Plan for and Conduct the Audit (2 meetings)

1. **Review** this audit guide and contact DOE with any questions.
2. Discuss the topics of **energy use and air quality** and why they matter.
   - Use the game on this page, and/or the PowerPoint presentation from the Air & Energy Workshop (available on your Resource CD).
   - Emphasize their relation to global climate change.
     - Be sure to emphasize the major source of Illinois's power, and the impact that generating electricity from coal has on our global climate.
   - Have students investigate some of the **Additional Resources** (p.4).
3. Discuss the **goals of the audit.**
   - To inventory how energy is used around the school in order to determine how energy could be conserved.
   - To learn how air quality is affected by current practices in the school and how it could be improved.
   - To learn about current energy savings and air quality improvements that are already in place in the school.
4. Decide **how many rooms** of the school your Club will audit for your "Air & Energy Sleuth" observations.
   - Depending on the size of your school, consider limiting the audit to one wing or floor of the school, or to representative areas such as a few classrooms, the kitchen, the school office, and a hallway.
5. **Notify appropriate administration,** maintenance staff and other teachers that students will be visiting areas of the school to conduct their air and energy audit.
   - Find out if there are areas where energy is used that are off limits to students, and the extent to which students will need to be supervised as they move around the school campus.
     - Feel free to use DOE's sample memo to explain the project (included on your resource CD).
   - **Ask the building engineer** if s/he wants to be involved in some way. Options for involvement may include:
     - Tours of the places where energy is used and measured in the building, such as the boiler room and the energy meter.
     - Attendance at a Club meeting to explain the school's heat and air conditioning and necessary maintenance.
     - Provision of the school's energy use reports and statements to help students better understand energy use at the school.

"Guess Which Gas…?"

By participating in this interactive game, Club members will be able to explain the definition of a greenhouse gas, give several examples of greenhouse gases, and name several different features and origins of various atmospheric gases.

Activity summary:

Each student gets a card with a different gas or component of air assigned to them. The card will not only have the written name of the gas but also its chemical formula, atomic structure, and two numbers. The first number is the molecule's concentration in our atmosphere, measured in parts per trillion. The second is the molecule's global warming potential (GWP). GWP looks at the capacity of the gas to absorb light and heat energy from the sun, thus trapping it in the atmosphere and contributing to the greenhouse effect. It is measured in relation to carbon dioxide. For example, methane has a GWP of 25. This means that if you measured the infrared absorption of a certain mass of methane, you would find that it absorbs 25 times more heat than the same mass of carbon dioxide.

Atmospheric concentration and GWP are important numbers because greenhouse gases of concern with regards to global climate change are either rapidly increasing in concentration, or have a very high global warming potential.

In this activity, descriptive statements will be read and students will move to one end of the room or the other based on if they think the statement applies to their molecule or not. The 'A' statement is read first, and students move accordingly.

Continued on p. 3

"Guess Which Gas…?" *continued*

Next, the 'B' statement is read, and students move again according to the information they now have from the 'B' statement about their molecule. They then check off the correct answer on the checklist found on the back of their card. After each pair of statements, Club moderators should lead a discussion of what students learned.

Directions:

1. Print/copy and cut apart air molecule cards, ensuring that you have one for each student. Be sure to print the sheets double sided so that each card has a molecule picture on one side, and a checklist on the back. For larger groups, multiple students can be assigned to the same molecule. Cards are in the appendix of this guide on p.15-20 and on the Air & Energy Resource CD.
2. Hand out air molecule cards to student participants (one to each student).
3. Read each yes/no statement (the 'A' statements) and the "Further Explanation" statements.
4. Students should move to one end of the room if they think the descriptive statement **does** apply to their component of air or the other end of the room if they think the description statement **does not** apply to their component of air.
5. After the students move, read the follow up explanation statement ('B') and have students move again to the correct end of the room. *Do not focus on the fact that students might make the wrong move, but that we are all learning and participating in a demonstration about the air in our atmosphere.
6. Discuss misconceptions, surprises, reactions, etc.

Statements:

1A You are a greenhouse gas.
Further explanation: Greenhouse gases absorb heat which then warms our atmosphere. Without them, Earth would be too cold to be inhabited. If their concentration is too great, however, Earth could become too warm to be inhabited.
1B Everything except N_2 and O_2.

2A You make up more than 15% of the atmosphere.
2B Nitrogen is the most prevalent gas in our atmosphere. Its portion of the atmosphere is nearly 80%. Oxygen is approximately 19%. All of the other gas molecules make up less than 1%.

3A You are a naturally-occurring gas.
Further explanation: Even if people weren't on the planet, these gases would still be found in the atmosphere.
3B Water, carbon dioxide, methane, nitrogen, nitrous oxide, oxygen, and ozone are naturally occurring gases.

4A You are a naturally-occurring, human-**influenced** gas.
Further explanation: These greenhouse gases occur naturally, but due to human influence exist in much higher concentrations in the atmosphere than they would otherwise.
4B Carbon dioxide and methane. Carbon dioxide is emitted by coal-fired power plants and industry. Methane is produced due to flatulence and decay; humans raise livestock in massive feed lots and fill landfills, both of which increase methane in the atmosphere.

5A You are a human-**made** gas.
Further explanation: These gases do not occur naturally, and are produced through industrial waste.
5B Chlorofluorocarbons (CFC's), hydrofluorocarbons (HFC's) & sulfur hexafluoride (SF_6) are human-made gases.

Continued on p. 4

"Guess Which Gas…?" *continued*

6A You are increasing in concentration.
Further explanation: As time goes on, more and more of this gas is in the atmosphere.
6B Carbon dioxide, methane, hydrofluorocarbons (HFC's) and sulfur hexafluoride (SF_6) are increasing in concentration. Carbon dioxide and methane are increasing due to human production in industrialized nations through transportation, industry, and livestock. The HFC's and SF_6 are increasing because they are substitutes for chlorofluorocarbons which were banned internationally within the past several decades because of their detrimental effect on the ozone layer.

7A You are a by-product of traditional energy production (coal-fired power).
Further explanation: When you burn coal, this gas is emitted.
7B Carbon dioxide and nitrous oxide. 40% of all U.S. carbon dioxide emissions and 18% of all U.S. nitrous oxide emissions come from coal-fired power plants.

8A Once emitted into the atmosphere, you will remain there for more than 50 years.
Further explanation: This is often referred to as atmospheric lifetime; it is the length of time it takes a gas to either leave the atmosphere or break down.
8B Carbon dioxide, nitrous oxide, sulfur hydrofluorocarbons, nitrogen, and oxygen.
Atmospheric lifetimes are listed below:
water vapor – 9 days
carbon dioxide – >10,000 years
methane – 12 years
nitrous oxide – 114 years
ozone – hours/days
chlorofluorocarbons – 45 years
hydrofluorocarbons – 9-18 years
sulfur hexafluoride – 3,200 years
nitrogen – >1 billion years
oxygen – 4 million years

9A You can be used as an energy source.
Further explanation: People can produce electricity from this gas.
9B Methane can be captured and burned to be used as an alternative energy source. For example, "cogeneration" is the production of electricity and heat through combustion of substances like methane. SC Johnson's Waxdale manufacturing plant in Racine, WI, uses the combustion of methane gas from a landfill a few miles away to generate the daily base load of electricity for his plant, plus between half and all of the steam needed for operations, depending on the season. Source: http://www.scjohnson.com/environment/conserving.asp (click "Using Greener Energy")

10A You are a "bad" gas.
10B This is a tricky question that doesn't really have a right answer! Nitrogen and oxygen are could definitely be considered "good" gases – they are not harmful. Chlorofluorocarbons could definitely be considered "bad" – they deplete the ozone and have been banned internationally. For most of the other greenhouse gases, however, the issue is not so straightforward. Without them, our planet would not be inhabitable. Gases like water vapor, carbon dioxide, ozone, nitrous oxide, and methane do contribute to climate change, but are necessary parts of our environment (e.g., are part of the water cycle, photosynthesis, etc.). HFCs and SF_6 have replaced more detrimental CFCs, and until alternatives are developed, are a better option. What do you think?

Continued on p. 5

Richard M. Daley, Mayor
City of Chicago
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Suzanne Malec-McKenna, Commissioner
Department of Environment

"Guess Which Gas…?" *con't*

Discussion Questions

1. What is a greenhouse gas? Why are they important?
   Greenhouse gases absorb heat which then warms our atmosphere. Without them, Earth would be too cold to be inhabited. If their concentration is too great, however, Earth could become too warm to be inhabited.
2. How do greenhouse gases relate to human-influenced climate change?
   Because of human activities, some greenhouse gases are rapidly increasing in concentration, thus contributing to excessive warming. Humans have also created some new types of gases not found in nature that are contributing to global climate change.
3. Are all greenhouse gases the same? What are some of their differences?
   No. Some stay in the atmosphere longer than others. Some absorb more heat than others (look at global warming potential on cards). Some are found naturally, and some are not. Some are found in greater concentrations than others.
4. How does this activity relate to energy conservation? To indoor air quality?
5. What did you find most surprising about what you learned today?

Extension / Demonstration:
Students arrange themselves in order from the least concentrated to most concentrated air molecules according to the numbers on their cards. Students again arrange themselves in order from the least global warming potential to the highest global warming potential

Part A: "How to Kill-A-Watt"

1. Hand out the **Activity Guide (p. 5)** and **Calculations Worksheet (p. 6).**
   - Discuss the worksheet with all of the Club members, and select which appliances your Club will measure.
2. Go through Steps 1-6 on the worksheet together – plug the first appliance into the Kill-A-Watt.
   - Decide on a timeframe – for example, we recommend that you select several students to record observations after two days and switch to a new appliance. If you are measuring appliances outside of your own classroom, be sure to get permission from the other faculty and staff members who use the equipment.

3. Follow the plan your Club laid out to observe how much electricity is used by 3-4 different appliances. Club members should fill out columns **A** and **B** on the **Calculations Worksheet**.

Part B: "Air & Energy Sleuth"

1. Hand out the **Air & Energy Sleuth Activity Guide (p. 7-8) and the Air & Energy Sleuth Observations Worksheet (p. 9-10)**, and explain the procedure.
   - Club members will divide into groups. Each group will be responsible for auditing specific areas within the school.
   - Club members will record their observations on the **Air & Energy Sleuth Observations Worksheet.**

2. Divide the Club into groups and assign a group to each audit area.
3. Have groups decide when they will audit their designated areas.
   - Club members should try to find times when they think they might catch problems such as lights and electronics left on inappropriately.
   - Immediately after school will probably be a good time in most cases.
   - Club members should make sure that the audit will not be disruptive.
4. During their chosen times, groups of Club members will audit their designated areas. Make sure that each group has enough copies of the **Air & Energy Sleuth Observations Worksheet**. They can audit four rooms/locations per double-sided worksheet.