in the table below with the results.

Your Energy-Saving Efforts Will Result in the Following Pollution Reductions:

Type of Pollution	Amount of Pollution (pounds)
Greenhouse Gases (CO ₂)	
Volatile Organic Compounds (VOC)	
Nitrogen Oxides (NO _x)	
Carbon Monoxide (CO)	
Sulfur Dioxide (SO ₂)	
Particulates (PM ₁₀)	
Toxic Metals Pollution	Amount of Pollution (milligrams)
Mercury (Hg)	
Cadmium (Cd)	
Lead (Pb)	

8) Use the Cleaner and Greener Web-Based Emission Reduction Calculator at www.cleanerandgreener.org/resources/emission_reductions.htm to check your results. To learn about what these pollutants represent in terms of your health, the environment, and the economy, visit www.cleanerandgreener.org/programs/schools/pollution.htm