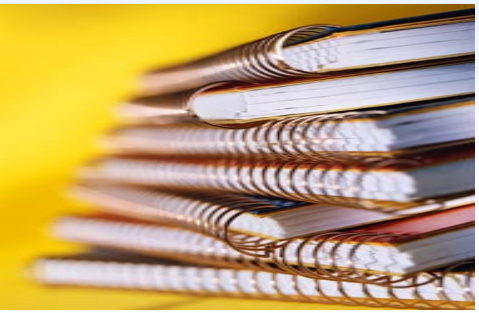
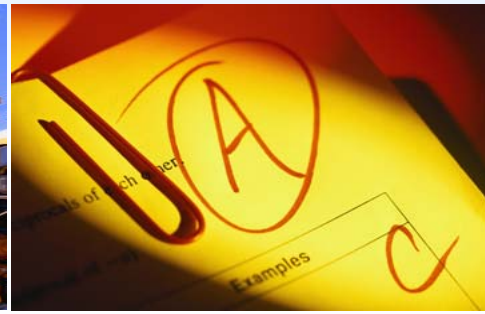
EPA's Climate CHECK

Climate Change Emission Calculator Kit TRAINING





Christopher Steuer
ICF International

16th Annual International Emission Inventory Conference
May 14th, 2007

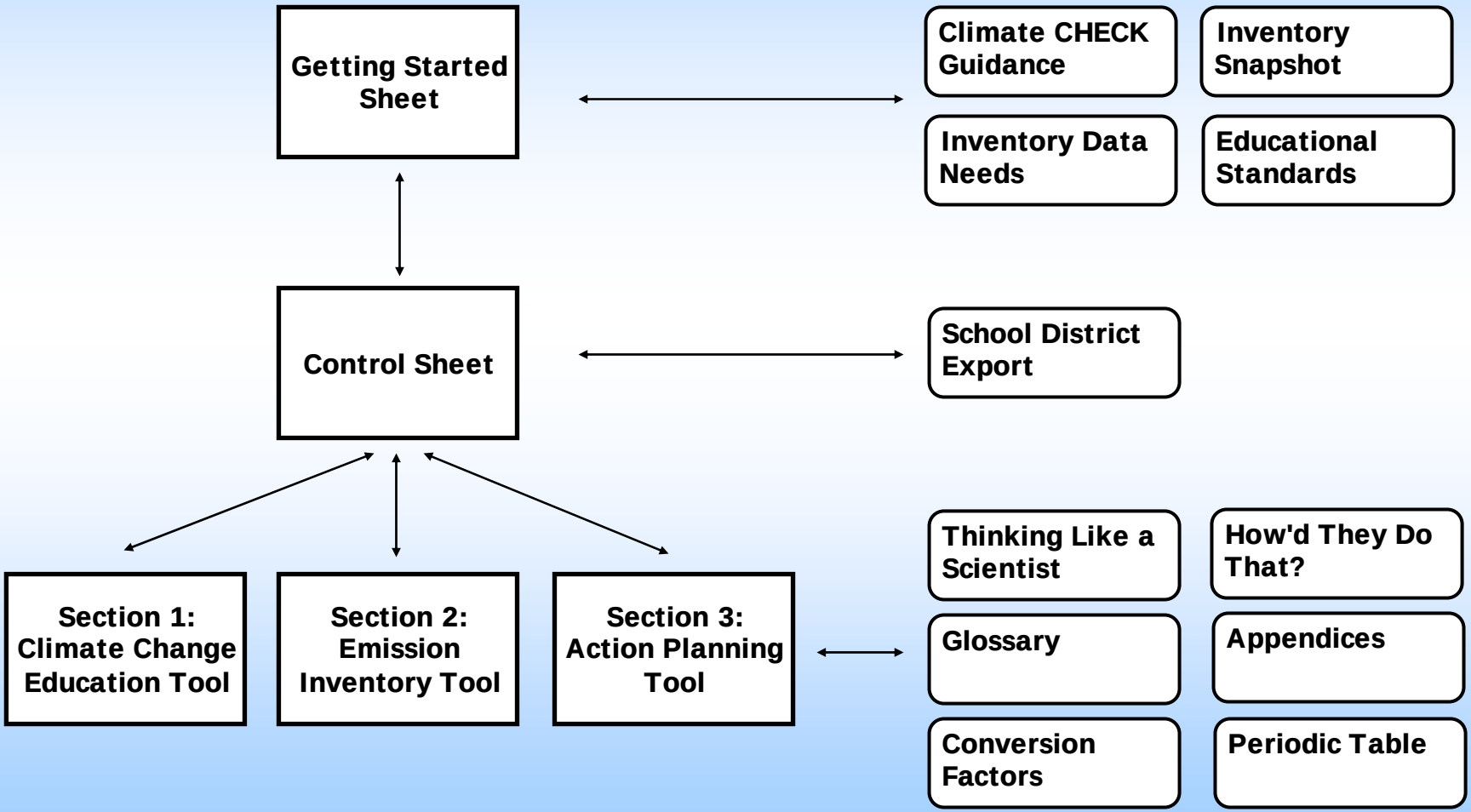
Overview

- What is Climate CHECK?
- Climate CHECK Structure
- Climate CHECK Content
- How can I get Climate CHECK

What is Climate CHECK?

- Excel-based tool designed to educate, estimate, and mitigate.
  - **Educate** high-school students about climate change and GHG emissions.
  - **Estimate** their school's GHG emissions by performing an emission inventory.
  - **Mitigate** their school's GHG emissions by developing and implementing an Action Plan.

Climate CHECK Structure



EPA's Climate CHECK

File Edit Module Options Type a question for help

Welcome to EPA's Climate CHange Emission Calculator Kit (Climate CHECK)

Get Started!

Climate CHECK is an interactive kit designed to:

- **Educate** high-school students about climate change and greenhouse gas (GHG) emissions,
- **Estimate** your school's GHG emissions by performing an emission inventory,
- **Mitigate** your school's GHG emissions by developing and implementing an Action Plan.

To begin using Climate CHECK, please click the "Get Started!" navigational button located in the top right-hand corner of this sheet.

Climate CHECK

Important information before you begin:

1) Before proceeding, **please register Climate CHECK** by sending an email containing your name, title, school name (if applicable), and the class level and subject you teach (if applicable) to ClimateCHECK@icfi.com. Registering Climate CHECK will ensure that you receive all updates to the kit. Questions and comments concerning Climate CHECK may also be sent to this address.

2) Please note: **Climate CHECK uses macros**. To make sure Climate CHECK functions properly, please make sure Excel's macro settings are set to "medium" and choose to enable macros when prompted. To do so, before opening Climate CHECK:

- Open Excel.
- From the "Tools" dropdown list, select "Options."
- On the "Security" tab, select the "Macro Security" button, choose "Medium," and press "ok."
- Close Excel and open the Climate CHECK file.
- When prompted by the dialog box upon opening Climate CHECK, please choose to "Enable Macros."

3) Climate CHECK was developed using **Excel 2003 and Windows XP**, and tested on Excel 2002. While the kit will function on older versions of Excel and Windows, these system settings are optimal.

4) Monitors with resolution settings of 1024X768 allow for optimal viewing of Climate CHECK.

5) Climate CHECK uses methods to estimate GHG emissions that were established by the Intergovermental Panel on Climate Change (IPCC) and are used to develop EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.

Developed By

ICF INTERNATIONAL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

EPA's Climate CHECK

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Climate CHECK - *Getting Started!*

Welcome Sheet | Control Sheet

Stationary Sources

Purchased Electricity and Steam

Mobile Sources

Waste Sent to Landfill

Wastewater

Land Management

Refrigerants and Air Conditioners

Now that you know some basics about performing an inventory, you can move ahead to the next sheet to begin the process of performing an inventory of your school's GHG emissions. Before you do, it might be helpful to familiarize yourself with some things to look out for from the list below.

Things to look out for:

	Pale Yellow Cells	These are the cells where you need to enter information or data. Press enter once you fill-out the cell.
	Pale Green Cells	These are the cells where Climate CHECK reports your emission results.
	Pale Orange Cells	These are the cells where Climate CHECK reports emission reductions or carbon that is sequestered. Sequestered emissions refer to carbon that is bound in materials or plants rather than emitted to the atmosphere as CO_2.

Next Sheet — Navigational Arrows: Use these to navigate through Climate CHECK.

Click to Print! Just press this button to quickly print out the current sheet.

Informational Chalkboards — Information chalkboards provide extra bits of information to help you complete emission estimates and navigate through Climate CHECK.

Calculate — Click the "Calculate" button to perform calculations.

Delete — The "Delete" button erases calculations you've made.

EPA's Climate CHECK

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Climate CHECK - *Getting Started!*

Welcome Sheet | Control Sheet

Did you know that everyday activities you do in your school can actually impact the climate? Heating your school, lighting your classroom, and disposing of your school's waste can cause greenhouse gas (GHG) emissions. These emissions can contribute to global warming, a phenomenon in which human activities can influence the temperature of the earth's atmosphere. This influence on the earth's atmospheric temperature can alter climate causing it to change. Scientists call this altering of earth's climate, climate change.

So, what is climate change anyway? And, how do my daily activities contribute to it? Climate change is a change in long-term weather patterns (such as temperature and annual rainfall). Some changes in climate occur naturally. Human activities that result in GHG emissions (like those mentioned above) can also cause changes in climate. When GHGs are emitted, they trap energy in the atmosphere, which can alter the world's climate.

How can I learn more about climate change and how to reduce GHG emissions at my school? EPA has created Climate CHECK to help you better understand climate change and create an inventory of the GHG emissions that result from activities at your school. Once you know how your school is contributing to GHG emissions, you can figure out how to reduce them!

Get Started!

The primary purpose of Climate CHECK is to help you learn about GHG emissions by performing an emission inventory for your school and investigating ways to reduce your school's GHG emissions. While performing the inventory, Climate CHECK provides information on GHGs, climate change, and other relevant information. The inventory is divided into sources, which are activities that release GHGs into the atmosphere. Information about GHG emission inventories and Climate CHECK's formatting and structure are below. When you are ready to perform an inventory you can click the "Control Sheet" arrow at the top of this sheet.

The buttons below provide additional resources that can be accessed through this sheet. These include guidance on how best to use Climate CHECK to perform an inventory at your school, a GHG emission inventory snapshot sheet that allows you to quickly estimate your school's GHG emissions from several key sources, a listing of the types of data you will need to perform a GHG emission inventory, information on how Climate CHECK meets the National Science Content Standards, and a sheet that explains the units (kgCO2E) Climate CHECK uses to report emissions. Each of these can be accessed by clicking the buttons below.

Guidance | Inventory Snapshot | Inventory Data Needs | Educational Standards | Understanding Units

What's a GHG emission inventory, and how can I create one for my school? A GHG emission inventory is a way to keep track of the GHGs that result from activities that take place at your school. An inventory does not measure GHGs directly. Instead, you estimate GHG emissions using data on school activities that ultimately result in GHG emissions. Scientists call these type of data "activity data." You can calculate GHG emissions by multiplying activity data by an emission factor. An emission factor tells us the amount of GHG emissions that are produced for each unit of activity data.

EPA's Climate CHECK

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Climate CHECK - *The Control Sheet*

Previous Sheet

Section 1 - Learn about GHGs and Climate Change

Click on the button below to learn about the greenhouse effect and the carbon cycle.

The Greenhouse Effect

Click on the button below to learn about climate change and how GHGs are affecting climate.

Climate Change Info

Click on the button below to learn about the impacts of climate change.

Climate Change Impacts

Click on the button below to find more information on GHGs, climate change, and ways to reduce GHG emissions for students as well as educational resources for teachers.

Links

Section 2 - Perform an Inventory of Your School's GHG Emissions

Once you've filled out the school-specific information above, click the "Prepare Climate CHECK!" button below to set up Climate CHECK for your School, then hit the "Let's Go" navigational button to begin performing an inventory.

Prepare Climate CHECK!

Let's Go!

Quick Links

Click the links below to jump to the sheet

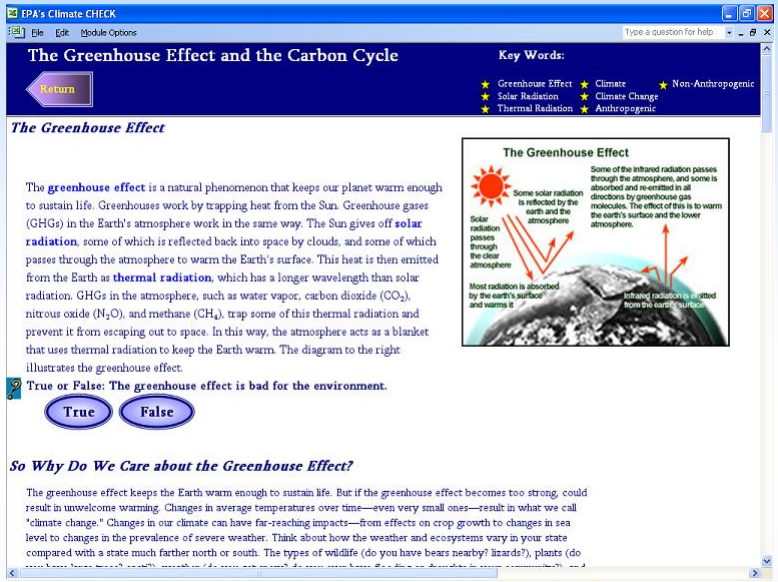
Stationary Combustion
Purchased Electricity and Steam
Mobile Sources
Landfilled Solid Waste
Wastewater Treatment
Refrigeration and Air Conditioning
Land Management
Emissions Summary

Reset the Kit

Have you already performed an inventory using the kit and would like to clear all the data to perform an inventory for another year or another school? No problem! Just click the reset button to reset the entire kit.

Section 1: Climate Change Education

- Provides text describing the greenhouse effect, the carbon cycle, and climate change drivers, science, and impacts.
- Supports the text with true-or-false and multiple choice questions.



Exercise: True/False

All GHGs are caused by human activity.

Section 1: Climate Change Education

True or False: All GHGs are caused by human activity.

True | False

Correct!

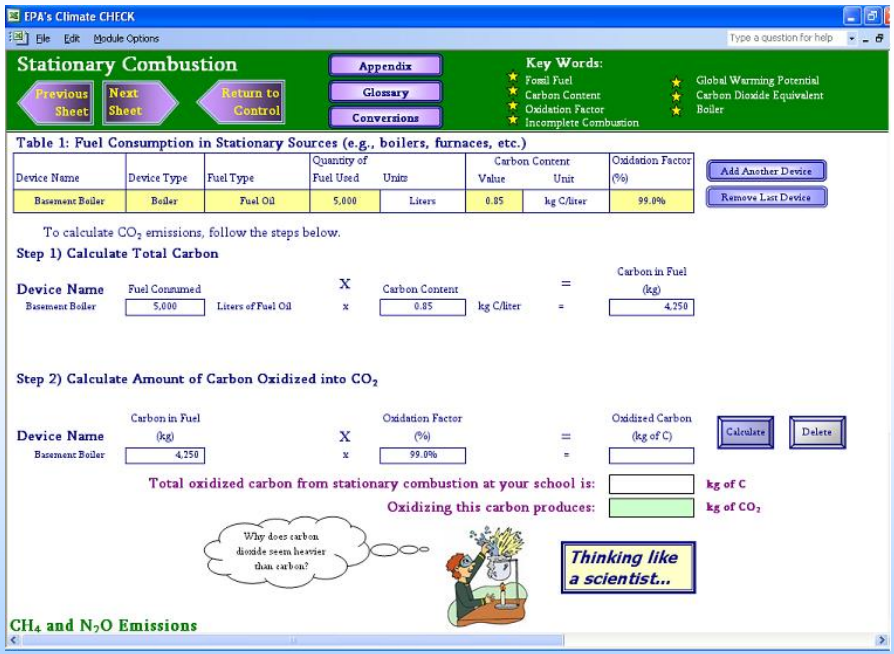
Answer: False Most GHGs occur naturally in the environment. The most important GHG—water vapor—is responsible for two-thirds of the greenhouse effect and is formed by the evaporation of water from oceans, lakes, and other sources. Other GHGs can occur naturally as well: for example, CO_2 is released as a waste product when humans and other mammals breathe. These types of emissions are considered to be **natural** or non-anthropogenic sources. These sources are normally balanced by natural **sinks**, such as trees and the ocean, which absorb GHGs from the atmosphere.

However, some human activities, such as burning fossil fuels for energy, cause emissions of GHGs that would not have occurred naturally. These human-induced emissions are called anthropogenic emissions. Even though anthropogenic emissions account for a relatively small portion of all of the GHGs in the atmosphere, they upset the natural balance between sources and sinks and increase the greenhouse effect. The result is an overall warming of the Earth's surface. In fact, global average surface temperatures have increased 0.5-1.0°F since the late 1800s. The 20th century's 10 warmest years all occurred in the last 15 years of the century (1985-1999).

Answer: False – ***Most GHGs occur naturally in the environment…however, some human activities, such as burning fossil fuels for energy, cause emissions of GHGs that would not have occurred naturally. These human-induced emissions are called anthropogenic emissions.***

Section 2: Emission Inventory

- Individual Source Sheets walk students through calculations to estimate GHG emissions from:
  - Stationary Combustion
  - Purchased Elec. and Steam
  - Mobile Combustion
  - Landfilled Solid Waste
  - Wastewater Treatment
  - Refrigeration and AC
  - Land Management
- GHG emissions include:
  - Carbon Dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous Oxide (N_2O)
  - Hydroflourocarbons (HFCs)



Exercise:

If the fuel oil consumed annually at your school contains approximately 4,200 kg of carbon, how many kg of carbon dioxide will be produced through its oxidation?

Table 1: Fuel Consumption in Stationary Sources (e.g., boilers, furnaces, etc.)

Device Name	Device Type	Fuel Type	Quantity of Fuel Used	Units	Carbon Content Value	Carbon Content Unit	Oxidation Factor (%)
Basement Boiler	**Boiler**	**Fuel Oil**	**5,000**	**Liters**	**0.85**	**kg C/liter**	**99.0%**

Add Another Device

Remove Last Device

To calculate CO_2 emissions, follow the steps below.

Step 1) Calculate Total Carbon

Device Name	Fuel Consumed		X	Carbon Content		=	Carbon in Fuel (kg)
Basement Boiler	5,000	Liters of Fuel Oil	x	0.85	kg C/liter	=	4,250

Step 2) Calculate Amount of Carbon Oxidized into CO_2

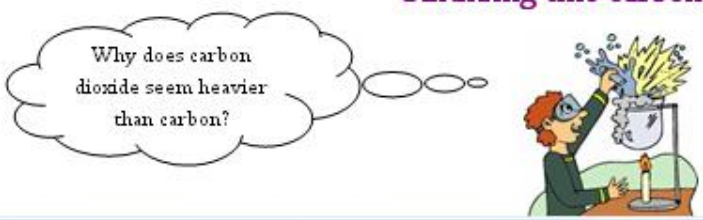
Device Name	Carbon in Fuel (kg)		X	Oxidation Factor (%)		=	Oxidized Carbon (kg of C)
Basement Boiler	4,250		x	99.0%		=	4,208

Calculate

Delete

Total oxidized carbon from stationary combustion at your school is: 4,208 **kg of C**

Oxidizing this carbon produces: **kg of CO_2**



Thinking like a scientist...

Answer: Approximately 15,400 kg of CO_2

(CO_2 has approximately 3.67 times the mass of C)

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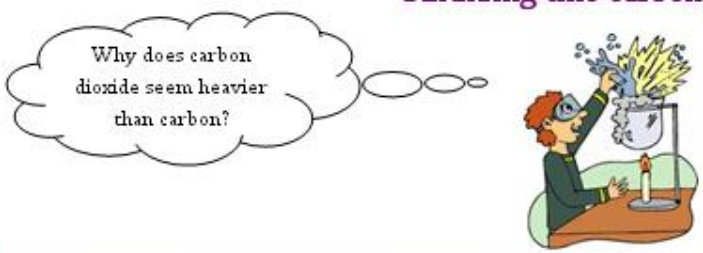
Calculate | Delete

Total oxidized carbon from stationary combustion at your school is: 4,208 **kg of C**

Oxidizing this carbon produces: 15,428 **kg of CO_2**



Thinking like a scientist...

CH_4 and N_2O Emissions

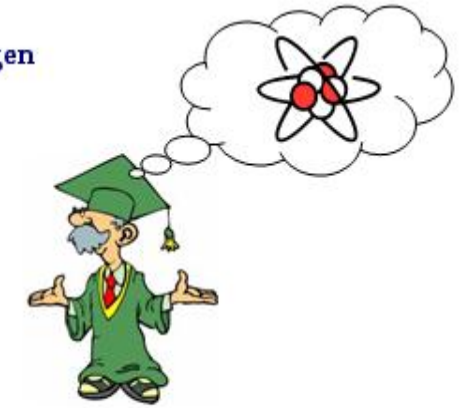
Thinking Like a Scientist...

Return

Carbon (C) vs. Carbon Dioxide (CO_2)

In 2003, U.S. emissions of CO_2 equaled 5,842 million metric tons. These CO_2 emissions occurred when carbon contained in fossil fuels, wood, and other carbon-based materials oxidized (underwent a chemical reaction with oxygen) usually because the fossil fuel, wood, or carbon-based material was combusted. During the oxidation process, each carbon atom picked up two oxygen atoms to become CO_2.
This same process happens at your school when fuels containing carbon such as natural gas, propane, or gasoline are combusted in stationary sources (e.g., boilers, heaters, generators) or mobile sources (e.g., cars, trucks, tractors).

Carbon dioxide must have more mass than carbon because it contains two additional oxygen atoms, but how much more?



Using a periodic table of the elements in your classroom, on the web, or in this kit, enter the atomic mass of a carbon atom and an oxygen atom in the yellow cells below.

Periodic Table

Atomic mass of a **carbon** atom:	12	(mean relative)	Correct!
Atomic mass of an **oxygen** atom:	16	(mean relative)	Correct!

The mass of a molecule of CO_2 is equal to:

The mass of **one** carbon atom: 12 plus the mass of **two** oxygen atoms: 16 + 16 = 32

The mass of a molecule of CO_2 is: 12 + 32 = 44

The percent of carbon in CO_2 is equal to the mass of carbon: 12 mass of a carbon atom Correct!

...divided by the mass of CO_2: 44 mass of a CO_2 molecule Correct!

27.27% percent of carbon in carbon dioxide

Carbon has 27.27 percent as much mass as carbon dioxide.

EPA's Climate CHECK

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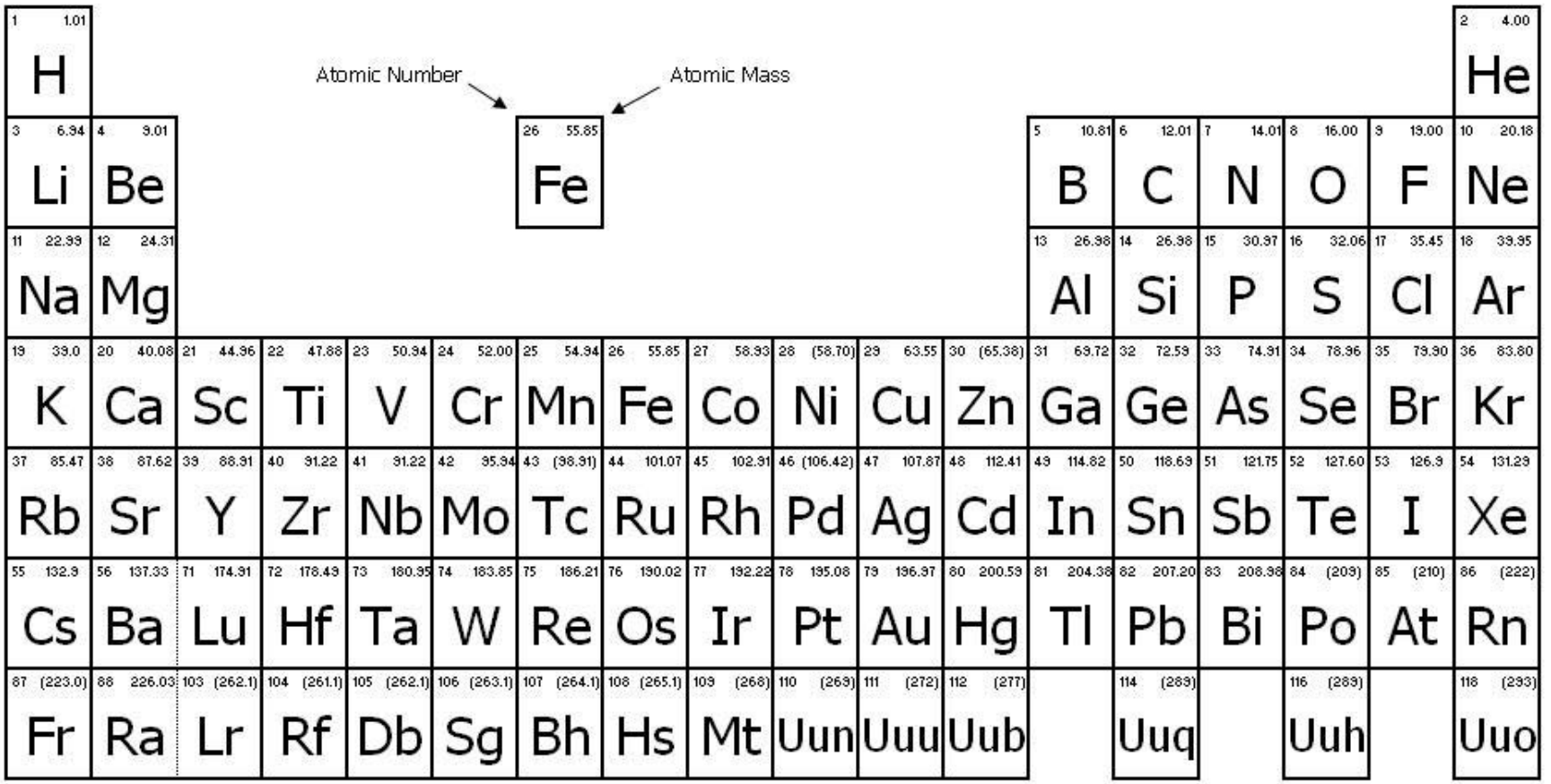
Periodic Table of Elements*

* Excludes Lanthanoids and Actinoids

Return



Stationary Combustion

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Appendix | Glossary | Conversions

Key Words:

- Fossil Fuel
- Carbon Content
- Oxidation Factor
- Incomplete Combustion
- Global Warming Potential
- Carbon Dioxide Equivalent
- Boiler

Total oxidized carbon from stationary combustion at your school is: 4,208 kg of C

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Thinking like a scientist...

CH_4 and N_2O Emissions

Although most GHG emissions from Stationary Combustion are in the form of CO_2, two other gases -- methane (CH_4) and nitrous oxide (N_2O) -- are also important emissions from these sources. Methane is a byproduct of **incomplete combustion** of the carbon in fossil fuels, while N_2O is formed when combustion of fossil fuels causes the oxidation of atmospheric nitrogen.

The amount of these gases produced during fossil fuel combustion depends on the amount and type of fuel combusted, control technologies, and age of the devices. Fuel types have their own emission factors, which express the amount of CH_4 or N_2O produced per kilogram of fuel combusted.

	CH_4	N_2O	
CH_4 and N_2O emissions from stationary combustion at your school are:	2.5	0.2	kg

Like CO_2, emissions of CH_4 and N_2O absorb heat given off by the earth's surface; however, they transfer the heat to the atmosphere differently than CO_2. An amount of CH_4 or N_2O transfers more heat to the atmosphere than the same amount of CO_2. Scientists call a GHG's ability to heat the atmosphere relative to CO_2 its **Global Warming Potential (GWP)**. If a gas has a **GWP** of 100, then 1 ton of that gas has the same impact on climate as 100 tons of CO_2.

GWPs are used to weight different gases into a common unit so that emissions from all gases can be compared. Scientists often use **carbon dioxide equivalent (CO_2 Eq. or CO_2E)** as the common unit. One ton of **CO_2E** has the same impact of carbon as 1 ton of CO_2. Without this conversion, emissions of different gases cannot be compared in a meaningful way since 1 ton of, say, N_2O has a very different impact on climate than 1 ton of CO_2.

Using the table in **Appendix B,** fill in the appropriate GWPs in the cells below. Then, complete the calculation to convert CH_4 and N_2O emissions into units of CO_2 Equivalent.

How'd they do that? *Calculation Explanations*

Return

Methane (CH_4) and Nitrous Oxide (N_2O) from Stationary Combustion

Background Information:

Methane and nitrous oxide emissions from stationary combustion are determined by multiplying the amount of fuel combusted by the amount of heat generated through that combustion (heat content). The resulting value reports the heat generated by combusting the fuel in Million British Thermal Units (MMBTU). The heat generated in MMBtu is then converted to Giga Joules (another energy unit) and multiplied by that fuel's CH_4 or N_2O emission factor.

Factors:

	Heat Content		CH_4 and N_2O Emissions Factors				Conversion Factors	
	Value	Unit	CH_4	Unit	N_2O	Unit	Value	Unit
Coal	23.38	MMBtu/ mt	10	g/GJ	1.4	g/GJ	1.055	MMBtu/ GJ^2
Natural Gas	0.036	MMBtu/ l	5	g/GJ	0.1	g/GJ		
Propane	0.031	MMBtu/ l	10	g/GJ	0.6	g/GJ		
Gasoline	0.044	MMBtu/ l	10	g/GJ	0.6	g/GJ		
Diesel Fuel	0.049	MMBtu/ l	10	g/GJ	0.6	g/GJ		
Fuel Oil	0.053	MMBtu/ l	10	g/GJ	0.6	g/GJ		
Kerosene	0.048	MMBtu/ l	10	g/GJ	0.6	g/GJ		

Example Equation:

Templeton Heights High School combusts 5,000,000 liters of natural gas in a natural gas boiler each year.

How many **kilograms** of CH_4 does the school produce through this combustion? kg round to the nearest whole number

How many **kilograms** of N_2O does the school produce through this combustion? kg round to the nearest whole number

Hide Answers

Methane from Natural Gas

$$5{,}000{,}000\ \text{liters} \times \frac{0.036\ \text{MMBtu}}{1\ \text{liter}} \times \frac{1\ \text{GJ}}{1{,}055\ \text{MMBtu}} \times \frac{5\ \text{grams}\ CH_4}{\text{GJ}} \times \frac{1\ \text{kg}}{1000\ \text{grams}} = \mathbf{853\ kg\ CH_4}$$

Nitrous Oxide from Natural Gas

$$5{,}000{,}000\ \text{liters} \times \frac{0.036\ \text{MMBtu}}{1\ \text{liter}} \times \frac{1\ \text{GJ}}{1{,}055\ \text{MMBtu}} \times \frac{0.1\ \text{grams}\ N_2O}{\text{GJ}} \times \frac{1\ \text{kg}}{1000\ \text{grams}} = \mathbf{17\ kg\ N_2O}$$

Sources:

[1] IPCC Stationary Emissions Factors Tier 1 (Residential)

EPA's Climate CHECK

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Stationary Combustion

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Appendix | Glossary | Conversions

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The amount of these gases produced during fossil fuel combustion depends on the amount and type of fuel combusted, control technologies, and age of the devices. Fuel types have their own emission factors, which express the amount of CH_4 or N_2O produced per kilogram of fuel combusted.

CH_4 and N_2O emissions from stationary combustion at your school are:	CH_4	N_2O	
	2.5	0.2	kg

Like CO_2, emissions of CH_4 and N_2O absorb heat given off by the earth's surface; however, they transfer the heat to the atmosphere differently than CO_2. An amount of CH_4 or N_2O transfers more heat to the atmosphere than the same amount of CO_2. Scientists call a GHG's ability to heat the atmosphere relative to CO_2 its **Global Warming Potential (GWP)**. If a gas has a **GWP** of 100, then 1 ton of that gas has the same impact on climate as 100 tons of CO_2.

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Using the table in **Appendix B,** fill in the appropriate GWPs in the cells below. Then, complete the calculation to convert CH_4 and N_2O emissions into units of CO_2 Equivalent.

	Emissions (kg)	x	GWP	=	Emissions	
CH_4	2.5	x		=		kg CO_2E
N_2O	0.2	x		=		kg CO_2E

Calculate | Delete

Exercise: What is methane's Global Warming Potential (GWP)? Nitrous oxide?

EPA's Climate CHECK

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Stationary Combustion

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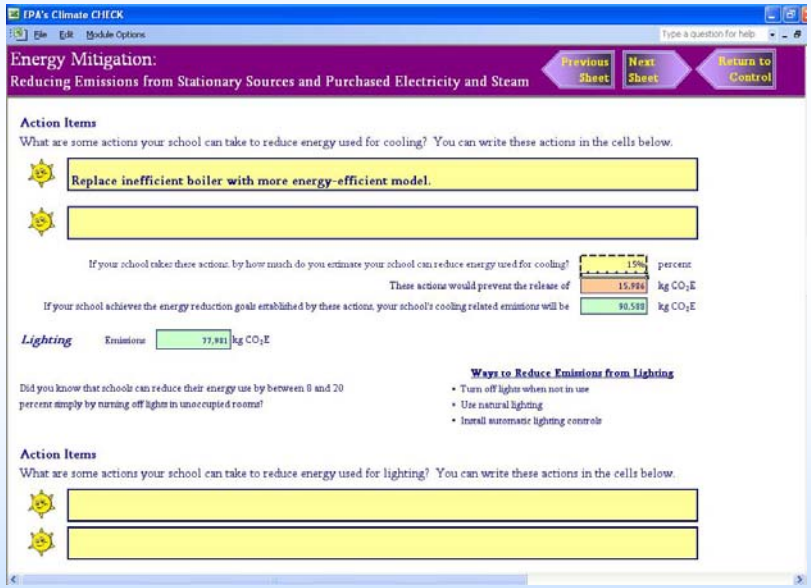
	Emissions (kg)	x	GWP	=	Emissions			
CH_4	2.5	x	21	=	53	kg CO_2E	Calculate	Delete
N_2O	0.2	x	310	=	62	kg CO_2E		

Answer: According to the IPCC's SAR, methane's GWP is 21 and nitrous oxide's GWP is 310.

Section 3: Action Planning

- Following an emission inventory, students can use Section 3 to plan actions to reduce emissions by Sector (e.g., Energy, Transportation)

- Students enter actions and percent reductions in emissions by source on Action Planning Sheets.



- These “mitigation actions” are summarized in an “Action Plan” that can be printed, signed, and displayed at their school.

Energy Mitigation:
Reducing Emissions from Stationary Sources and Purchased Electricity and Steam

Previous Sheet | Next Sheet | Return to Control

Action Items

What are some actions your school can take to reduce energy used for cooling? You can write these actions in the cells below.

Replace inefficient boiler with more energy-efficient model.

If your school takes these actions, by how much do you estimate your school can reduce energy used for cooling? 15% percent

These actions would prevent the release of 15,986 kg CO_2E

If your school achieves the energy reduction goals established by these actions, your school's cooling related emissions will be 90,588 kg CO_2E

Lighting Emissions 77,981 kg CO_2E

Did you know that schools can reduce their energy use by between 8 and 20 percent simply by turning off lights in unoccupied rooms?

Ways to Reduce Emissions from Lighting

- Turn off lights when not in use
- Use natural lighting
- Install automatic lighting controls

Action Items

What are some actions your school can take to reduce energy used for lighting? You can write these actions in the cells below.

Action Plan

Previous Sheet

Return to Control

Action Plan for DC School

The following emissions were estimated for your school.

	GHG Emissions ($kgCO_2E$)				
	CO_2	CH_4	N_2O	HFC	**Total**
Stationary Sources	15,428	53	47		15,527
Purchased Electricity	244,411				244,411
Purchased Steam	0				0
Mobile Sources	1,440,564	1,350	5,139		1,447,054
Waste		79,386			79,386
Wastewater		2,564	643		3,207
Air Conditioning and Refrigeration				1,156	1,156
Land Management	1,180	0	9		1,190

We are committed to taking the following actions in order to achieve GHG emission reductions at our school.

Energy Action Team Name: _____

Emission Reductions: 15,986 kg CO_2E

- Replace inefficient boiler with more energy-efficient model.
- Start a bike-to-school program
- Install energy-efficient light fixtures
- Shut off computers and other electronic equipment over night
- Plant trees
- Install energy-efficient windows
- Purchase alternative-fuel school buses
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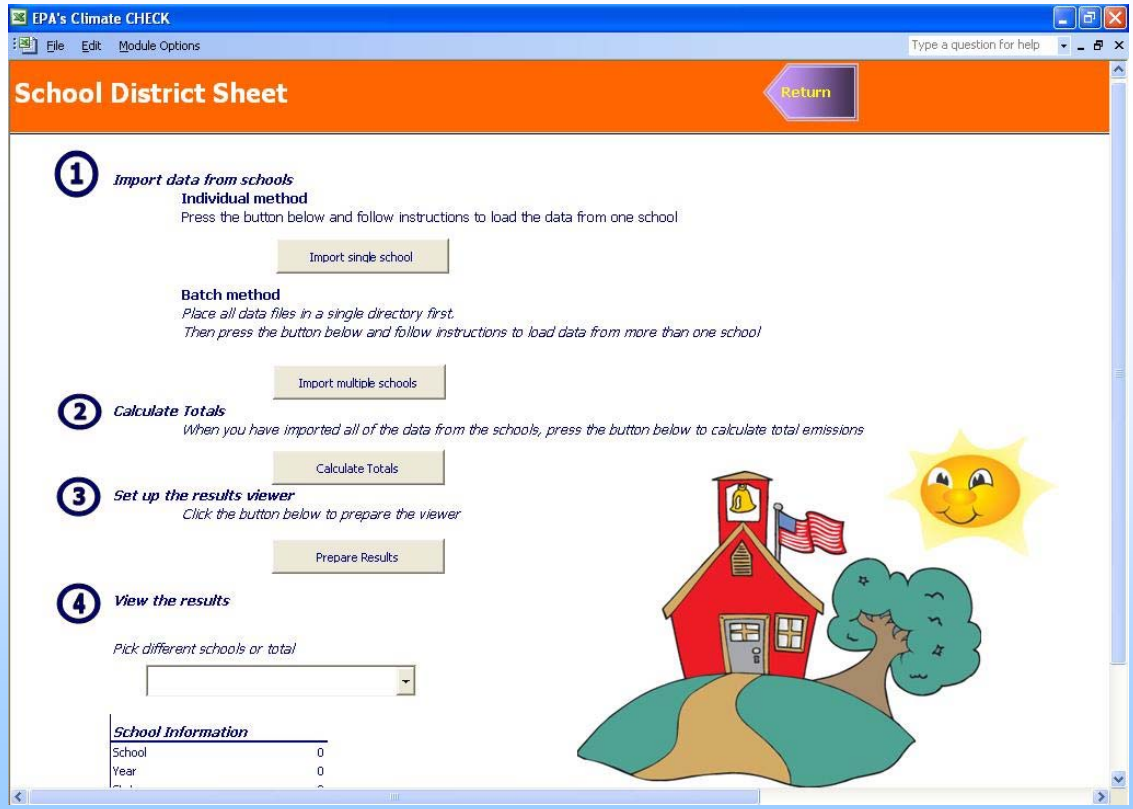
School District Compiler

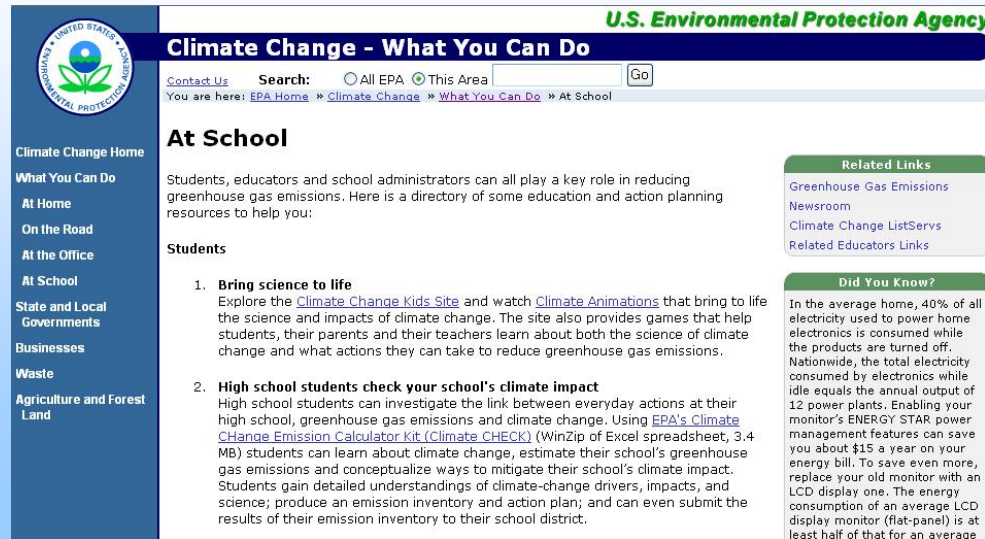
- After completing an emission inventory and action plan, students can export the results of their inventory and email them to their school district to support district-wide climate change programs.



How can I get Climate CHECK?

- EPA's global warming website
  - http://www.epa.gov/climatechange/wycd/school.html
- ClimateCHECK@icfi.com
- Special thanks to Karen Scott of EPA

  Scott.Karen@epa.gov



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