



# Climate Master Handbook

A GUIDE TO SHRINKING YOUR CLIMATE FOOTPRINT  
AND MOTIVATING OTHERS TO DO THE SAME

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# INTRODUCTION TO CLIMATE MASTERS

***This handbook is intended for participants in the Climate Master training program. It is designed to provide a basic level of knowledge for each of the topic areas covered. At the end of each section you will find local resources and supplementary activities to deepen your understanding of the topic as it relates to your own life and to help you reduce your personal greenhouse-gas emissions and motivate others to do the same.***

The Climate Leadership Initiative (CLI) developed a highly successful model for educating citizens about climate change and engaging them in activities in their household and community to help resolve the issue. That model, initiated as a research project, includes two primary components: the Climate Master train-the-trainer course and the household climate consultations conducted by trained climate masters.

Most of today's strategies to reduce greenhouse gas (GHG) emissions focus on large sources such as power plants, industrial facilities, and vehicles, with the goal of achieving the greatest results from initial efforts. Households, however, could be considered the ultimate end-users of most energy production via home heating, cooling, appliances, food, travel, and embedded energy in products that households purchase. Therefore, households, directly or indirectly, produce significant amounts of GHG emissions. Yet the general public's understanding of climate change remains low and few people think they personally can do much about the problem.

CLI discovered that a community-based approach can effectively reduce GHG emissions. To date, the program has resulted in average GHG emission reductions of more than 4,000 pounds per participant, increases in regular use of alternative transportation, energy-efficient purchasing, and reduced use of disposable items, among other climate-positive actions.

The Climate Leadership Initiative aims to disseminate the model to communities across the region and nation, providing training, materials, ongoing technical assistance, and monitoring, with the goal of developing sustainable programs. Individuals benefit from cost savings, an increased sense of well-being, empowerment, and good health. Some participants say the program changed their life. Communities benefit from reduced greenhouse-gas emissions, support for climate-positive technology and policy, increased volunteerism for climate change and energy efficiency, and leadership training, as a diverse swath of community members join around a uniting theme: acting locally to curb global climate change.

**Visit the Climate Leadership Initiative at [www.climateleadership.org](http://www.climateleadership.org)**



*The goal of the Climate Master program is to increase understanding among individuals and households about the causes of and solutions to climate change and to encourage and achieve reductions of personal greenhouse gas (GHG) emissions.*

## **What Is a Climate Master?**

Climate masters participate in thirty hours of training on climate change science and action strategies for reducing personal GHG emissions. The training topics include identifying and reducing emissions in transportation and food choices, home energy use, and yard, consumption, and waste practices.

## **Volunteer Commitment**

In exchange for the training, climate masters will volunteer for at least 30 hours within six months from the start of their course, sharing the information they have learned and supporting behaviors that reduce GHG emissions. Climate masters will receive their certification upon completion of their volunteer time. Those who do not complete their volunteer work must pay \$240 for materials and instruction.

## **Fulfilling the Commitment**

Our staff will work with volunteers directly to set up appropriate, fulfilling, and enjoyable opportunities to share their skills and knowledge. All volunteer work must be pre-approved by the volunteer coordinator or it will not count toward qualifying hours. The following choices are acceptable options for fulfilling your obligation.

### **1. Work as a household GHG emissions consultant**

We encourage volunteers to work directly with households. This could take the form of a one-time household climate consultation or ongoing assistance. Climate masters will share tailored emission-reduction strategies with those households and ask participants to make changes they believe are possible for their household.

We will schedule consultations for you with people who contact us. We also ask that you set up five to ten of your own consultations with people you know, using our materials and returning the commitment forms and surveys to us.

### **2. Table events**

The public is hungry for information on what they can do in their own lives to reduce their greenhouse gas emissions. When we table events, we help people calculate their carbon footprint, provide information on reducing emissions, and encourage people to sign up for household consultations, our list serve, or the next Climate Master class.

### **3. Other activities**

Other volunteer opportunities include public speaking, writing or editing materials, special events, and other opportunities suggested or approved by the volunteer coordinator. We are also open to your suggestions for ways to fulfill the volunteer commitment. Again, we prefer that most participants work directly with households, but we can discuss alternatives you may find more appropriate.

## **Reporting Volunteer Hours**

We require that participants track their hours and turn in a monthly time sheet (available at the back of the handbook and online). In order to assess the effectiveness of the Climate Master program, we need to know what and how much our volunteers are doing in the community. If you are not completing and reporting your volunteer hours, we cannot continue this program. Please share your outreach efforts with us and help make this program a success!

## **Class Information**

Please ask questions if you are unclear on a topic. We ask that you avoid using instruction time to debate issues, expound on your beliefs, or describe your knowledge of the subject to the class and the instructors. Other students will prefer to hear what the instructors have to share during their presentation time. Classes begin promptly at 6 p.m. and run until 8:45 p.m.



# CLIMATE MASTER SAMPLE SYLLABUS

## Class 1: Introduction to Course and Climate Change Science

### Topics

- Objectives and expectations of the Climate Master program
- Getting to know other participants
- Completion of paperwork
- Overview of climate change science

## Class 2: Home Energy

### Topics

- Our local energy portfolio and the regional power grid
- Reducing energy use in space and water heating, lighting, and appliances

### Preparation

- Bring your latest energy bills to class
- Read Section Two: Home Energy

## Class 3: Transportation

### Topics

- Local transportation options: bike resources, carpools, and group-pass programs
- Driving tips for reducing emissions
- Biofuels

### Preparation

- Chart the miles you drive in a week, the purpose, and number of passengers you carry
- Read Section Three: Transportation

## Class 4: Consultation Techniques and Training

### Topics

- Working with people in their home
- Specific tools for conducting consultations

### Preparation

- Read the consultation work sheets and answer the questions
- Read Section Nine: Consultations

## Class 5: Yard and Garden

### Topics

- Composting
- Low-emissions yard care
- Trees
- Home gardens—feeding yourself over winter, or putting the garden to bed

### Preparation

- Walk through your yard and consider the steps involved in its maintenance
- Read Section Six: Yards

## Class 6: Food Emissions

### Topics

- Food emissions along the supply chain

### Preparation

- Keep track of what you eat in a day or a week
- Read Section Eight: Food

## Class 7: Renewable Energy

### Topics

- Local utility options for renewable energy
- Options at home: incentives, priorities (start with efficiency!)

### Preparation

- Calculate the cost of renewable energy for your home, such as solar panels or renewable-energy credits
- Read Section Five: Renewable energy

## Class 8: Consumption, Waste, Green Building, Home Consultation

### Topics

- Embodied emissions
- Recycling and precycling
- Energy in buildings and building materials
- Green building
- Practicing home consultation

### Preparation

- Track your waste for a day
- Read Section Four: Green building and Section Seven: Consumption

## Class 9: Consumption (Part Two), Communication

### Topics

- Voluntary simplicity
- Communicating for change

### Preparation

- Track your purchases for a day

## Class 10: Graduation

### Topics

- Presentations
- Potluck
- Graduation

### Preparation

- Finish your presentation

## Booster training

### Topics

- Making your voice heard
- Preparing for Climate Impacts

## SECTION ONE: CLIMATE CHANGE 101

### Key Learning Points

- Humans have increased atmospheric concentrations of greenhouse gases.
- Greenhouse gases absorb heat resulting in increased average global temperatures.
- Average global temperatures have been increasing over the last century.

The materials in this chapter provide a broad overview of climate change, focusing primarily on causes and impacts. While the scientific understanding of climate change is improving so rapidly and encompasses so many fields of research that it's difficult for even climate-change professionals to stay up to date, it's important that climate masters understand the general concepts involved in climate science and know where to go for more information.

### The basics

The earth remains habitable in part thanks to gases in the atmosphere that trap a portion of the sun's energy. These are called greenhouse gases because of their ability to absorb heat, much as the windshield of a car baking in the sun will retain and radiate heat inside the vehicle. With too few of these gases, our planet would be too cold to inhabit. But recent human activity has led

to a marked increase in atmospheric greenhouse gases. This exponential increase in atmospheric concentrations has led scientists to recognize these gases as pollutants that are destabilizing our climate, with already apparent and potentially severe consequences.

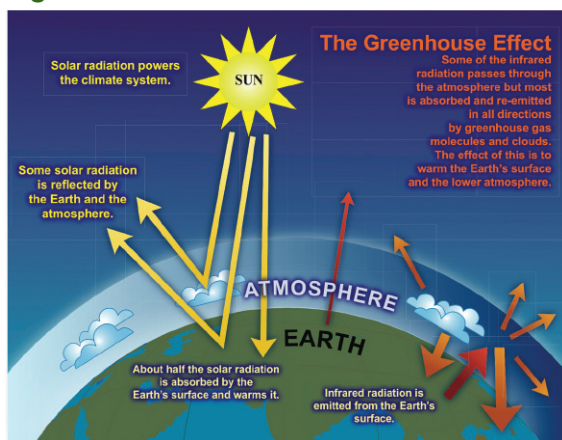
Since 1750 and the onset of the industrial revolution, concentrations of carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>) have increased significantly (by approximately 36%, 18%, and 148%, respectively) in the atmosphere as a result of human activity.<sup>1</sup> Increases in carbon dioxide are due primarily to the burning of fossil fuels and to changes in land use, such as deforestation. Agriculture is largely responsible for increases in nitrous oxide (fertilizer use) and methane (livestock). Nitrous oxide is also released from fossil fuel burning and methane is also emitted from natural gas distribution and landfills.<sup>2</sup>

Global concentrations of all three of these greenhouse gases, measured in parts per million (ppm), now far exceed preindustrial values, as determined from ice cores spanning many thousands of years. The atmospheric concentration of carbon dioxide, the most important greenhouse gas released by human activity, now far exceeds the natural range over the last 650,000 years (that natural range is 180–300 ppm; June 2008 levels reached 383.9 ppm).<sup>3</sup>

### The bottom line

Perhaps the most important outcomes of the 2007 Intergovernmental Panel on Climate Change (IPCC) report are the declarations that the evidence is now “unequivocal” that the Earth's atmosphere and oceans are warming, and that it is “very likely” (greater than 90% likelihood) that

Figure I-1. Greenhouse Effect



Greenhouse gases absorb and radiate heat back into our atmosphere.

Source: Intergovernmental Panel on Climate Change Working Group I, “The Physical Science Basis,” 2007, [www.ipcc.ch](http://www.ipcc.ch)

most of the increase in global-average temperatures since 1950 can be attributed to human-caused emissions of heat-trapping gases.<sup>4</sup> (Note: Science does not employ the concept of “proof.” Proof is a mathematical term. Science uses a “balance of evidence” approach to determine the likelihood of an event.) The report also states that greenhouse-gas emissions must peak by 2015 and decrease by 80-90% by 2050 in order to avoid dramatic temperature increases and the severe economic, social, and environmental impacts that would accompany such increases. According to the IPCC, making this shift requires action within the next two to three years at all levels of society.

## Evidence of warming

In part we know that the climate is warming because of direct observation of increased average air and ocean temperatures and widespread melting of snow and ice, alongside rising global-average sea levels. Eleven of the last twelve years rank among the twelve warmest since 1850 with average global temperatures up since the beginning of the industrial age.<sup>5</sup> The average temperature of the global ocean has increased to depths exceeding 9,800 feet, and the ocean has been absorbing more than 80% of the heat added to the climate system. This warming causes sea water to expand, contributing to sea level rise.

Other observations include changes in Arctic temperatures and ice cover, widespread changes in precipitation amounts, shifts in wind patterns, and changes in ocean salinity. Finally, observations show increases in the incidence of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of hurricanes. Figure I-2 shows a graph of the recent increases in global temperature and global sea level alongside the decrease in snow cover in the Northern Hemisphere. For more details on observed changes, see the IPCC Summary for Policy Makers.<sup>6</sup>

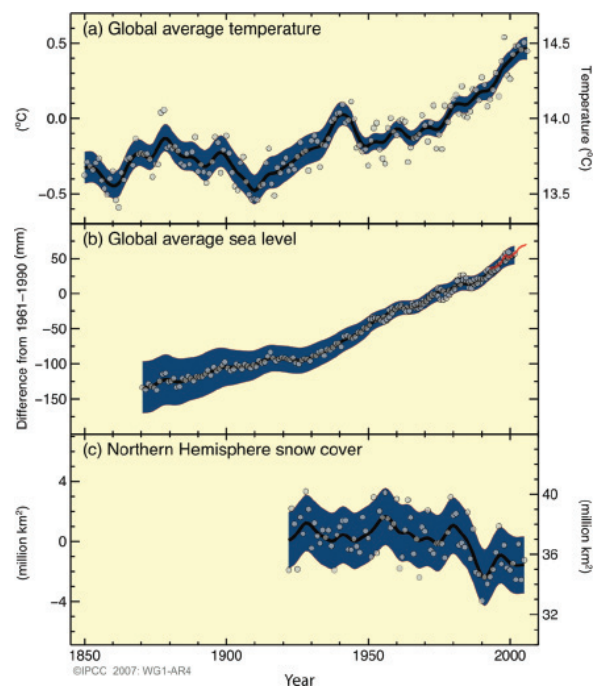
## Projections of the future

For the next two decades, models project a global warming of about 0.36°F per decade, continuing a documented warming trend of about the same magnitude since 1990. The mid-range of global-average surface warming expected during the twenty-first century falls between 3.2°F and 7.2°F, while the full range for the century is 2°F to 11.5°F. According to the Copenhagen Diagnosis (2009),

which serves as an update of the IPCC’s 2007 report, given unmitigated emissions, global sea-level rise may well exceed 1 meter by 2100. The upper limit has been estimated as 2 meters sea-level rise by 2100. Sea-level will continue to rise for centuries after global temperature have been stabilized and several meters of sea level rise must be expected over the next few centuries.<sup>7</sup>

Some of the most severe initial US impacts are likely to affect the Southwest, which is expected to receive less rainfall and experience more warming. The snow season is expected to shorten, and the total snow cover to shrink. Effects on the Pacific Northwest, subject to regional factors including El Niño and ocean circulation phenomena, carry higher uncertainty.

Figure I-2. Observed Physical Change



Observed changes in (a) global average surface temperature; (b) global average sea level; and (c) Northern Hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961-90. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a) and (b) and from the time series (c).

Source: Intergovernmental Panel on Climate Change Working Group I, “The Physical Science Basis,” 2007, [www.ipcc.ch](http://www.ipcc.ch)



## Conclusion

All told, global climate change may be the greatest existing threat to humankind and the ecosystems we and all other organisms depend on for life. We have changed the global climate and are now beginning to observe the consequences. Some of the changes will be erratic and unpredictable, but we must prepare for the projected and the unexpected. Our other duty is working to slow and reverse the trend of warming by decreasing human-produced greenhouse-gas emissions. This action is referred to as mitigation.

One key point not often emphasized in mitigation is the role of individuals, as opposed to industry or the transportation sector, in the emission of greenhouse gases. Emission sources are often broken down into sectors including transportation and energy production, as well as industrial, residential, and commercial energy use. Other important sources are deforestation, changes in land use, and landfills. However, the very creation of these categories blurs the fact that individuals like you are at the root of all of these emissions. After all, there would be no transportation, energy production, industry, or commerce if it were not for our human needs and desires. Trees are cut down to build our homes, to

### “Climate” vs. “Weather”

Many confuse the two words in everyday speech, usually with no dire effect. But for purposes of dealing with climate change, the distinctions are critical.

**Weather** is changeable day by day. Cool, wet summers are not unknown, nor are 70-degree days in winter. Local, transient phenomena produce local, transient weather effects.

***Can the planet truly be warming if we’re having a damp and dreary summer? Yes.***

That’s because **climate** is “weather” averaged over time. For instance, Western Oregon’s climate typically consists of cool, wet winters that build snowpack in the mountains, showery springs that last through June, and dry, warm to occasionally hot summers that end about mid-October. Eastern Oregon is colder in winter and hotter in summer, while the coast is the reverse due to climate effects of the ocean and mountains.

There are larger temporal climate effects, too. Most of us recognize that an El Niño disturbance will result in drier-than-normal weather over the year, while a La Niña will be wetter than usual. More expansively, there is a switch (known as the Pacific decadal oscillation) that seems to flip every twenty to thirty years, going from a drier-than-usual climate to a wetter-than-usual one.

None of these tells us if it’s going to rain this weekend. That’s **weather**.

Global warming is a **climate** effect, a rise in average temperatures, a background effect with which shorter-term climate effects interact to produce weather. A hot year will tend to be hotter and a cool year, not as cool. A La Niña might produce more intense rain in April and less moisture in August than it would have absent the effects of climate change.

Global warming will have – is likely already having – such weather effects. Some of these are predictable: overall warmer weather year-round, less snowpack, melting glaciers, more extreme storms, and so on. Some are far harder to predict.

***Will it rain more or less? Will that precipitation come on the same timetable as now or will the pattern shift?***

We can’t use today’s weather to judge in what ways climate change is already affecting us. We can look at global-average effects and effects observed over the passage of years to see where the disturbing patterns of climate change are coming into focus.

*From the Oregon Governor’s Advisory Group on Global Warming, “Primer on Global Warming”*

make paper, and to clear land for agriculture—which provides food for humans and our livestock. By the same token, if we are responsible for these emissions, then we, too, have a responsibility and the power to influence the reduction of these greenhouse-gas emissions.

Tactics for reducing emissions vary from place to place and person to person. Sources of greenhouse gases diverge between communities based on land use, whether people are using hydropower or burning fossil fuels for energy, the energy and resource intensity of local industry, and other factors. On top of that, individuals have different emissions profiles based on their individual transportation patterns, their home energy use, their diet, their consumption of material goods, and how they care for their yard (if they have a yard).

While the details may seem confusing, at the heart of the matter we must decrease our burning of fossil fuels and reduce our emissions from agriculture and deforestation. The Climate Master course is designed to provide you with tools to decrease the emissions you are responsible for and to motivate, educate, and inspire others to do the same. Congratulations for taking the step of joining this course!

## Additional resources

University of Oregon Climate Leadership Initiative, Economic and greenhouse gas assessments: <http://www.theresourceinnovationgroup.org/public/>

Intergovernmental Panel on Climate Change (IPCC), 2007. *Fourth Assessment Report*: [www.ipcc.ch](http://www.ipcc.ch)

Climate Crisis Coalition: Climate change news feed [www.climatecrisiscoalition.org](http://www.climatecrisiscoalition.org)

University of Washington Climate Impacts Group: Interdisciplinary research on climate change impacts on the Pacific Northwest: <http://cse.washington.edu/cig/>

Real Climate: Climate change science blog: [www.realclimate.org](http://www.realclimate.org)

Environmental Protection Agency: *Glossary of Climate Change Terms*: [www.epa.gov/climatechange/glossary.html](http://www.epa.gov/climatechange/glossary.html)

*Setting the Record Straight: Responses to Common Challenges to Climate Science*, Climate Leadership Initiative <http://www.theresourceinnovationgroup.org/climate-educ-lit-pubs/>

## Sample assignment

Visit an online carbon calculator (such as the Environmental Protection Agency's [www.epa.gov/climatechange/emissions/individual\\_calculator.html](http://www.epa.gov/climatechange/emissions/individual_calculator.html)) to assess your personal greenhouse-gas emissions.



## Implications for Oregon and Washington

### IPCC Findings Specific to Western North America

- Greatest warming is expected at high northern latitudes.
- Snow cover (and snow-water equivalency) is projected to contract.
- Snow cover is projected to melt earlier, leading to higher spring flows and lower late-summer flows.
- Extreme weather events (heat waves, drought, and heavy precipitation) are expected to increase.
- Increases in total precipitation are very likely at high (northern) latitudes.
- Ocean pH is expected to decline (a phenomenon known as acidification).

It's getting warmer, on average, and it's getting warmer faster. Models project a warmer climate for the Pacific Northwest during the twenty-first century, with temperatures increasing at a rate of 0.5°F per decade (slightly higher than the global-average warming) at least through 2050. This rate is two and one-half times faster than the warming observed in this region during the twentieth century.

Changes in precipitation appear less certain than changes in temperature. Most of the scenarios project little change to the overall

amount of precipitation by mid-century. However, the models do show a little less summer precipitation and a little more winter precipitation. Because of warmer winter temperatures, we are likely to see more of that precipitation fall as rain and less as snow during winter months, especially at lower elevations.

Sea-level rise will affect coastal Oregon and Washington, but the effects are expected to be gradual over the next several decades, and they will vary due to tectonic and other vertical land motions that can accentuate or offset changes in sea level depending on location. The greatest impact in Oregon is likely to be from Florence northward to Astoria, where the land is subsiding.

Climate Leadership Initiative research on forest fires estimates that, compared to an "average year" during the twentieth century, an average year in the 2020s could feature a 50% increase in the number of acres burned, and an average year in the 2040s is projected to feature a 100% increase in the number of acres burned.<sup>6</sup> Fires are likely to become the destructive force in our area that hurricanes are in the Southeast.

## SECTION TWO: HOME ENERGY

### Key Learning Points

- Space heating and cooling account for approximately 45% of home energy use.
- Appliances, including refrigerators, account for another 45%.
- Many energy savings are possible through behavioral changes.
- Reduced energy use results in fewer GHGs being emitted.

This chapter begins an exploration of the sources of our home emissions and the range of actions we can take to reduce those emissions. The materials cover energy basics, energy use, “green tags,” and resources for reducing home energy use.

In the US, energy used in residential buildings makes up 20% of our GHG emissions, according to the US EPA.<sup>1</sup> Home-energy emissions depend on how much and what kind of energy is used. The emissions associated with the kind of energy hinge on what combination of electricity, natural gas, heating oil, and other fuels a household uses, as well as what fuels make up the local electricity portfolio.

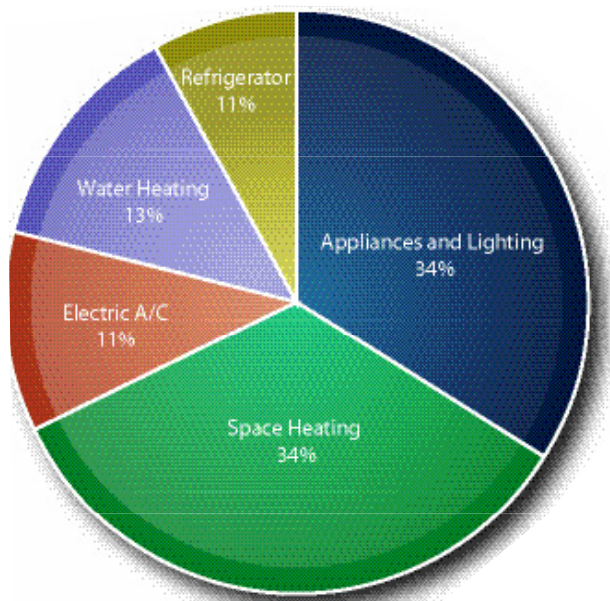
### Typical home emissions

It is easy to identify where energy-related emissions come from within most homes: space heating and cooling typically take the cake, constituting about 45% of home energy use. All the heating and cooling systems in the United States emit a combined 150 million tons of carbon dioxide annually.<sup>2</sup>

Appliances and lighting follow with a combined 34% (with the majority used by appliances). The refrigerator alone uses 11% of household energy; more energy than any other appliance in the house. Water heating typically comes in at around 13%. Although these percentages vary from household

Figure 2-1.

Typical Energy Use for U.S. Households



Heating accounts for the biggest chunk of a typical utility bill.

Source: U.S. Department of Energy, Energy Efficiency and Renewable Energy, based on 2005 Building Energy Data Book. [www.eere.energy.gov/consumer/tips/appliances.html](http://www.eere.energy.gov/consumer/tips/appliances.html)

### Key Terms

**Kilowatt hour:** A kilowatt hour, or kWh, is 1,000 watt hours, which is the amount of energy used powering a one-kilowatt load for an hour. To put it another way, if you turn on ten 100-watt light bulbs for one hour, it will use up one kilowatt hour of electricity.

**Megawatt hour:** A megawatt hour, or MWh, is 1,000 kilowatt hours.

**British Thermal Unit (BTU):** The quantity of heat required to raise the temperature of one pound of water by 1°F at a constant pressure of one atmosphere.

**Therm:** A unit of heat equal to 100,000 British thermal units or 1,000 calories.

**Short ton:** 2,000 lbs.

**Long ton:** 2,240 lbs.



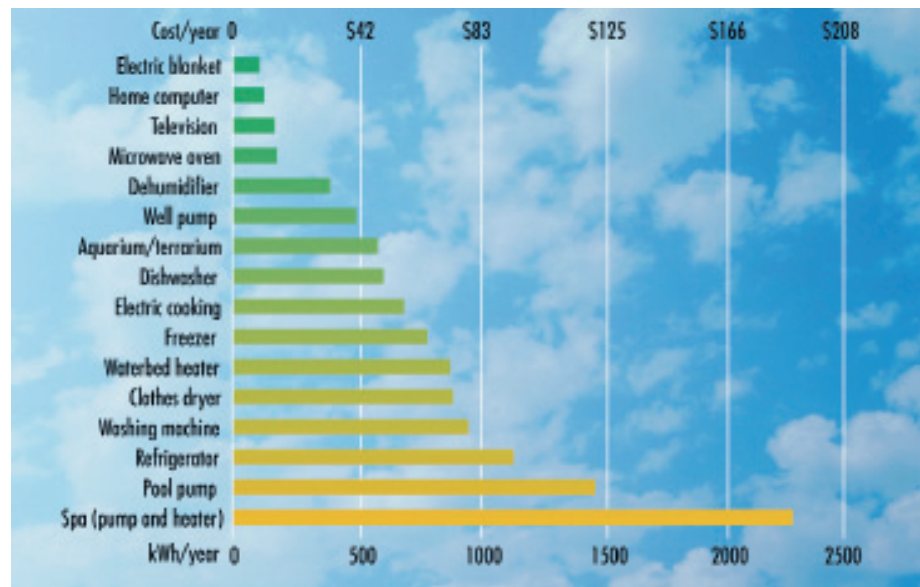
Figure 2-2.

### Average Annual Appliance Use

A refrigerator uses about five times the energy of the average microwave. New Energy Star-rated refrigerators use 40% less energy than their conventional counterpart sold in 2001. This figure excludes space and water heating.

Source: U.S. Department of Energy, Energy Efficiency and Renewable Energy, "Energy Savers."

[www.eere.energy.gov/consumer/tips/appliances.html](http://www.eere.energy.gov/consumer/tips/appliances.html)



to household, these numbers give us a good idea of where to start when looking for ways to reduce energy use and energy-related emissions. Another clue to a household's energy use comes from an obvious place: the utilities. So how does this residential-energy use fit into the bigger picture of local emissions and what does all this energy contribute in terms of greenhouse gases?

### Broader impact

Reducing energy use even in communities with low-emission power frees extra "clean" energy for other users on the regional grid. For example, Oregon's electric system is part of a grid that extends throughout the Pacific Northwest, Canada, and California. Utilities buy and sell electricity on a quarterly and even a daily basis.

For example, a household in Eugene, Oregon, where the utilities use a good deal of emissions-free hydropower that starts turning off their lights when they leave a room suddenly reduces their utility's need to provide power. The hydropower is already being generated; it's cheaper than the fossil fuels being burned for the regional system mix, so the natural gas power plants will ease their production to save money. This means that even these "low-emissions" customers can make a big difference by saving energy at home.

Regardless of the climate impact, many of the changes that individuals can make to reduce home energy use will also save them money previously

wasted on unused heat, appliances, and lights. What follows is an overview of some strategies for reducing energy use and emissions in the home, primarily through behavior change. See the Green Building section for energy savings through building shell changes.

Figure 2-3. Average Annual Energy Consumption

Aluminum smelter .....	300 aMW
Paper mill.....	110 aMW
Steel mill .....	46 aMW
Average home.....	.01 aMW
Food processor .....	2-3 aMW
Office building.....	1-5 aMW
Elementary school .....	4 aMW
Large hospital.....	5-10 aMW

Average annual energy consumption for the average household, industry, and community assets such as schools and hospitals. Energy consumed is measured in average megawatts (aMW). An aMW is one megawatt of capacity produced over one year, or 8760 MWh.

Source: Oregon Department of Energy, "Energy Use in Oregon," 2003.



## Heating and cooling

The amount of energy used for heating and cooling a home is a function of five primary factors:

1. the desired temperature of the home;
2. the amount of time the house needs to be kept at that temperature;
3. the amount of space being heated or cooled;
4. the efficiency of the heating or cooling system;<sup>3</sup>
5. and the insulation and airflow of the building

Follow these steps to improve efficiency in each of these areas.

### Temperatures

*Heating:* Keep your house in the 60° range. For every degree you lower your heat in the 60° to 70° range, you'll save an average of 3% on heating costs.

*Air conditioning:* Keep your house at 78° or higher for energy-saving benefits. Each degree lower adds 3% to your cooling bill, while each degree higher will save you 3%.

*Digital thermostats:* More accurate than non-digital ones. To ensure your non-digital thermostat is accurate, calibrate it by placing a simple digital wall thermometer close by and see if they match.

*Thermostat Settings:* Don't set your thermostat at a higher or lower temperature than normal in the hope of heating or cooling your house faster: it will not heat or cool your home any faster and could result in unnecessary expense. Remember, thermostats are a switch, not an accelerator.

*Is "off" really off?* Some older thermostats don't turn the heat off completely.

*Appliance location:* Don't place lamps, TV sets, or other heat sources near your air-conditioning thermostat. The thermostat senses heat from these appliances, which can cause the air conditioner to run longer than necessary.

### Time

*Setbacks:* Longer and larger setbacks save more energy, while shorter and smaller setbacks save less. Save money by allowing your home to get cooler when you're asleep or away from home. For example, set your thermostat back 10° to 15° for eight hours to cut your annual heating bill by 5 to 15%. That's an annual saving of up to 1% for each degree of a setback that lasts more than eight hours, according to the U.S. Department of Energy.

### Space

*Zoning:* Room-by-room or "zoned" heating systems allow you to heat only those areas of the house that you use most, saving energy and money. Heat unused areas only enough to prevent moisture, mold and condensation. (Note: many whole-house furnace systems are not designed to shut off individual room vents because it decreases overall efficiency and may damage the system.)

*Furniture:* Arrange furniture to take advantage of the heating and cooling source. Move couches, bookshelves and beds away from vents. Face your sofa toward the vent for maximum comfort, or at least tuck your favorite spot into a warm space in the room.

*Fans:* Spread heated air more effectively without greatly increasing your power use by installing a ceiling fan, or simply use a floor fan pointed diagonally and upward across the room. This will make the room feel more comfortable without turning up the heat. Fans are much more energy-efficient for cooling than air conditioners.

*Curtains:* Close curtains to insulate your home more effectively (at night in the winter, during the day in the summer). If your heat source is under a window, tie curtains back to the wall at the bottom to ensure heat enters your room, not the window space. You can tuck the curtains behind a string pinned to each side of the window for a simple fix.

### Heating System Efficiency

Maintaining your heating and cooling systems not only provides savings and increased comfort, but also helps ensure your safety.

*Cleaning:* Dust and vacuum thermostats, heating coils, fins, and fan blades regularly to maximize efficiency.

*Ducts:* Seal and insulate ducts.

*Filters:* Change or clean your air filters every 1-2 months.

*Regular service:* Service your heat pump and/or furnace once every year.

*Winter air conditioning:* Cover your wall unit in the winter, and remove window units during the colder months to reduce heat loss.

*Heating Systems:* Consider upgrading your heating system to a high-efficiency heat pump or gas furnace. Check with your utility provider for rebates and information on efficiency.

**Woodstoves vs. Fireplaces:** Woodstoves are at least five times more efficient than wood-fired fireplaces. Look for EPA-certified high efficiency woodstoves. Additionally, use a fan to distribute the heat.

**Wood heating:** Don't use wood heat and other heating systems at the same time. A roaring fire can exhaust as much as 24,000 cubic feet of air per hour to the outside, which must be replaced by cold air coming into the house from outside. Your other heating system must warm up this air, which is then exhausted through your chimney.

**Fireplaces:** A wood-burning fireplace is one of the most inefficient heat sources you can possibly use, since it sucks warm air from your entire house up the chimney. A few tips to reduce energy losses:

- Keep your fireplace damper closed unless a fire is going. Keeping the damper open is the same as keeping a window open in the winter.
- Install and use tempered glass doors.
- When you use the fireplace, reduce heat loss by opening dampers in the bottom of the firebox (if provided) or open the nearest window slightly—approximately one inch—and close doors leading into the room. The fire needs oxygen to burn, and will suck cold air through all the cracks in your house to get it.
- In addition, lower the thermostat setting to between 50° and 55°F when using the fireplace.

### **Low Cost Building “Envelope” Improvements**

*For a more in-depth discussion of green building see Section Four: Green Building*

Warm air leaking into your home during the summer and out of your home during the winter can waste a lot of your energy dollars and send your emissions through the roof.

**Envelope:** One of the quickest dollar-saving tasks you can do is caulk, seal, and weather strip all seams, cracks, and openings to the outside (plumbing, cable, telephone, wiring, outlets). You can use just about anything—cloth, paper, insulation, caulking—and can save as much as 10% on your heating and cooling bill by reducing the air leaks in your home.

**Windows:** Use plastic storm windows or invest in double- or triple-paned glass or permanent storm windows. They can cut your heat loss in half.

**Insulation:** Insulate your walls, ceiling, and floor.

**Exhaust Fans:** Check exhaust fans when not in use to make sure the dampers are closed. If the damper is open, your fan is now a chimney.

**Garage:** Using a light bulb or bulbs instead of a portable heater can reduce energy costs and help keep moisture problems at bay. A portable heater can cost twenty dollars a month to operate (1,500 watts for five hours per day average).

**Outbuildings and RVs:** Energy consumption can be as much as a small house. Follow the same efficiency practices you would at home.

## **Appliances**

Buying a new appliance? Look for the Energy Star label as a minimum, but be aware that there is a wide variation of energy consumption even between labeled products. Visit the Energy Star web site to compare energy use of different models before buying. Check with your local utility for rebates and incentives, state and federal tax credits, and manufacturer's rebates.



### **Refrigerator (“Energy Hog” of appliances)**

- Set your refrigerator to 38–40 degrees. Measure with a thermometer in a glass of water.
- Locate away from heat sources and away from items or walls that block airflow to the coils.
- Cool food before refrigerating. Immersion in cold water is a safe option for rapid cooling.
- Keep it full—even if only with water jugs. Mass stays cold more easily than does air.
- Unplug and get recycle your second refrigerator. By eliminating an older, energy-inefficient refrigerator or freezer, you can save ten to twenty dollars a month. Check with your local utility for incentives for recycling.
- Refrigerators have become dramatically more efficient over the last thirty years. Find the energy usage of your refrigerator by visiting the Home Energy web site at [www.homeenergy.org/consumerinfo/refrigeration2refmods.php](http://www.homeenergy.org/consumerinfo/refrigeration2refmods.php) and typing in the model number.

- When buying a new refrigerator, reduce emissions by buying only the size you need and choosing a model with the freezer on top or underneath.

### Freezer

- Set the thermostat between 0 and 10 degrees for product, not air temperature. Test by packing a thermometer tightly in frozen foods.
- Keep the freezer full. Use water jugs if needed.

### Cooking

- Use small appliances when suitable, e.g., a toaster oven or microwave instead of a stove.
- Preheat the oven only for five minutes or less.
- With glass pans you can set your oven 25 degrees lower than normal.
- Use a timer and don't peek! Opening the door drops the temperature by 25 degrees and wastes power.
- Turn off your oven fifteen minutes before the end of baking time.
- Cook more than one thing at a time.
- Use the self-clean function sparingly (if at all).
- Cover pots and pans with lids to use a third less energy.
- Use pots and pans with flat bottoms and tight lids, and use the same size burner as the pan.
- Don't use foil on burner pans or in the oven. It decreases efficiency and the life of the elements.

### Dishwasher

Use the "air dry" selection or turn the dishwasher off and open the door at the end of the wash cycle. This can save 40% of the energy cost.

Wash full loads only.

### Washer

- Wash clothes in cold or warm water. Using cold water reduces your washer's energy use by 75%. Always rinse in cold water. Use cold water detergent.
- Try to wash full loads only and don't overload. If you don't have a full load, adjust the water level to fit the size of your load.
- Minimize the amount of detergent used. The washer's motor works harder with more suds.

### Dryer

- Using a dryer costs approximately 25 cents a load (using 2,500 watt hours for 30 minutes). You can save energy and money if you follow these tips:
- Clean the lint trap. This can reduce energy use by 5–10% as it improves airflow.
- Replace the vent cover with a louver-type cover. This will increase airflow by 20–50%.
- Don't overload the dryer.
- Sort loads by clothing weight and material type. For instance, dry towels and heavier cottons in a separate load from lighter-weight clothes.
- Use an extra spin cycle in your washing machine to get as much water out as possible.
- Use the sun and line-dry your clothes, which is recommended by clothing manufacturers for some fabrics.



### Television and other electronic devices

- Unplug small appliances and electronic devices, or put them on a switched outlet or power strip that you can click off when not in use.

Many TVs, DVD players, computer peripherals, and chargers use electricity even when they are switched off. For instance, the "phantom load" from a TV alone can easily cost \$100 a year, even if it's never turned on. Anything with a light or a clock is using energy.

- When buying a new TV, be aware that larger TVs typically consume more power than smaller ones. In fact, an average American's large plasma television will actually consume more electricity annually than their refrigerator! New Energy

Star standards will be introduced in May 2010, with expectations that only 25% of existing models will qualify for the newer requirements. Also, California recently passed a law mandating even higher efficiency levels for new TVs.

- Don't keep your TV on just for "noise."



## Lighting

- Use fluorescent instead of incandescent lights: compact fluorescent light bulbs (CFLs) are three to five times more efficient and last ten times longer than incandescent. Although early fluorescent lighting products rendered colors poorly when compared to incandescent light, today's Energy Star–qualified lighting performs well and has high color rendering index (CRI) scores (a measure of how accurately an artificial light source displays colors).
- Use task lighting to focus light where you need it, rather than brightly lighting an entire room.
- Turn off the lights in any room you're not using, or consider installing timers, photocells, or occupancy sensors to reduce the amount of time your lights are on.

## Water Heating

- *Temperature:* Lower your thermostat to 120 degrees. Every ten-degree reduction in temperature will save you approximately ten dollars a month on your electricity bill, or eight dollars a month if you use a gas water heater.
- *Timer:* Use a timer on your water heater, or manually use the circuit breaker to turn off your electric water heater while you're asleep or away from the house. The cost of a twenty-dollar timer can be recouped in just two or three months of use.
- *Turn it off:* When you leave the house for three days or more, be sure to turn off your electric water heater, or turn your gas heater to the "pilot" setting.
- *Insulation:* Insulate the first six feet of the hot and cold water pipes connected to the water heater.
- *Faucet Aerators:* Use faucet aerators and low flow shower heads to reduce the amount of hot water used.
- *Tank location:* Placing a "thermal break" between a heat-absorbing concrete floor and your tank can save approximately twenty dollars a year.
- *Stop leaks:* Cold water leaks cost you money in water and sewer fees. Hot water leaks are even more costly, since you not only pay for the lost water, but also for the electricity or gas to heat its replacement. Replace washers in faucets to prevent and repair leaks. For toilets, find leaks by placing colored water in the tank (a tea bag or food coloring works well). If after an hour

the color appears in the toilet bowl, the flapper valve is leaking and should be replaced.

- *Check for leaks:* To determine if you have "invisible" leaks in your pipes, first read your water meter. Don't use any water in the house for one hour. If the meter has moved, you have a leak somewhere in the system. Once it's fixed, notify the city to avoid sewer charges for all that water.
- *Keep the tank clean:* Periodically drain off the sediment in the bottom of the tank. Sediment buildup can insulate the water from the heating element. Open the drain valve or faucet at the base of the water tank and drain a gallon or two of water into a container until it runs clean (see your manufacturer's instructions).

## Tools for saving energy

### Digital wall plate thermometers (Plate Pals)

This device measures the actual temperature in the room. The thermostat may be set to 68°, but the actual temperature may be different. Thermostats, especially older models, are frequently off by a number of degrees.

Take the face plate off of a light switch in a room you use frequently and replace it with the digital wall plate thermometer. An inside wall is preferable to one on an exterior wall. If the digital wall plate thermometer indicates the temperature is 70° or higher, turn the heat down.

We recommend 67° or less when people are home and awake, and 58° or less at night or when no one is at home so long as no one has health needs that require higher temperatures.

### Hot water thermometer

Use a pencil-like thermometer to measure the temperature of your hot water: Wait 2 hours after use of hot water to measure. Measure the water temperature at the sink closest to the water heater. (If you are not sure where your water heater is, use any sink). Turn on the hot water and let it run until it is at its maximum temperature. Put a container in the sink under the stream of hot water. Place the thermometer in the container (remove the sheath) as the hot water is collecting and refilling under the stream of hot water in your sink. When the dial on the thermometer stops rising, this is the temperature of your hot water.

The ideal temperature is 120°. If the temperature of your hot water is higher—130° or more—turn



it down. It is wasting energy and could scald or burn you. If the temperature is less than 120°–110° or below—adjust the temperature on your water heater to avoid bacteria growth.

### **Adjust your electric water heater temperature**

Turn off the water heater at the breaker in your electrical panel. Using a screwdriver, remove the small door that houses the thermostat. There are two on most electric water heaters, so make sure to change both thermostats.

Move aside the fiberglass insulation. You will see a small dial with numbers indicating temperature: 110, 120, 130, 140, and so forth. Insert a screwdriver into the groove and adjust the temperature to 120 degrees. Repeat for the second thermostat. (Some water heaters use A, B, C or high, medium, low settings instead of degrees.)

Replace the fiberglass and the metal covers, then turn on the water heater at the breaker to resume operation of your tank. Once you've adjusted the setting, recheck using the thermometer for accuracy.

### **Refrigerator-freezer thermometer**

This squat, square thermometer measures the temperature in your refrigerator and freezer.

Leave it in the refrigerator overnight, and note the temperature when you open it in the morning (or when it hasn't been opened for a few hours).

On the following day, check the freezer using the same process.

The ideal refrigerator temperature is 38–40 degrees; ideal freezer temperature is 0–10 degrees.

If temperatures are lower than this, your appliance is wasting energy. If the temperatures are higher than this, your food may spoil or could become unsafe. Set your refrigerator and freezer to the proper temperature.

Recheck in twenty-four hours for accuracy.

### **Switch and outlet sealers (Foam)**

These foam pads keep the cold air outside from entering through light switches and plug-in outlets inside your home.

First, remove the switch or plug plate with a screwdriver. Then, install one foam pad for each plate, using them only on outside walls, not on walls between rooms.

### **Compact Fluorescent Light Bulbs (CFLs)**

(14-watt CFL = 60-watt incandescent; 20-watt CFL = 75-watt incandescent; 23-watt CFL = 100-watt incandescent)

Install these bulbs in lamps or light fixtures that are used the most in your home.

Read packaging for how to use them.

Please remember to recycle your CFLs, as they contain a minute amount of mercury.



### **Additional resources for reducing household emissions**

Do-It-Yourself Home Weatherization Guide, Bonneville Power Administration: [www.bpa.gov/energy/n/energy\\_tips](http://www.bpa.gov/energy/n/energy_tips)

A Consumer's Guide to Energy Efficiency and Renewable Energy, U.S. Department of Energy's Energy Efficiency and Renewable Energy web site: [www1.eere.energy.gov/consumer/tips](http://www1.eere.energy.gov/consumer/tips)

San Jose Energy Saving Hints: [www.sanjoseca.gov/esd/natural-energy-resources/ER-Tips-home.htm](http://www.sanjoseca.gov/esd/natural-energy-resources/ER-Tips-home.htm)

U.S. Department of Energy "Energy Saver\$" Tips: [www1.eere.energy.gov/consumer/tips/pdfs/energy\\_savers.pdf](http://www1.eere.energy.gov/consumer/tips/pdfs/energy_savers.pdf)

US EPA Green Homes site: [www.epa.gov/greenhomes](http://www.epa.gov/greenhomes)

Compact Fluorescent Lighting: [www.fcgov.com/conservation/lighting-faq.php](http://www.fcgov.com/conservation/lighting-faq.php)

### **Sample assignment**

Check your refrigerator's energy consumption at Home Energy magazine's site: [www.homeenergy.org/consumerinfo/refrigeration2/refmods.php](http://www.homeenergy.org/consumerinfo/refrigeration2/refmods.php)

Implement one or more actions from the list above to reduce emissions in your home and save money.



## Local Energy Information

According to the Eugene Water and Electric Board (EWEB), the average residential use for their customers is 1,000 kWh a month, or 12,000 kWh a year. The average residential natural gas customer in western Washington and Oregon uses 685 therms of natural gas annually.

According to the City of Eugene's Greenhouse Gas Emission Inventory, the residential sector accounted for 22% of total city emissions in 2005. This amounts to approximately 200,000 short tons of carbon dioxide equivalent.<sup>4</sup> This percentage only accounts for electricity and natural gas used in residences, and does not account for the emissions embodied by food or material goods, or for residential transportation. The other sectors the city considered are transportation (51%), commercial (17%), industrial (10%), and waste (0%, because of methane capture at the landfill; the city inventory does not account, however, for emissions related to goods we consume that are manufactured and transported outside the city).

According to the same report, most of the residential emissions in Eugene come from natural gas (83%), with 15% from electricity, and 1% or less from wood and light fuel oil. That doesn't mean that natural gas is

providing four-fifths of the energy in the area, but rather that natural gas has more associated greenhouse-gas emissions in the area than does electricity. Since 1980, electricity has accounted for about 20% of all power use in the area.

The same does not hold for the rest of the country or even the rest of the state. EWEB's energy mix relies heavily on hydropower and produces about 0.1 pounds of carbon dioxide (CO<sub>2</sub>) per kWh. In contrast, other electricity providers in the state use more coal and natural gas, producing an average of one pound of CO<sub>2</sub> per kWh.

It may seem, therefore, that the greatest opportunities for reducing residential energy-related emissions in EWEB territory derive from fuel switching from natural gas to biogas or electricity and conservation in households using natural gas. Fuel switching to electricity as a solution, however, ignores the fact that "clean" power not used by EWEB customers can displace fossil-fuel generated electricity at other points on the regional grid.

## State of Oregon tax credits are available for:

### Appliances

- Clothes washers
- Dishwashers
- Refrigerators

### Vehicles

- Alternative fuel vehicles
- Hybrid vehicles

### Fuel cells

- Fuel cells

### Solar

- Solar space heating
- Solar water heating

### Heating, ventilation, air conditioning (HVAC)

- Air-conditioning systems
- Combination water- and space-heating systems
- Ducts
- Furnaces and boilers
- Ground-source heat pumps
- Heat pump and air conditioner testing
- Heat pump systems
- Heat-recovery and energy-recovery systems
- Wastewater heat recovery

### Water heaters

- Combination water- and space-heating systems
- Solar water heating
- Water heaters
- Wastewater heat recovery

### Wind

- Wind systems

For lists of specific qualifying appliances and equipment, application forms, and instructions, visit: [www.oregon.gov/energy/cons/res/retc.shtml](http://www.oregon.gov/energy/cons/res/retc.shtml).

## Local Resources for Home Energy Savings

### Eugene CFL Recycling Centers

Aqua Serene ..... 2836 W. 11th  
Brighter Homes Lighting ..... 1968 W. 6th  
Emerald People's Utility  
District Energy Store ..... 33733 Seavey Loop  
Eugene True Value Hardware ... 2825 Willamette  
Greater Goods ..... 515 High  
Heinke Electrical & Lighting ..... 645 Adams

Jerry's Home Improvement ..... 2600 Hwy 99 N  
Lane Electric Co-op ..... 787 Bailey Hill Rd  
Next Step Recycling ..... 2101 W. 10th

### Springfield CFL Recycling Locations

B & I True Value Hardware ..... 5790 Main  
Jerry's Home Improvement ..... 2525 Olympic  
Oregon's Constant Gardener ..... 423 Q St.

### Additional Resources for Reducing Household Emissions

**Eugene Water and Electric Board (EWEB):** Programs, incentives, audits, and energy-saving tips: [www.eweb.org/saveenergy/home](http://www.eweb.org/saveenergy/home)

**Energy Trust of Oregon:** Services and cash incentives for customers of NW Natural, Portland General Electric, Pacific Power and Cascade Natural Gas: <http://energytrust.org/residential/incentives>

**Home Energy Calculator, Emerald People's Utility District.** Easy-to-use tool for various home energy saving measures. The tool calculates electricity costs and provides details on how to implement changes: [www.epud.org/hec.aspx?section=home](http://www.epud.org/hec.aspx?section=home)

**State of Oregon tax credits:** Lists of specific qualifying appliances and equipment, application forms, and instructions: [www.oregon.gov/energy/cons/res/retc.shtml](http://www.oregon.gov/energy/cons/res/retc.shtml)

## SECTION THREE: TRANSPORTATION

### Key Learning Points

- Transportation accounts for more than 25% of the annual greenhouse gas emissions in the US.
- Behavioral changes can greatly reduce the emissions associated with personal transportation and save money.
- Air travel accounts for 13% of transportation related emissions.

The average American drives twenty-nine miles a day, spends fifty-five minutes each day behind the wheel, and spends nearly a fifth of household income on transportation (see Table 1, below). In the U.S., 65% of households own two or more vehicles. However, the \$6,214 that a household spends on an average car annually does not account for the full social and environmental costs of driving.<sup>1</sup>

Transportation makes up more than one quarter of our greenhouse-gas emissions in the United States.<sup>2</sup> That figure would be even greater if you accounted for “life-cycle” emissions



from vehicle manufacturing, road construction and maintenance, and the extraction and refining of fuel. In addition, transportation is the fastest growing sector of greenhouse-gas emissions in the country.<sup>3</sup> The carbon dioxide emissions that result from the burning of gasoline and diesel fuel are on the rise. CO<sub>2</sub> emissions make up 80% of total U.S. greenhouse-gas emissions.

Although our transportation habits can be among the most entrenched, and few people want to or will accept decreased mobility or access, simple changes can result in significant emissions reductions.

**Table 3-1: Driving Costs**

Driving Costs	Small Sedan	Medium Sedan	Large Sedan	Average
Total cost per mile (if gas costs \$2.30/gal)				
10,000 miles per year	per year	per year	per year	per year
Cost per mile x 10,000 miles	\$1,308	\$1,592	\$1,725	\$1,542
Cost per day x 365 days	\$4,350	\$5,716	\$7,282	\$5,783
Decreased depreciation*	-\$150	-\$286	-\$330	-\$257
Total cost per year	\$5,503	\$7,022	\$8,677	\$7,067
Total cost per mile**	\$.550	\$.702	\$.868	\$.707
*decreased depreciation for mileage under 15,000 annually				
**total cost per year/total miles per year				
Source: American Automobile Association, “Your Driving Costs” (2009), <a href="http://www.scribd.com/doc/14610083/2009-Edition-of-AAA-Your-Driving-Costs">www.scribd.com/doc/14610083/2009-Edition-of-AAA-Your-Driving-Costs</a>				

In the United States, the average vehicle emits about one pound of CO<sub>2</sub> per mile. Here's why: burning a gallon of gasoline results in the release of almost twenty pounds (19.4 pounds exactly) of carbon dioxide into the atmosphere. Diesel burning results in 22.2 pounds of CO<sub>2</sub> per gallon. The average mileage in the U.S. is 20.3 miles per gallon, when combining cars and light trucks.<sup>4</sup> So a car getting twenty miles per gallon, emitting almost twenty pounds of carbon dioxide per gallon, emits a pound of CO<sub>2</sub> for each mile driven.

The Rocky Mountain Institute (RMI) writes, "The average American personal vehicle uses 570 gallons of gasoline per year, which results in the emission of 11,400 pounds of carbon dioxide. Since, on average, each household owns 1.85 vehicles, this means that the average household emits 21,000 pounds of carbon dioxide annually."

As mentioned above, a gallon saved is twenty pounds of CO<sub>2</sub> kept out of the atmosphere.

**Here are some simple ways to save big:**

- Carpooling cuts those emissions at least in half, depending on how many people you fit in the car. The more the better!
- Once-a-week carpooling will cut the average commuter's emissions by half a ton a year, according to the RMI.
- Choose the household's most efficient vehicle each time you drive.
- Better yet, for those shorter trips, leave the car at home and hop on a bike, a bus, or just walk for zero emissions, zero cost, and a breath of fresh air.
- Combine errands.

- Try to live close to where you work and shop to minimize transportation emissions.
- See *Local Resources* for programs to support people in leaving their car at home or living vehicle-free. Become familiar with these offerings as well as bicycle and mass transit resources.



**Cutting vehicle emissions**

When you cannot avoid driving, simple techniques can cut gasoline use and greenhouse-gas emissions.

- Keeping vehicles well-tuned can increase fuel efficiency an average of 4% and up to 40%, particularly if there are significant repair needs.
- Maintaining recommended tire pressure can cut fuel use by 3%.
- Use the recommended grade of oil. This can save you 1-2% of fuel use.<sup>5</sup>
- Cleaning out the stuff sitting in the trunk is another way to save fuel; every extra 100 pounds you haul takes 1-2% off your fuel efficiency.<sup>6</sup> Rooftop storage does not just add weight; the drag costs you money and emissions as well.

TAKE ACTION	SAVE MONEY	SAVE CO <sub>2</sub> (lbs.)
To improve fuel efficiency by up to 30%, tune and maintain your car:		
Check tire pressure regularly and inflate as needed to save up to 3% of fuel	\$38	305
Use recommended oil grade to save 1%	\$12	102
Keep engine tuned to save up to 4% of fuel	\$51	407

## Drive smarter

Although every car is different, fuel economy typically plummets at speeds higher than 60 m.p.h. Excessive acceleration and braking will also cut your efficiency by about a third on the highway and 5% in town.<sup>7</sup> Idling gets zero miles per gallon, so if you are stopping for more than about thirty seconds, turn off the car. Most cars run better when warmed up by driving than by idling, so avoid polluting your neighborhood with excess exhaust.<sup>8</sup>

Then there are the dollar savings that accompany decreased driving or reducing the number of cars in the household. The American Automobile Association (AAA) calculates that it costs fifty-seven cents a mile for the average sedan that is driven 12,500 miles a year (as the annual mileage increases the costs are less per mile, but greater overall). AAA estimates the total annual cost of driving 12,500 miles as \$7,015, including operating costs and ownership costs. In some cases, getting rid of a car in exchange for car rentals or participation in a car share can make a lot of financial sense. Imagine what you could do with an extra \$7,000 in your pocket each year.

For those interested in purchasing a vehicle, consider the energy and emissions involved in manufacturing new vehicles. Multiple studies have determined that vehicle replacement every eighteen years minimizes life-cycle energy use (energy used in manufacturing, driving, and disposal) and carbon dioxide emissions for a generic sedan driven 12,000 miles annually. However, shorter life spans minimize regulated pollutants like carbon monoxide and oxides of nitrogen.<sup>9</sup> One option is buying a used, fuel-efficient vehicle or one that can run on alternative fuels.

If you're still interested in buying new, consider fuel economy and alternative fuel options. Check fuel economy labels and buy the most fuel-efficient vehicle possible. This usually means a smaller, hybrid, or even completely electric engine. Visit [www.fueleconomy.gov](http://www.fueleconomy.gov) to compare fuel efficiencies. If you're thinking about a hybrid, be sure that it matches your driving needs, as these vehicles are most efficient for in-town driving. A locally made electric vehicle may suit your needs if you don't need to transport a lot of materials or people and if you travel primarily (or solely) in close range.

Another option is to go for a dual-fuel vehicle that can run on E85 (a blend of 15% gasoline and

85% ethanol), or a diesel vehicle that you can fill with biodiesel. Although the exact emissions from biofuels depends on the feedstock and the refining process, using 99% biodiesel typically results in 75% fewer greenhouse-gas emissions than diesel; using 85% ethanol generally results in 18% fewer greenhouse-gas emissions than gasoline.<sup>10</sup> However, the use of biofuels is contingent on the existing infrastructure. The number of stations carrying biofuels is increasing dramatically, but you'll still be stuck using fossil fuels in the form of E10 or 100% gasoline if there's nowhere to fill up on E85.

Visit the National Ethanol Vehicle Coalition: [www.e85fuel.com/e85101/flexfuelvehicles.php](http://www.e85fuel.com/e85101/flexfuelvehicles.php), or the EPA's Alternative Fuels and Advanced Vehicles Data Center to find biofuel-compatible vehicles: [www.homeenergy.org/consumerinfo/refrigeration2/refmods.php](http://www.homeenergy.org/consumerinfo/refrigeration2/refmods.php). See section five for more on biofuels.

## Air travel emissions

Air travel is a form of transportation with a heavy environmental impact, resulting in about 1.26 pounds of carbon dioxide equivalent (CO<sub>2</sub>e) per passenger mile, or more than 2.5 tons of CO<sub>2</sub>e for a round trip flight from coast to coast.<sup>11</sup> Compare this to the one pound per mile in the average U.S.



vehicle (meaning .5 pounds per passenger mile when you ride with a friend, or .3 pounds with two people), 0.42 pounds per passenger mile on a bus, and 0.35 pounds per passenger mile for travel by train (depending on the efficiency of the actual train or bus and the number of passengers). Short-haul flights result in greater emissions per mile than do long-haul flights, due to the extra energy needed for takeoff and landing.

In 1992, aircraft accounted for 2% of anthropogenic (human-caused) carbon dioxide emissions, or 13% of transportation-related emissions.<sup>12</sup> These numbers may not seem like much until you consider



the small percentage of the population taking those flights and just how vital—or avoidable—those flights are.

The Intergovernmental Panel on Climate Change (IPCC) estimates that the flights taken in 1992 contributed about 3.5% of anthropogenic climate change that year.<sup>13</sup> The difference between the two percentages reflects the emission of other gases such as nitrous oxide, sulfur oxides, and water vapors, and the greater warming potential of nitrous oxide when released high in the atmosphere.

Contrails, or the water vapor crisscrossing the sky after planes pass overhead, have an unclear effect on warming. When contrails spread and linger, they behave like cirrus clouds, and we do know that cirrus clouds stop heat from leaving the atmosphere. The impact of air travel on cirrus cloud formation is not included in the 3.5% mentioned above. All told, the IPCC estimates that the total climate impact of flying is about two to four times that of the CO<sub>2</sub> emissions alone.

Unfortunately, small comfort can be taken from recent and future gains in efficiency: While air travel is increasing at about 5% a year, fuel use is still increasing by around 3% a year.

So what can we do? Carefully consider every flight and every trip. Try to make the most of each journey and cut out those that are not top priority. You'll save money, the stress of delayed or cancelled flights, and literally tons of greenhouse-gas emissions. As much as possible, book direct routes with few landings and takeoffs. When possible, travel by bus, train, or a fuel-efficient car full of people. Each flight you avoid takes a major bite out of your personal emissions and is something to be proud of.

## Additional resources

### Vehicle Resources

Fueleconomy.gov contains information on driving efficiently, vehicle mileage, biofuels, and hybrids. [www.fueleconomy.gov](http://www.fueleconomy.gov)

The U.S. Environmental Protection Agency's Green Vehicle Guide has the stats on the latest fuel-efficient vehicles. [www.epa.gov/greenvehicles](http://www.epa.gov/greenvehicles)

40mpg.org provides hybrid advocacy, information about the fuel efficiency of various vehicles, and calculators. [www.40mpg.org](http://www.40mpg.org)

## Sample assignment

Reduce one vehicle trip this week. If you don't drive, try to help someone else avoid using their car one time this week.



## Local Transportation Resources

### Vehicle

point2point solutions provides employer programs, Smart Ways to School, car- and vanpools, and other local transportation options. [www.ltd.org/cs/csindex.html](http://www.ltd.org/cs/csindex.html)

Keep Us Moving is a user-friendly site that contains regional information about the transportation planning process, current projects, and information about transportation options. The site is maintained by the Lane Council of Governments. [www.KeepUsMoving.info](http://www.KeepUsMoving.info)

Lane Transit District provides bus service in and around the Eugene and Lane County. Check out their website [www.ltd.org/index.html](http://www.ltd.org/index.html) for more details.

Amtrak offers daily rail service both north to Portland and beyond as well as south into California. Check out schedules and fares at [www.amtrak.com](http://www.amtrak.com)

### Bicycle

The City of Eugene web site contains bike maps and resources for biking in Eugene. [www.eugene-or.gov/transportation](http://www.eugene-or.gov/transportation)

Greater Eugene Area Riders (GEARS) invites the community to join club members on several weekly bike rides. Rides vary in location, distance, and terrain. The main purpose of GEARS is to foster bike riding. [www.eugenegears.org](http://www.eugenegears.org)

is a nonprofit organization committed to community involvement in manufacturing, using, and advocating sustainable modes of transportation. The center provides Pedalers Express delivery service, education and youth programs, Oregon Cycling magazine, and more. [www.catoregon.org](http://www.catoregon.org)

The UO Department of Public Safety strongly encourages bicycling as a way of responsible transportation. This site lists the availability of covered parking, safety recommendations, and local shops where you may purchase adequate gear for the conditions. <http://safetyweb.uoregon.edu/node/30>

The Oregon Department of Transportation web site includes links to the Oregon Bicyclist Manual and information on laws and regulations as well as a list of bike travel web resources. [www.oregon.gov/ODOT/HWY/BIKEPED](http://www.oregon.gov/ODOT/HWY/BIKEPED)

Lane Community College is currently offering classes on bicycle maintenance and marathon training. For a full list of courses, visit [www.lanecc.edu](http://www.lanecc.edu)

The University of Oregon Craft Center frequently offers classes on bicycle maintenance. Visit [www.craftcenter.uoregon.edu](http://www.craftcenter.uoregon.edu) for more information.

The Center for Appropriate Transportation

## SECTION FOUR: GREEN BUILDING

### Key Learning Points

- Buildings of all types account for 30% of greenhouse gas emissions.
- Greenhouse gases come from all stages in the life cycle of the building; from raw material extraction to daily use to decommissioning.
- GHG emissions should be factored into building-related decisions.

According to the U.S. Green Building Council, in the United States, buildings account for:

- 30% of greenhouse-gas emissions
- 36% of total energy use; 65% of electricity consumption
- 30% of raw materials use
- 30% of waste output (136 million tons annually)
- 12% of potable water consumption

Greenhouse-gas emissions derive from energy used throughout the life of the home and those embodied within building materials (although that may not be reflected in the greenhouse gas emission numbers above). Thus, the emissions come from the entire lifecycle of a building—from raw materials extraction, product manufacturing, construction, or renovation, operation and maintenance, through to decommissioning. Below are a few rules of thumb for reducing emissions in buildings.

- Build for efficiency. Of the above-mentioned emissions, the largest portion usually comes from operation and maintenance. Thus, it is important to design buildings for energy efficiency, maximizing passive solar heating and cooling as well as “daylighting” (placing windows and reflective surfaces to most effectively use daylight).
- Insulate well. Sufficient insulation is key, and the needs vary depending on your location and the part of your home. Attic spaces and ceilings need the greatest levels of insulation, as a poorly insulated attic will allow heat to rise right out of your home. Higher R-values are more resistant to heat loss.
- Use energy-efficient windows. They can be costly up front, but save thousands over the long run. Look for low-E windows (heat reflective) with low U-factors (U-value

describes how much heat passes through the window considering all combined components—sash, glass, and frame. The lower the U-factor, the better). Many energy-efficient windows are made of vinyl, which is toxic in manufacturing and can off-gas in the home. Wood and fiberglass are less toxic window materials. Consider triple-paned windows.

- Install energy-efficient heating and cooling systems, and ensure that ducts are well insulated and sealed.
- A well-placed overhang, awning, or blind can cut the need for summertime cooling dramatically.
- Light-colored and/or “living roofs” reduce summer heat absorption. Metal roofs are durable, recyclable, and energy efficient, but more costly up front than asphalt.
- Consider setting up plumbing and wiring to be compatible with solar hot water and electricity.
- Size matters. Bigger buildings require more materials, more space heated or cooled, and they provide more room to fill with products, some high in embodied emissions.
- Reuse. Avoid the emissions involved in resource extraction and production by reusing building materials.
- Reduce. Eliminate or reduce construction waste.
- Think lifecycle. Ask about the lifecycle emissions of the materials you use. Seek out those with low-embodied emissions and low toxicity. Concrete has very high amounts of

greenhouse gas emissions associated with its production. Using local materials can reduce transportation-related emissions. “Rapidly renewable” materials such as cork, straw, and bamboo quickly convert carbon dioxide into biomass. These materials regenerate in less than ten years.

- Go for durability. Save money in the long run and decrease embodied emissions by avoiding frequent replacement and waste. If reroofing with asphalt composite, consider a 40-year roof instead of the standard 20-year roof.
- Use the sun. Orient the longer axis of the house east to west. When the sun travels low in the winter sky, the long southern face of the home will absorb heat through walls or, better yet, a good portion of the home’s windows. The rooms on the south side should be those where most activity takes place. Overhangs can shield against summer sun.



According to the Northwest Ecobuilding web site, “Many aspects of a green building are concrete and specific: the high-efficiency lighting, the properly shaded south-facing window that admits winter sun but blocks summer sun, or the living room floor made of salvaged wood. These are the manifestations of a green building that are easy to see; that you can touch; that you can list in a spreadsheet...But the principles that green buildings embody also require attention to other more complex or subjective questions:

- *How will present and future occupants use the building?*
- *What does the site suggest about where the building should be located?*
- *What’s the value of cleaner indoor air?*
- *Is the building’s general design and appearance consonant with its surroundings?*
- *How much more is given back to the community by supporting local builders and retailers?*
- *What’s the future economic value of energy self-sufficiency?”*

These questions are worthy of consideration, and highlight the need for systems thinking when making decisions, a mode that considers broad effects of our actions and constructions.

## Lower-cost energy efficiency opportunities

There are numerous technologies available to improve energy efficiency, the most important factor for reducing building related GHGs. The following ideas have been adapted from suggestions by the Energy Information Administration. Savings in both energy consumption and money are available by installing insulation, maintaining and upgrading existing equipment, and practicing energy-efficient behaviors as described in section two of this handbook. Recall that a 2° adjustment to the thermostat setting (lower in winter, higher in summer) can reduce heating bills by 4-6% and prevent 500 pounds of carbon dioxide from entering the atmosphere each year.<sup>1</sup> Programmable thermostats automatically control temperature for time of day and season.

### Heating and Cooling Systems.

For those purchasing new systems, efficient options include air-source heat pumps, geothermal heat pumps, high-efficiency gas furnaces, low-intensity infrared space heating, and programmable thermostats.

**Insulation and Weatherization.** Investing in insulation and weatherization products can reduce heating and cooling needs. Warm air leaking into indoor spaces during summer and out during winter can waste a lot of energy. Insulation wraps indoor spaces in a nice warm blanket, but air can still leak in or out through small cracks. Often the effect of small leaks is the same as leaving a door open. One of the easiest money-saving measures is to caulk, seal, and weather-strip all the cracks to the outside.

**Doors and Windows.** Energy-efficient doors are insulated and seal tightly to prevent air from leaking through or around them. If your doors are in good shape and you don’t want to replace them, make sure they seal tightly and have door sweeps at the bottom to prevent air leaks. Installing insulated storm doors provides an additional barrier to leaking air. Replacing older windows with new energy-efficient ones can reduce air leaks and utility

bills, as described previously. The best windows shut tightly and are constructed of two or more pieces of glass separated by a gas that provides an insulating barrier. If older windows cannot be replaced, an option is to caulk any cracks around the windows and make sure they seal tightly, then add storm windows or sheets of clear plastic to the outside to create additional air barriers. Windows, doors, and skylights are part of the government-backed Energy Star program that certifies energy-efficient products. To meet Energy Star requirements, windows, doors, and skylights must meet requirements tailored for the country's three broad climate regions.

## **Additional resources**

The Building Green web site houses the industry's often-used Green Spec guide, a source book for green-building materials, as well as articles on policy, siting, energy, materials and more. [www.buildinggreen.com/menus](http://www.buildinggreen.com/menus)

The U.S. Green Building Council serves as a gateway to information on case studies, research centers, design and materials resources, and more. [www.usgbc.org](http://www.usgbc.org)

## **Sample assignment**

Take one step to increase the efficiency of your building shell, either by adding insulation, sealing air leaks, or by increasing or reducing solar heat and light (depending on the season).



## Local Green Building Resources

- Green-building news, products, and books: [www.oikos.com](http://www.oikos.com)
- Useful fact sheets on the Northwest Ecobuilding Guild: [www.ecobuilding.org](http://www.ecobuilding.org)
- The City of Portland's Green Building Program: [www.portlandonline.com/bps/index.cfm?c=41481](http://www.portlandonline.com/bps/index.cfm?c=41481)
- City of Eugene Green Building Program, with information on green-building basics, permits, and local demonstration projects: [www.eugene-or.gov/greenbuilding](http://www.eugene-or.gov/greenbuilding)
- BRING Recycling sells reusable building supplies and offers deconstruction services for salvaging materials: [www.bringrecycling.org](http://www.bringrecycling.org)

## SECTION FIVE: RENEWABLES

### Key Learning Points

- Renewable energy is derived from non-fossil fuel sources that can be produced without reducing key natural resources or negatively affecting people.
- There are many tax credits and rebates designed to encourage the use of renewable energy for home and transportation.
- Biofuels offer renewable alternatives to gasoline and diesel that can reduce GHGs.

This section builds upon the home energy and transportation sections to explore tools and strategies available to reduce greenhouse-gas emissions. Once a household implements efficiency measures, renewable energy sources are a means of cutting greenhouse-gas emissions associated with burning fossil fuels.

Renewable energy can be defined as energy derived from non-fossil fuel sources that can be produced without reducing key natural resources or negatively affecting people and the environment. Although none are without impact, the following are examples of renewable energy: wind, wave, tidal, and solar electric production, solar water heating, passive solar, small-scale hydro, and biomass.

In order to reduce the climate footprint of our use of home and transportation energy, we must both make our homes and travel as energy efficient as possible and switch to renewable energy.

### Home Installations

At home, invest first in efficiency to maximize the cost effectiveness of purchasing renewable energy systems (or renewable power from your utility) for what remaining power is needed.

After investing in efficiency, check out your “solar window” to decide if solar electricity or water heating are right for your home. A solar array should face south (although east or west is okay in some cases) and should have unshaded exposure to the sun between 9 a.m. and 3 p.m. year-round. In addition, there must be sufficient room for all the panels. The percentage of electricity that photovoltaics can generate depends on the household’s use and the size of the array. Typically, a solar water heater can provide about 50% of a household’s needs throughout the year, even the Pacific Northwest.<sup>1</sup>

It usually makes sense to install solar water heaters before installing solar photovoltaic panels: Why make electricity to heat water when you can use the sun to heat the water directly? The payback period is generally much shorter for solar water heaters than for solar photovoltaic systems.

With sufficient wind, small wind electric systems are one of the most cost-effective home-based renewable energy systems. In the right area they can cut electricity bills 50-90%, help avoid the high costs of putting in electrical lines to remote locations and, with a battery system, help provide uninterrupted power supplies through extended utility outages.

There are numerous tax credits and rebates available from utilities, the state, and the federal government. Visit the Database of State Incentives for Renewables and Efficiency at [www.dsireusa.org](http://www.dsireusa.org) to find out what incentives are offered in your area.

### Green tags and renewable energy certificates

While some households will be able to install systems to produce renewable energy, many people will buy renewable energy from their utility or renewable energy certificates, or “green tags,” instead.

The Eugene Water and Electric Board explains green tags as follows: “Renewable energy certificates (REC), sometimes called ‘green tags,’ represent the positive environmental attributes or benefits of renewable generation like wind, solar, and geothermal power. Renewable generation displaces less environmentally friendly forms of energy production that burn fossil fuel and cause air and water pollution. The electricity produced by renewable generation is the same as conventional generation. However, the displacement of fossil-fuel generation leaves a positive environmental impact

by comparison. In essence, the REC is a record of the positive environmental attribute produced when the renewable generation displaces fossil-fuel generation.”

Renewable energy certificates are a method of documenting and tracking the environmental attributes of renewable energy generation. RECs can only be produced in an equal amount to the amount of electricity generated from a qualifying new renewable generator. RECs are traded in wholesale markets between suppliers and organizations that use the certificates to meet regulatory requirements for investments in renewable energy, and in retail programs.

Ask your electricity, natural gas or fuel provider about options for purchasing renewable energy or green tags. Many utilities and independent companies sell RECs in blocks of 100 or 1,000 kilowatt hours or for an extra charge per kilowatt hour. While you will not necessarily receive the actual electrons generated by the renewable power plant, your additional contribution provides the funding to support the generation of power from renewable sources.

## Transportation

Biofuels are alternatives or additives to fossil-based fuels made from organic materials. The most widely used biofuels are biodiesel and ethanol. Due to cost, limited supply, and some vehicle limitations, most biofuels are sold blended with petroleum-based fuels. Blends are represented by the first letter of the biofuel and the percentage of that biofuel (e.g., 100% biodiesel is B100, 85% ethanol is E85).

Biodiesel derives from vegetable or animal fats such as rapeseed (canola), soy, other oilseed crops, used cooking oil, or animal tallow through a process called transesterification, in which alcohol is reacted with the oil to remove the glycerin. The fuel can be blended with or substituted for diesel fuel in compression-ignition (diesel) engines with no modification to the vehicle. However, the solvent properties of biodiesel may necessitate filter changes and other maintenance for vehicles, equipment, and storage devices previously used for older diesel, as the biodiesel cleans out the petrodiesel deposits. In cold weather, pure biodiesel gels, so it is necessary to use a biodiesel blend at those times.

Ethanol is made from converting the carbohydrates in biomasses such as corn, sugar beets, wood waste, and straw into sugar, which is then fermented into ethanol, a form of alcohol. More than 3 million flexible-fuel vehicles that can run on E85 or higher-percentage blends have been sold in the United States, although many of their owners remain unaware of this option.<sup>2</sup> Most gasoline-powered vehicles can run on E10.

Biofuels are generally considered a move toward sustainability because they are a renewable resource, can be produced domestically, are biodegradable and nontoxic, and typically produce fewer emissions than fossil fuels. The final greenhouse-gas emissions can be less for biofuels than for fossil fuels, by about 18% for E85 and about 75% for B100, depending on production method and feedstock.<sup>3</sup> This is because of the carbon sequestered in the growing of feedstocks for the fuels and because of decreased tailpipe emissions. While the carbon dioxide released into the atmosphere through biofuels combustion is equivalent to the amount absorbed by the growing feedstock plants, there are other emissions to consider. Energy sources other than sunlight are necessary to grow those feedstocks. Those sources include fossil fuels burned in tractors and made into fertilizers and pesticides, and those fuels needed to transport the final product. As the demand for biofuels grows, peat swamps and forests are being cleared for biofuel crops, releasing stored carbon. When land use changes are incorporated into the lifecycle emissions for corn-based ethanol as it is currently produced, the emissions are higher than the lifecycle emissions of gasoline.<sup>4</sup>

Controversy rages about the impact of rising demand for corn-based ethanol on the food supply. The International Food Policy Research Institute estimates that biofuels account for as much as one-third of the price increase for global commodities. In short, the issues with biofuels illustrate the fact that we are part of a complex system without simple fixes.

Visit the National Ethanol Vehicle Coalition website, [www.e85fuel.com/e85101/flexfuelvehicles.php](http://www.e85fuel.com/e85101/flexfuelvehicles.php), or the EPA's Alternative Fuels and Advanced Vehicles Data Center, [www.afdc.energy.gov/afdc](http://www.afdc.energy.gov/afdc).

## Additional resources

Database of State Incentives for Renewables and Efficiency for local information on incentives and rebates across the nation: [www.dsireusa.org](http://www.dsireusa.org)

The National Biodiesel Board, the trade association for biodiesel with information on location of biodiesel dealers. [www.biodiesel.org](http://www.biodiesel.org)

Green Car Congress, with news on sustainable transportation and links for biofuels, electric vehicles, and more. [www.greencarcongress.com/topics.html](http://www.greencarcongress.com/topics.html)

U.S. Department of Energy's Energy Efficiency and Renewable Energy site: Beyond the basics on solar power, wind, hydro, and other renewables. [www.eere.energy.gov](http://www.eere.energy.gov)

Home Power magazine: Useful articles on various topics in renewable energy systems for homes. [www.homepower.com](http://www.homepower.com)

Columbia Willamette Clean Cities Coalition: Alternative fuels station locator, local events and other resources. <http://www.cwcleancities.org/>

## Sample Assignment

Investigate the feasibility of a home installation of renewable energy. If you cannot generate your own renewable energy and you're not already doing it, sign up for green power or RECs. If you are already enrolled, talk to a friend or family member about signing up.

Find out if your car can run on biofuels and where biofuels are available.

## Local Renewables Resources

Eugene Water and Electric Board (EWEB) information on their Greenpower program. [www.eweb.org](http://www.eweb.org)

Emerald People's Utility District web site. [www.epud.org](http://www.epud.org)

Springfield Utility Board ECOchoice program: [www.subutil.com/conservation\\_services/ecochoice/](http://www.subutil.com/conservation_services/ecochoice/)

Energy Trust of Oregon: [www.energytrust.org](http://www.energytrust.org)

Oregon Department of Energy Renewable Rebates: [www.oregon.gov/ENERGY/CONS/RES/RETC.shtml](http://www.oregon.gov/ENERGY/CONS/RES/RETC.shtml)



## SECTION SIX: YARDS

### Key Learning Points

- Composting reduces emissions from waste
- Trees cool the home in summer and sequester carbon dioxide
- Chemical yard care products are sources of yard emissions
- Planting and yard care using fewer energy-burning tools reduces emissions

#### Emissions in our yard come from:

- synthetic, fossil fuel-based fertilizers, pesticides, and herbicides
- gas and electric mowers, edgers, and leaf blowers
- embodied emissions in yard furniture and tools
- outdoor heaters
- waste sent to a landfill, where it decomposes anaerobically and releases methane

#### Opportunities to reduce emissions in our yard:

- reducing the use of synthetic products
- switching to human powered (or at least electric) equipment
- buying pre-owned or recycled furniture and equipment
- composting food and yard waste
- planting trees for shade and carbon sequestration
- growing food

By composting food and yard waste, planting trees and plants that require little applied water or fertilizer, using push mowers, and practicing yard care that requires expending few natural resources, we can reduce emissions around our home and at the landfill. We can further reduce our food-related emissions by growing some of our food at home, discussed in section eight of this handbook.

**Composting** food waste reduces one pound of carbon dioxide equivalent (CO<sub>2</sub>e) per pound of food waste.<sup>1</sup> (CO<sub>2</sub>e is a unit of measurement to compare greenhouse gases based on their warming potential.) Composting results in aerobic (with oxygen) digestion of the food waste which produces CO<sub>2</sub>. On the other hand, sending food to a landfill results in anaerobic (without oxygen) digestion which

produces methane. Although both are greenhouse gases, methane has 21 times the warming potential of carbon dioxide.<sup>2</sup> Making a compost pile also reduces emissions from transportation of waste, frees space in the landfill, and may allow people to save money by decreasing their trash services. And finished compost can be used as a fertilizer in flower and vegetable beds instead of petroleum-based fertilizers (discussed below). For those who live in apartments or don't have adequate room for a compost pile, a worm bin can be another means of disposing of organic waste without sending it to the landfill. See the resources at the end of this section to get started.

**Planting trees** at home serves two important purposes for reducing emissions: regulating temperature in the home and storing carbon. Trees draw carbon dioxide out of the atmosphere and convert it into sugars, which stores carbon for the tree. Softwood trees can sequester 26 pounds of carbon annually, or about a ton over their lifetime.<sup>3</sup>

When placed correctly, trees can shade the home or, at the very least, the home's air conditioning unit and can save electricity used to cool the house. If planted to shade an air conditioning unit or the south and west sides of a home, the shading can reduce the costs of cooling by an average of \$175 a year.<sup>4</sup> Planting deciduous trees will allow for sunlight to enter the home in the winter while providing shade in the summer. In addition, trees or high shrubs planted along the north side of a home can reduce heating costs in the winter by providing a wind block.

**Lawns** are just about the most resource-intensive landscape. Part of the problem is the large amounts of energy and natural resources needed to achieve the ideal that many people strive for with their lawns, roses, and other such plantings. An easy way

to reduce energy and resource use is to change our standards. Mowing a little higher, accepting a lighter lawn color and the occasional weed can cut down on emissions with very little effort. Reducing lawn size is another simple way to trim emissions (if replaced by plants with little need for applied water or fertilizer). Instead of using gas lawn mowers, try an electric or, better yet, a push mower. If you mow your lawn regularly (so that it is never more than two or three inches long), you can “grasscycle” your yard clippings. “Grasscycling” means leaving or spreading the clippings on the lawn or other parts of the yard.



The mulch provided by the cut grass decomposes and provides nutrients for your yard. Leaves and other lawn debris can provide a cover for the compost or garden beds. Grasscycling, mulching, and leaf cover all reduce the need for chemical fertilizers and water. These fertilizers require large amounts of fossil fuels in production and distribution, and the nitrous oxide released from these fertilizers as they break down in the soil is 310 times more potent than carbon dioxide.<sup>5</sup> On top of that, many homeowners overfertilize their lawns, resulting in further unnecessary emissions.

By planting non-resource-intensive species in our yards, we can reduce our emissions and save water. Native plants are adapted to the regional climates, and they provide an alternative to grass, roses, and other needy plants in landscaping. These plants tend to require less fertilizer and summer water, although they still will require some upkeep to look picture-perfect. Planting native species provides the additional benefit of creating habitat and forage for local fauna.

If you are working with a landscaper or landscaping company, ask them to take up climate-friendly practices. Provide them with the resources at the end of this section for more information.

**Outdoor Furniture and Appliances** If you are barbecuing, lump charcoal produced from sustainably managed forests offers an alternative

to briquettes for charcoal enthusiasts. If charcoal is your fuel of choice, use a chimney tower instead of lighter fluids, which contain volatile organic compounds. These compounds contribute to ground-level ozone pollution, which can cause

health problems. Chimney towers are easy to use, reduce the amount of time needed to prepare the coals, and require no lighter fluid. And, if you’ve already got a charcoal grill and want to switch to less emission intensive gas or propane, try to find a used one to decrease the emissions involved

in mining and manufacturing. For no-emissions meals, try building a solar oven for summertime outdoor use.

Outdoor patio heaters also contribute to your household’s carbon emissions. These heaters use propane gas, and not very efficiently. According to a report by the United Kingdom’s Market Transformation Programme, outdoor patio heaters on average consume 30,400 BTUs. Wear a sweater or jacket instead of firing up your heater.

In general, the more new items we purchase to fill our outdoor living spaces, the more embodied emissions we rack up. Each chair, table, umbrella, hammock, fire pit, or bench has greenhouse-gas emissions associated with the mining or harvesting of materials, the energy used in manufacturing, the transportation of each item, and in some cases the energy used by the final product. Buy used

items and those made from recycled materials to decrease the embodied emissions associated with your outdoor living space.

## **Additional Resources**

### **Composting**

Compost Guide: [www.compostguide.com](http://www.compostguide.com)

Cornell Waste Management Institute  
<http://cwmi.css.cornell.edu/composting.htm>

GreenGuardian.com: Food Waste  
[greenguardian.com/throw2\\_food.asp](http://greenguardian.com/throw2_food.asp)

### **Landscaping**

Greenscaping Your Lawn and Garden, U.S.  
Environmental Protection Agency  
[www.epa.gov/epaoswer/non-hw/green/owners.htm](http://www.epa.gov/epaoswer/non-hw/green/owners.htm)

Tree Planting and Backyard Conservation, Natural  
Resources Conservation Service

[www.nrcs.usda.gov/Feature/backyard/treeptg.html](http://www.nrcs.usda.gov/Feature/backyard/treeptg.html)

### **Native Plants**

Plant Native, [www.plantnative.org/index.htm](http://www.plantnative.org/index.htm)

Moss Gardening and Transplanting

[www.mossacres.com](http://www.mossacres.com)

### **Water Conservation**

Saving Water Partnership, an extremely useful website  
covering natural yard care, plant selection, composting,  
soil, rain barrels, and more. [www.savingwater.org/outside.  
htm](http://www.savingwater.org/outside.htm)

Drip Irrigation: [www.irrigation.org](http://www.irrigation.org)

## **Sample Assignment**

If you don't use a compost pile or a worm bin, set one up. If you already have one, mentor an interested friend and get them started. Take a step toward reducing the need for heavy expenditures of natural resources for your outdoor space through reducing your lawn size, changing your standards, or switching to manual raking and mowing.

### **Local Yard Resources**

Master Gardener Program, OSU Extension Service:

[www.extension.oregonstate.edu/mg](http://www.extension.oregonstate.edu/mg)

Emerald Chapter, Native Plant Society of Oregon,

<http://emerald.npsoregon.org>

## SECTION SEVEN: CONSUMPTION AND WASTE

### Key Learning Points

- Avoid “upstream” emissions by curbing consumption
- Reuse items before recycling.
- Recycle as necessary
- Compost organics (typically food and yard waste)
- Buy products made with post-consumer recycled content

Greenhouse-gas emissions are associated with material goods at nearly every phase of their life cycle, from extraction, to production, to use (in some cases), through to the methane released from decomposition in the landfill.

US residents generated an average of 4.6 pounds of waste per person per day in 2006, for a grand total of 251.3 million tons that year.<sup>1</sup> If we're tossing that much away, think of all that we're consuming. Knowing that a ream of non recycled content paper is associated with 35.7 pounds of carbon dioxide emissions makes it easier to conceive of all the embodied energy and emissions associated with the goods we consume and throw away.<sup>2</sup>

The Environmental Protection Agency estimates that residential waste makes up 55-65% of the nation's waste stream, but even industrial and construction waste results from demand by individuals. According to the United Nations Systemwide Earthwatch initiative, industrialized countries account for only 20% of the world population but consume 86% of aluminum, 81% of paper, 80% of iron and steel, and 76% of timber produced globally. In the average American's lifetime, he or she will consume 540 tons of construction materials, 18 tons of paper, 23 tons of wood, 16 tons of metals, and 32 tons of organic chemicals. Although we are recycling a higher percentage of our waste than in the past, we create more waste per capita each year. In 1960, Americans averaged 2.68 pounds per person per day, but this jumped to 4.4 pounds per person per day by 1997.

Today, it is very easy to find one-time use items created for convenience, which only increases the amount of waste produced.

Concerns about increasing quantities of waste and the associated GHG emissions have become more serious due to the short life cycles and heavy packaging of more and more goods. For years there has been a push for Americans to develop policies that make manufacturers more responsible for their product from material extraction to end of product life. Many people feel that products should

**Table 7-1: Example Waste Composition, State of Oregon, 2000**

Material	Percent of Waste Stream	Tons Disposed
Paper	22.1%	53,257
Food	16.22%	39,087
Inorganics (wallboard, concrete, fiberglass)	12.78%	30,797
Plastics	9.7%	23,375
Miscellaneous Organics	9.61%	23,159
Wood	8.81%	21,230
Metals	8.78%	21,158
Yard Debris	5.92%	14,267
Textiles	2.92%	5,518
Glass	2.29%	5,518
Household Hazardous Waste	.87%	2,097
<b>Total</b>	<b>100%</b>	<b>240,982</b>



be made more durably (rather than for “planned obsolescence”); made easier to dismantle for repair, reuse or recycling; and made with fewer toxic and landfill-bound materials. Not only would this reduce the amount of landfilled material, but it would also decrease the amount of GHGs that are released from manufacturing new products. Generally, the fewer products we consume, particularly those made from virgin materials, the fewer GHGs are released into our atmosphere.

The chart on page 39 shows the waste composition for the United States. Much of what ends up in our landfill could be recycled (glass, metals, paper) in a process that requires less energy and far less resources than using new materials. All of the organics (food, wood, yard debris, miscellaneous organics) could be composted, creating nutrient-rich soil and resulting in carbon dioxide emissions, rather than more potent methane emissions.

Reducing our waste not only decreases our greenhouse-gas emissions and other pollutants, but also conserves natural resources and landfill space, saves energy, and strengthens our local economy.

Thanks to curbside recycling and yard waste composting, many people are used to recycling household waste.

But recycling requires the use of fossil fuels as raw material and for energy in processing—including transporting the waste—as does creating the original products we are recycling. In order to curb emissions associated with waste, we need to reduce the amount of waste we generate in the first place.

The next step is reusing items we might normally throw away or recycle—like soft-drink bottles and yogurt containers. The final step, after reduction and reusing, is to recycle items we cannot reuse. Aside from reducing our greenhouse-gas emissions, these actions will save us money in the long run.

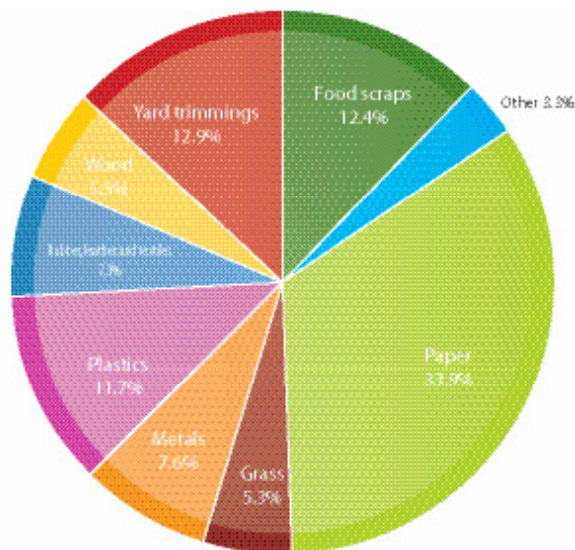
## Reduce

Here are some ways we can reduce waste before it becomes waste, an idea known as source reduction:

Buy less. When making a purchase, consider the following:

- Do I need to buy this?
- Can I buy this secondhand or remanufactured? Remanufactured products use 85% less energy in production.<sup>3</sup>

Figure 5. Total MSW Generation (by Material), 2006  
251 Million Tons (Before Recycling)



Source: [www.epa.gov/waste/nonhaz/municipal/pubs/msw06.pdf](http://www.epa.gov/waste/nonhaz/municipal/pubs/msw06.pdf)

- Is it available with post-consumer recycled materials? Purchasing these products saves energy and raw materials, and sustains a market for recycled items.
- Is it reusable?
- Is it durable and repairable, e.g., can the shoes be resoled? Can I replace appliance parts?
- Does it contain toxic substances? Many toxic materials are petroleum-based and result in emissions of greenhouse gases.
- Can I avoid the packaging? If not, can the package be composted or at least recycled?
- Sign up with the Direct Marketing Association to stop junk mail.
- Print on both sides of the paper and reuse paper.
- Rent or share items like tools, camping and outdoor recreation equipment, or books.
- Bring your own cup to the coffee shop and reusable cloth bags to the store.
- Host a clothing, book, or music exchange instead of going shopping.
- Many cleaning products are petroleum-based. Using nontoxic cleaners, varnishes, and paints not only reduces greenhouse-gas emissions, but also the flow of toxic waste from the household to the environment. See the end of this chapter for alternatives.

## Reuse

Another important step in reducing waste is reusing. Gently used clothing, furniture, electronic equipment, appliances, and magazines can be donated to churches, charity organizations and community groups instead of thrown away. Instead of buying a new electronic item, consider purchasing a used or refurbished product and reduce emissions associated with manufacturing. Instead of recycling those prepared-food containers, use them to bring your lunch with you to work or school. These containers can also be used for storage in the refrigerator or freezer as well. Glass jars make excellent containers for storing small household items such as nails, screws, push pins, and sewing supplies. If you are planning on remodeling your home, be sure to donate wood, windows, cabinets, and fixtures to a place such as a recycling center that resells these used building materials and seek out similar materials for your own projects.

## Recycle

The final chapter in waste reduction is recycling. Recycling reduces methane emitted from waste decomposing in landfills as well as the amount of raw material used in creating new goods. In the case of paper products, recycled paper preserves forests that store carbon dioxide, both in the trees and in the soil beneath the trees. According to the Lane County Recyclers Handbook, "The energy saved by recycling one glass bottle would light a 100-watt light bulb for four hours. Every ton of paper recycled saves 4,100 kilowatt hours of energy, . . . 7,000 gallons of water, and reduces water pollutants by as much as 35%."

Composting and "grasscycling" are two other ways to reduce our methane emissions associated with landfills (see section six). By diverting organic wastes from landfills, we reduce the overall amount of methane emitted from landfills as the organic wastes decompose. The resulting rich compost provides nutrients to your yard and garden, reducing your need for fertilizers that are often fossil fuel-based.

## Additional resources

Metro: Fast facts about waste prevention. [www.oregonmetro.gov/index.cfm/go/by.web/id=526/level=2](http://www.oregonmetro.gov/index.cfm/go/by.web/id=526/level=2)

U.S. Environmental Protection Agency, Municipal Solid Waste, Source Reduction, and Reuse. [www.epa.gov/msw/sourced](http://www.epa.gov/msw/sourced)

Columbia University, Environmental Stewardship website. [www.columbia.edu/cu/environment/docs-wydc/reuse-recycle/index.html](http://www.columbia.edu/cu/environment/docs-wydc/reuse-recycle/index.html)

Minnesota Office of Environmental Assistance, Waste Prevention: Source Reduction Now. [www.pca.state.mn.us/oea/publications/srn.pdf](http://www.pca.state.mn.us/oea/publications/srn.pdf)

## Sample assignment

This week, practice asking yourself the following questions before making a purchase:

- Why do I want this?
- How often will I use it?
- What are my alternatives?
- Can I get along without it?

## Stop Junk Mail!

Sign up at [www.41pounds.org](http://www.41pounds.org) to start the process, or send a postcard or letter to:

Mail Preference Service  
Direct Marketing Association  
PO Box 643  
Carmel NY 15012-0643

Include your complete name, address, ZIP code, and a request to "activate the preference service."

## RECYCLING FACTS

*From the Lane County Recyclers Handbook*

A child born in an American family will put a stress on the world's resources that is thirty times greater than a child born in a poor nation.<sup>4</sup>

People in the United States make up 5% of the world's population but use 25% of the world's resources and generate 30% of its garbage.<sup>5</sup>

The average American consumer uses nearly twenty tons of raw materials each year—twice that of the average Japanese or European.<sup>6</sup>

### Paper

The United States consumes 734 pounds of paper products per capita versus 212 for West Germany and 127 for the European Economic Community as a whole.<sup>7</sup>

Making paper from recycled fiber generates 75% less air pollution.<sup>8</sup>

One person uses and discards two pine trees worth of paper products per year.<sup>9</sup>

Every time you recycle a forty-inch stack of newspapers, you save the equivalent of one southern pine tree.<sup>10</sup>

Recycling one-half the paper used throughout the world today would free 20 million acres of forest from paper production.<sup>11</sup>

The average office employee discards 1.5 pounds of recyclable paper each day, or about 360 pounds per year.<sup>12</sup>

Old corrugated containers account for nearly 50% of the total paper that is recycled.<sup>13</sup>

Recycling 437,000 tons of paper reduces air emissions equivalent to that produced by 200,238 cars driving on year. The total benefit from paper recycling in the United States is equivalent to taking 24 million cars off the road.<sup>14</sup>

### Glass

The energy saved from recycling a glass bottle will light a 100-watt bulb for four hours.

Producing a new glass bottle from recycled glass uses 30% less energy than if raw materials were used.<sup>15</sup>

### Plastics

The amount of plastic waste generated has been increasing by about 10% per year for the past twenty years.<sup>16</sup>

If just one-fourth of U.S. households used ten fewer plastic bags per month, 2.5 billion fewer bags would go to landfills each year.<sup>17</sup>

### Aluminum

Aluminum made from recycled cans uses 95% less energy than if made from virgin (bauxite) ore.<sup>18</sup>

The average aluminum beverage can in the U.S. contains about 51% post-consumer recycled aluminum.<sup>19</sup>

100% of all beer and soft-drink cans are made of aluminum.<sup>20</sup>

### Steel and Tin Cans

The amount of tin ore left in the world will last only 31 years if use grows at projected rates.<sup>21</sup>

One ton of steel cans contain 3.8 pounds of tin.<sup>22</sup>

The average American uses 130 steel cans per year.<sup>23</sup>

### Tires

Every year Americans throw away 260 million tires. If stacked, they would reach a height of about 32,000 miles.<sup>24</sup>

If all car owners kept their tires properly inflated, we could save up to 2 billion gallons of gas each year.<sup>25</sup>

### Packaging

Americans throw away twice as much packaging as they did in 1960.<sup>26</sup>

30% of municipal solid waste is made up of packaging.<sup>27</sup>

### Junk Mail

The amount of junk mail received by the average household doubled between 1977 and 1987.<sup>28</sup>

Americans receive almost 2 million tons of junk mail every year.<sup>29</sup>

About 44% of junk mail is never opened or read.<sup>30</sup>

## DID YOU KNOW?

### The Aluminum Can

*From Lean Thinking by James P. Womack and Daniel T. Jones*

The aluminum can is more costly and complicated to manufacture (from virgin material) than the beverage.

Typically, bauxite is mined in Australia and trucked to a chemical-reduction mill where a half-hour process purifies each ton of bauxite into a half ton of aluminum oxide. When enough of that is stockpiled, it is loaded on a giant ore carrier and sent to Sweden or Norway, where hydroelectric dams provide cheap electricity.

After a monthlong journey across two oceans, it usually sits at the smelter for as long as two months. The smelter takes two hours to turn each half ton of aluminum oxide into a quarter ton of aluminum metal. These are cured for two weeks before being shipped to roller mills in Sweden or Germany. There, each ingot is heated to nearly 900 degrees Fahrenheit and rolled down to a thickness of an eighth of an inch. The resulting sheets are wrapped in ten-ton coils and transported to a warehouse, where they are rolled tenfold thinner, ready for fabrication.

The aluminum is then sent to England, where sheets are punched and formed into cans, which are then washed, dried, painted with a base coat, and then painted again with specific product information. The cans are then palletized, fork lifted, and warehoused until needed.

They are then shipped to the bottler, where they are washed and cleaned once more, then filled with soda. The filled cans are sealed with an aluminum “pop-top” lid at the rate of fifteen hundred cans per minute. Palletized again, the cans are shipped to a regional distribution warehouse, and shortly thereafter to a supermarket where a typical can is purchased within three days.

Drinking the cola takes a few minutes, throwing the cans away takes a second. The United States still gets three-fifths of its aluminum from virgin ore, at twenty times the energy intensity of recycled aluminum, and throws away enough aluminum to replace its entire commercial aircraft fleet every three months.

## Local Resources

City of Eugene Solid Waste and Recycling website. [www.eugene-or.gov/pdd](http://www.eugene-or.gov/pdd)

Sanipac: Recycling and garbage collection in Eugene and Springfield. [www.sanipac.com](http://www.sanipac.com)

Bring Recycling. [www.bringrecycling.org](http://www.bringrecycling.org)

Next Step Recycling. [www.nextsteprecycling.org](http://www.nextsteprecycling.org)

### Local Waste Facts

- Residential waste made up 41% of Oregon's waste stream in 2000, according to the Department of Environmental Quality's Oregon Solid Waste Composition Study.
- Most of Lane County's waste goes to Short Mountain Landfill, where about 75 to 80% of the methane is captured and used to create power for about 1,200 houses.
- In 2003, Lane County residents recycled 45% of waste.



## SECTION EIGHT: FOOD

### Key Learning Points

- To minimize GHG emissions, buy and eat:
  - » fewer animal products (especially beef and dairy.)
  - » minimally processed/packaged food.
  - » only what you need, 25% of food is thrown away in the US.
  - » organic and seasonal local foods when possible.
  - » food grown close to home (especially for veggie products.)

The average U.S. household is responsible for about eight tons of CO<sub>2</sub>e emissions annually related to their food consumption.<sup>1</sup> Fortunately, these emissions are very flexible, as we can change the carbon footprint of our diet with every meal choice.

When looking at the full life-cycle of the food system, including production, transportation and distribution of food, the vast majority of food related emissions, 83%, derive from the production phase, with transportation accounting for just 11%. The growing body of research on the food system's carbon footprint shows that cutting down on red meat and dairy are a surefire way to trim emissions. Eating local, while important for protecting the local "foodshed" and economy, plays only a minor role in reducing food emissions.<sup>2</sup> Other strategies for reducing food emissions, like eating unprocessed and organic foods and avoiding food waste also play a part in reducing emissions.

Modern agriculture relies on large expenditures of fossil fuels at all levels of food production and distribution, from plowing and fertilizing fields, to transporting crops to storage, to processing and packaging products, to the final trip to the consumer's home (where further energy is used to store and prepare food). Moreover, at every stage of this process, food is wasted and thrown away.

### Eat your veggies!

According to the Food and Agriculture Association of the United Nations, livestock uses 30% of the world's surface land area and accounts for a whopping 18% of CO<sub>2</sub>e emissions, including land use changes, fertilizers for feed, and energy use.<sup>3</sup> Unlike the other components of our personal climate footprints where CO<sub>2</sub> is the major offender, half of

our food emissions are in the form of methane and nitrous oxide.<sup>4</sup>

Cows raised for dairy and meat belch methane (which has twenty-one times the warming potential of carbon dioxide) as their four guts digest the fibrous grass that makes up their diet. Cows raised on corn (of which there are many these days) belch even more methane than grass-fed cows. According to the Worldwatch Institute, this methane makes up 16% of the overall methane emissions produced per year.<sup>5</sup> Data from the U.S. Department of Energy supports that statistic: 94% of total methane emissions from agriculture are directly related to livestock.

Food related nitrous oxide (N<sub>2</sub>O) emissions derive primarily from fertilizer application and other cropping practices. As livestock do not efficiently transform plant energy into animal-based energy, globally, livestock use 78% of agricultural land and 33% of cropland.<sup>6</sup> As a result of this, much soil management is related to livestock production.

Feedlots (a type of confined-animal feeding operation) also rely on antibiotics and grain production to increase meat yields, further increasing demands for fossil fuels. Much large-scale meat production occurs in areas that have been recently deforested for production of animal products. The cost to the atmosphere of meat production also embodies the loss of forests that fix, or sequester, CO<sub>2</sub>—many of them in tropical areas where plants are able to photosynthesize year-round.

Researchers at Carnegie Mellon found that switching from red meat or dairy to another protein source less than one day a week has the same impact on emissions as eating a pure "local"

diet.<sup>7</sup> A University of Chicago study compared the average American diet, which includes red meat, to the emissions produced by a Chevrolet Suburban; the lacto-ovo vegetarian diet was much closer to the emissions of a Toyota Prius, a low-carbon emissions car.

Although many focus on the impact of red meat on the global climate, deep-sea fishing also requires large amounts of fossil fuel in catching, storing, and transporting fish from sea to market.

In fact, the University of Chicago study found that a diet rich in fish nearly equaled the emissions associated with a red-meat diet. In addition, because many of the world's fisheries have collapsed due to over-fishing, fishing methods have become increasingly invasive and destructive on marine ecosystems.<sup>8</sup>

## Eat whole foods

Processing and packaging foods is an energy-intensive practice—and we're surrounded by a multitude of these products.

For example, a can of cola purchased at the market embodies the emissions for extraction of raw materials for the can and the cola, soda and can manufacturing, and distribution. This all happens before the can makes it to your refrigerator (the appliance that uses more energy than any other in your home). After you have finished the cola, disposing of the empty can leads to further emissions as it is transported to the landfill, where its embodied energy is wasted, or to a recycling center, where energy is used for it to be made into a new product.

If we shop for whole foods, like fresh vegetables and grains, instead of packaged and processed foods, which are often high in calories and low in nutrition, we can reduce the energy demand required to transport and produce food commodities. In every step of processing, food is wasted and energy is used for processing and transportation. Of the total amount of energy used in the United States, about 16% is consumed by the food production system. Of that 16%, nearly a third is used for processing, 10% for transportation, and 17.5% for agriculture.<sup>9</sup>

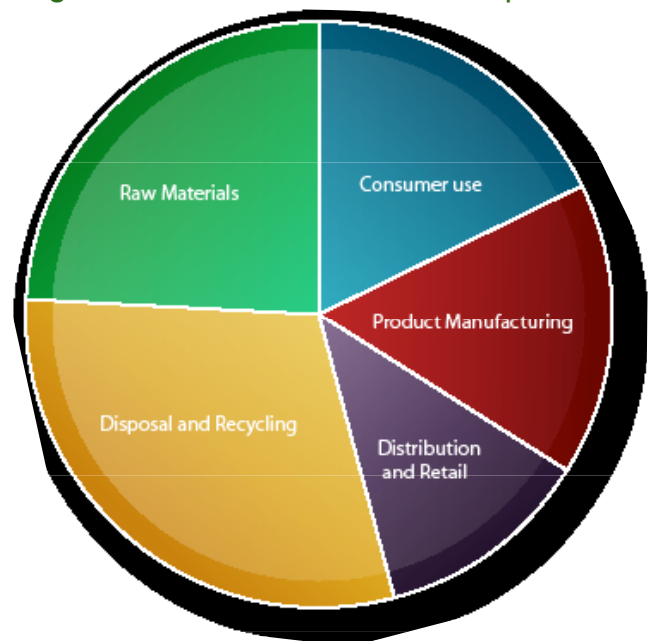
## Waste

Americans throw away about a quarter of the food we prepare, at a cost of a billion dollars a year, according to the Environmental Protection

Agency (EPA). This waste comes from households, restaurants and cafeterias, and doesn't include the food wasted in processing, transportation and grocery stores. Food scraps made up 12.5% of the solid waste generated by American households in 2007.<sup>10</sup> Uneaten food causes emissions upstream, before the food reaches its intended point of use, and downstream, in the landfill. Upstream emissions are from growing, transporting and processing the food, while downstream emissions are the methane released from organic material decomposing anaerobically (without oxygen) in the landfill.

A clear means of dealing with waste is avoiding it in the first place. Buy only what you need and be aware of portion sizes in restaurants. Deal with food waste at home by composting it or feeding it to worms in a worm bin. Not only will you reduce your waste, but you may be able to save money by reducing your trash service. The EPA recommends that large-scale producers of food waste follow a hierarchy of first reducing waste, then feeding people with the waste, then feeding animals, and finally, composting waste. In some cases, waste fats and alcohols are now being made into biofuels for transportation.

Figure 8-1. Can of Cola Carbon Footprint



This diagram from the Carbon Trust illustrates the carbon footprint of a can of cola, from cradle to grave, and its intensive fossil-fuel requirements.

Source: *Carbon Footprints in the Supply Chain: The Next Step for Business* (2006).

## Transporting food

Despite the recent focus on transportation from farm to store, these so-called “food miles” account for only 4% of our food related emissions, with transportation as a whole making up 11% of food related emissions.<sup>11</sup> However, disruptions to the food supply are one projected impact of climate change due to changes in weather, water supplies, and distribution systems. Eating local foods could help protect your community against these risks by building a more resilient local food system. If you are working towards eating more local foods, eating with the seasons increases your chances of finding food produced locally, in-season, and more efficiently. Food grown locally, but out of season, can require additional energy for production in heated greenhouses. For example, the energy used for growing hothouse tomatoes in winter in England has been shown to require more energy (for heating or lighting) than importing tomatoes from Spain shipped by truck.<sup>12</sup>

The trip from the supermarket to our home can contribute among the largest expenditures of energy in the foods’ travels. Consider that a truck carrying tomatoes will be packed to the brim, using one engine to carry pounds and pounds of tomatoes. We might carry just two bags of groceries home in our otherwise empty vehicle. Most of the fossil fuels burned in that journey home are being used to move the hulking body of the vehicle, rather than to move our groceries. One way to avoid unnecessary transportation emissions is to grow a portion of your own food, and then bike, walk, or use public transportation for your other shopping.

When possible, consider both mode of transportation and distance when attempting to reduce GHG emissions associated with distribution of consumer goods, since we cannot assume that food grown and produced closer to home has fewer GHG emissions associated with its journey than does food produced further away. The difference in the efficiency of various modes of transportation of our food (air, truck, rail, and barge in increasing order of fuel efficiency) means that closer doesn’t always equal fewer emissions.

The difference between transport by air and by barge can be staggering. For example, a pineapple from Hawaii is grown 800 miles closer to Oregon than one grown in Costa Rica, but transported by air it embodies fifty times more GHG emissions than a pineapple shipped from Costa Rica. According

to the U.S. Department of Transportation, one gallon of fuel can transport one ton of food fifty-nine miles by truck, 202 miles by rail, 514 miles by barge, but only seven miles by air.<sup>13</sup> Although most food is transported by other means (barge to truck, for example), transporting food by air is on the rise. According to a report released in the United Kingdom, food transport by air increased more than any other mode of transportation between 1992 and 2004.<sup>14</sup> Foods commonly transported by air include asparagus, avocados, cherry tomatoes, citrus, lettuce, specialized and processed meats and fruits, strawberries, and seafood.<sup>15</sup>

## Go organic

Modern conventional agriculture relies heavily on fossil fuel, and therefore results in GHG emissions in almost every aspect of production, including:

- Fuels burned in machinery.
- Fertilizers, pesticides, herbicides, and fungicides used in farming are made from fossil fuels and require energy for transportation, and in particular, production. Synthesizing nitrogen for fertilizers requires massive amounts of energy. Nitrogen fertilizers, organic or not, release nitrous oxide (a greenhouse gas) from the soil.
- The embodied emissions—the emissions produced in the manufacture and maintenance of a product, to its point of use—in machinery used for plowing, harvesting, and irrigation.

One way to reduce the emissions associated with food production is by purchasing organic food. Organic farming methods typically require less fossil fuel use because they do not rely on chemical fertilizers; organic farms are also limited in the amount and types of pesticides that can be used. A twenty-two-year study from the Rodale Institute demonstrated that conventional farming methods require 3.7 barrels of oil per hectare of crop production, while organic farming methods needed only 2.5 barrels of oil to produce the same crop yield. Organic farmers rely less on machinery and more on labor-intensive practices to weed and harvest fields.<sup>16</sup> In addition, soil farmed organically has been found to store greater amounts of carbon dioxide than soil farmed by conventional methods. The same Rodale Institute study concluded that fields farmed organically stored at least twice, and up to three times, as much carbon than fields farmed using conventional methods.<sup>17</sup>

### Other Considerations:

When buying products like coffee, tea, chocolate, and tropical fruit, purchasing goods certified as “fair trade” ensures that the people producing the food are receiving the benefits of its sale in the global market. For instance, fair trade coffee farmers receive US\$1.26 per pound of coffee, while the international rate for coffee is US\$1 a pound. When middlemen are put in the picture, the coffee bean farmer may actually receive as little as \$.50 per pound of coffee.

Fair trade certification includes environmental requirements, ensuring less environmental destruction and deforestation than conventional fertilizer-intensive or slash-and-burn methods. By cultivating fair trade products, farmers can earn more and, in turn, return more of their profits to their community and invest in sustainable farming.<sup>18</sup>

### Take-home points

Reduce food emissions by:

- Reducing the red meat and dairy in your diet and choosing grass-fed when available
- Cutting down on other animal products.
- Buying only what you need; wasted food is pointless emissions
- Supporting organic agriculture
- Avoiding processed and packaged goods
- Cutting shopping emissions by biking, walking, using public transport, or combining errands
- Cooking efficiently
- Buying local foods in season and learning about food distribution in your area

### Additional resources

Leopold Center for Sustainable Agriculture. [www.leopold.iastate.edu](http://www.leopold.iastate.edu)

Local Harvest Community Supported Agriculture. [www.localharvest.org/csa](http://www.localharvest.org/csa)

### Sample assignment

Make one or more shifts in your eating and purchasing patterns to reduce greenhouse-gas emissions. Cut out one meat-, fish-, or dairy-based meal a week. Replace one or more of your food staples that are processed and/or packaged with their unprocessed/unpackaged counterpart.

## Local Resources

Oregon Roadside Guide to Eco-Healthy Eating, Oregon Environmental Council. [www.oeonline.org/resources/livinggreen/pdfs/roadfoodguide](http://www.oeonline.org/resources/livinggreen/pdfs/roadfoodguide)

Willamette Farm and Food Coalition. [www.lanefood.org](http://www.lanefood.org)



## SECTION NINE: HOME WATER CONSERVATION

### Key Learning Points

- Water shortages are already common in many areas of the U.S. and the world and are projected to increase as a major consequence of climate change.
- The energy used to produce, distribute, and dispose of water results in GHGs.
- Conserving water both inside and outside of the home is an easy way to reduce GHGs and optimize our water supply.

### A shrinking resource

As temperatures rise in the coming years, fresh water could become the single most important natural resource on earth. In the Pacific Northwest and other parts of the world, warmer temperatures are leading to more precipitation falling as rain instead of snow and a shrinking snowpack. Reduced and earlier spring runoff leads to lower flows later in the summer when demand is highest. Fresh water lakes and rivers are shrinking, and in some cases, are drying up. Oceans are rising, threatening coastal fresh water supplies. Changing precipitation patterns will result in flooding in some areas and drought in others, disrupting food production and transportation.<sup>1</sup>

Moreover, as the global population grows, our demand for water is stressing water supplies and distribution systems, creating threats to our health, our economy, and the environment. With the world's population expected to increase by another three billion people by 2050, we will need massive improvements to our water efficiency in agriculture in order to feed ourselves. Globally, irrigation accounts for 70% of freshwater withdrawals. Although we only need one half to one and one half gallons of water daily, each calorie of food energy produced requires 2.6 gallons of water. Daily, we consume approximately 528 to 1321 gallons of water through food production.<sup>2</sup>

In the United States, power production also plays a role, with irrigation and thermoelectric power each responsible for approximately 40% of freshwater withdrawals. However, thermoelectric power generators return the vast majority of the water they use for cooling, and so actually consume just a small portion of what they withdraw.<sup>3</sup> For example, in 1995, thermoelectric power plants consumed

just 3.3% of the total annual freshwater withdrawal, while agriculture consumed 84% of the total withdrawn.<sup>4</sup>

With this combined pressure on the water system, many parts of the country are experiencing shortages. In 2003, the United States General Accounting Office (GAO) reported that, even under normal weather conditions, at least 36 states anticipated local, regional, or statewide water shortages within ten years.<sup>5</sup> Many municipalities across the country are already experiencing water

### The ENERGY STAR® and WaterSense<sup>SM</sup> Programs

In 1992, the EPA and the U.S. Department of Energy created the ENERGY STAR program as a voluntary labeling program to reduce energy consumption. It is now a worldwide program with over forty product categories. Products carrying the ENERGY STAR label either exceed the government's minimum federal standards for energy use, or, if there are no federal standards, have energy-saving features.

In 2006, the EPA created the WaterSense program to help consumers conserve water. The program provides consumers with water conservation and product information and lists of professional partners. To carry the WaterSense label, a product must be approximately 20% more water efficient than a similar product.

shortages and are instituting water use restrictions. Cities as diverse as Denver, Las Vegas, St. Louis, and New York have mandatory seasonal or year round residential water use restrictions.

There are also GHG emissions associated with fresh water consumption. Water utilities use energy to pump water from its source (e.g. lakes, rivers), purify, store, and distribute it to the consumer, then to treat and dispose of it. At home, without a solar hot water system, heating water requires more energy, and therefore results in more GHGs. This means that water conservation presents us with an opportunity to both prepare for the impacts of climate change and reduce our own impact on the climate.

## Indoors

### Water Conservation & Reducing Emissions

The U.S. Environmental Protection Agency states that approximately 3% of United States energy consumption, approximately 56 billion kilowatt hours (kWh), is used for drinking water and wastewater services, adding approximately 45 million tons of GHG to the atmosphere.<sup>6</sup> If one out of every hundred households were retrofitted with water efficient appliances and fixtures, we would save around 100 million kWh of electricity annually, and reduce the subsequent GHG emissions by 80,000 tons – equal to removing nearly 15,000 cars from the road for a year.<sup>7</sup>

### Typical Home Water Use

The EPA estimates that the average American household uses approximately 100 gallons of water per day and spends up to \$500 a year on water and sewer.<sup>8</sup> By replacing plumbing fixtures (faucets, shower heads and toilets) with low flow devices and replacing old washing machines, dishwashers and refrigerators with ENERGY STAR or WaterSense rated appliances, we can reduce our consumption by about 35% and save \$170 per



year.<sup>9</sup> If all U.S. households installed water-efficient appliances, the country would save over 3 trillion gallons of water and more than \$18 billion dollars per year.<sup>10</sup>

We can save even more by changing personal water use habits such as turning off the faucet while brushing our teeth and taking shorter showers. When we use water more efficiently and avoid using water during peak hours (morning and evening), we save even more by reducing the need for costly water supply infrastructure investments and new wastewater treatment facilities.

## Outdoors

*(For more information on reducing carbon emissions in the landscape, see Section Six:Yards)*

Although residential outdoor water demand varies greatly around the country due to different climate and geographic conditions, water demand typically increases during summer months due to outdoor watering and recreational activities. According to the American Water Works Association Research Foundation, nearly 60% of water goes to outdoor uses.<sup>11</sup> Of the water used for irrigation, the EPA estimates that up to 50% may be wasted due to poor watering practices.<sup>12</sup> Ironically, high water use occurs in the hottest months, when surface water sources such as lakes, rivers, and reservoirs are at their lowest, potentially straining our water supplies.

To help manage water supplies and reduce peak use (the highest periods of demand), your water utility may have developed outdoor water conservation programs specific to your water supply and climate conditions, so check with your utility to learn more.

### Water-Efficient Landscape Principles

- Plan and design. Select appropriate plants for your conditions and group them in zones based on their water needs. Plant shade trees and add structures like arbors that will cool the landscape. If you have a large property, consider leaving part of it wild. This will not only reduce the need for watering, but also will attract and provide habitat for beneficial insects, birds, and other wildlife that can serve as natural pest control.
- Improve your soil. You can have your soil tested by your local county extension office in order to match plants with appropriate soil types. The ideal soil will contain pores for both drainage and water holding capacity. Some soils may

Native, or indigenous plants, have evolved over millions of years and are uniquely adapted to the climate, hydrology, and geography of their region. Because they are often found in “plant communities” that have evolved together, they also provide habitat for beneficial insects and fauna.

#### The Benefits of Native Plants<sup>14</sup>

- Able to survive weather cycles and soil conditions of their native regions.
- Filter and remove pollutants and contaminants from water and the soil.
- Once established, require less water than ornamental or exotic plants.
- Provide food and nesting sources for native, beneficial insects and wildlife.
- Don’t require fertilizer and require fewer, if any, pesticides.
- Help reduce air pollution (if planted in place of turf grass, don’t require mowing).



benefit from amendments with organic material or loosening soil to enhance their water holding capacity.

- Sensible turf. Lawns are appealing for play areas, absorbing runoff, cooling, and as a design element, but typically require supplemental irrigation if year-round green is desired. Minimizing turf areas and following efficient irrigation practices can minimize the water used for this thirsty landscape element.
- Choose plants with low water needs. This might include native plants that are already adapted to your region’s climate and soil conditions.
- Mulch beds to retain moisture lost to evaporation. Several inches of mulch can also limit the growth of weeds that compete for moisture.
- Keep your turf and plants healthy with regular maintenance. Water efficient plants will require less watering, and therefore less maintenance.
- Water your yard and garden efficiently, as described below.

#### Smart Watering

- Water to the weather. Be aware of weather conditions and water accordingly. Evapotranspiration (ET) is the sum of soil evaporation and plant transpiration and is affected by wind, temperature, and humidity.

Many utilities use ET rates to provide watering guidelines for their customers. Check with your water utility for local irrigation information.

- Use soaker hoses or a drip system with emitters that deliver water directly to the roots. According to the EPA, drip systems use 20-50% less water than overhead systems.<sup>13</sup>
- If using a sprinkler system, consider installing a system that automatically accounts for ET. Widely used in agriculture and golf course management, such systems are now available in residential sprinkler systems.
- If hand watering, water at the roots. Water deeply and infrequently, unless your planting area is so shallow that you can’t water deeply without creating runoff.
- Set watering systems to run between 9pm to 3am or 9am to 3pm for optimal performance. You may lose some water to evaporation, but avoiding watering during peak morning and afternoon hours (when many other people are using water) reduces demand on the water distribution system and can avoid the need to expand infrastructure solely to meet that peak. Your watering system will also function better because it will be operating under full pressure.
- Avoid watering in windy conditions.

## Ways to Save Water

- Install low flow faucet aerators & shower heads.
- Replace older toilets with new low flow models.
- Repair dripping faucets & leaks.
- Flush the toilet less frequently
- Reuse potable water (from cleaning vegetables for example) for house & garden plants.
- Replace old refrigerators, dishwashers and washing machines with ENERGY STAR rated appliances with low water factors. Search the internet to find the water factor (a measure of water efficiency) for specific appliances. Check in with your utility for incentives.
- Turn off water when not immediately using (while brushing your teeth, shaving, washing your face, etc.).
- Only wash full loads of dishes and clothes (or set the water level for the size of your load) and use the energy and water saving options. When purchasing a new clothes washer look for the ENERGY STAR label. These clothes washers may automatically adjust the water level to the volume or weight of the load. (WaterSense does not rate washers or any other appliance due to ENERGY STAR label infringement. ENERGY STAR labeling now, or soon will, include the water factor in labeling criteria for all appliances that use water.)
- Store drinking water in the refrigerator rather than running water until it gets cool.
- Compost organic kitchen waste rather than using the disposal.
- Sweep patios, driveways and sidewalks rather than hosing them off.
- Don't use the hose to clean gutters and downspouts.
- Wash your car at a commercial car wash. They recycle the water.
- Use a rain barrel to store rain water for irrigation, making sure to cover the water with a fine enough screen to deter mosquito breeding.

## Local Water Facts

Eugene Water and Electric Board (EWEB) uses one kWh of electricity to filter, pump and distribute every 1,000 gallons of water.

Typical EWEB customers use nearly 3,000 gallons per person each month. In the hottest months, 70% of the water EWEB provides is used for landscaping. EWEB suggests that in August, the hottest month of summer, the average lawn needs 4,000 gallons of water per 1,000 square feet in order to prevent grass from going dormant. Shrubs require half, and annual vegetable gardens require three quarters of this amount.

The EWEB website features rebates, conservation tips, and weekly watering recommendations based on current ET rates. Customers can sign up to receive the weekly recommendations by email. [www.eweb.org/waterconservation](http://www.eweb.org/waterconservation)

Springfield Utility Board also offers water conservation resources at [www.subutil.com/water\\_service/saving\\_water](http://www.subutil.com/water_service/saving_water)

## Local Resources

Eugene Water and Electric Board (EWEB) offers their customers many tools to reduce water and energy use, including sprinkler timer rebates and the Green Grass Gauge program, which offers a free gauges that measure sprinkler output and weekly watering recommendations. 541-685-7000. [www.eweb.org/waterconservation](http://www.eweb.org/waterconservation)

Springfield Utility Board provides suggestions for water conservation and broadcasts hot weather advisories during extended hot periods. 541-744-3782. [www.subutil.com](http://www.subutil.com)

Oregon Department of Energy Conservation Division provides tax incentives and information on energy and water efficient appliances. [www.oregon.gov/ENERGY/CONS/RES/tax/appliances.shtml](http://www.oregon.gov/ENERGY/CONS/RES/tax/appliances.shtml)

The Native Plant Society of Oregon: [www.npsoregon.org](http://www.npsoregon.org)

## Additional Resources:

U.S. Environmental Protection Agency WaterSense Program: [www.epa.gov/watersense/index.htm](http://www.epa.gov/watersense/index.htm)

The United States ENERGY STAR Program: [www.energystar.gov](http://www.energystar.gov)

Energy Trust of Oregon Industry and Agriculture Program: <http://energytrust.org/industrial-and-ag/incentives/agriculture/>



## SECTION TEN: PREPARING FOR CLIMATE CHANGE

### Key Learning Points

- The impacts of climate change will continue for centuries even after we reduce emissions.
- We need to prepare now for climate change impacts at all levels of society
- Preparation planning can and should be rolled into existing planning efforts
- Climate change mitigation and preparation are different, but have some overlapping strategies

### The need to prepare

Throughout this handbook we have explored climate change mitigation strategies, i.e. what we can do to reduce emissions. Strategies include driving less, eating a “low-carbon” diet, and conserving energy in our homes. However, an equally important need is climate change preparedness, that is, taking steps to prepare for the impacts of climate change. Preparation strategies include educating ourselves about, and preparing for, the climate change impacts that will affect us as individuals and in all sectors of society.

Due to climate inertia – the lag time between when something affects the atmosphere (as in GHG) and when we experience the consequences (as in climate change impacts) – even if emissions were cut completely today we will experience climate change impacts for literally thousands of years. For example, air temperatures will continue to rise for at least a century after GHG emissions have stabilized and declined. Likewise, warmer ocean temperatures and melting glaciers will lead to rising sea levels for millennia, according to the Intergovernmental Panel on Climate Change (IPCC) 2007 Synthesis Report.<sup>1</sup>

While scientists cannot state with total certainty that the extreme climate related events (e.g., hurricanes and floods) we have witnessed over the past decade are caused by climate change, many such events are in line with the expected impacts of a rapidly warming climate. According to the IPCC, “Warming of the climate system is unequivocal, as evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.”<sup>2</sup> With this warming comes projections of current and future drought, increased extreme storm events and wildfire, more frequent flooding, and other climate events. Unfortunately, these consequences are already playing out across the nation and the globe.

According to the United States Global Change Research Program (GCRP), and other sources, areas throughout the United States will be affected by the following impacts.<sup>3</sup>

- Climate change will stress water resources.
- Crop and livestock production will be increasingly challenged
- Ocean acidification will threaten shell fish and marine food chains
- Coastal areas are at increasing risk from sea-level rise, storm surge, and salt water intrusion into groundwater and estuaries.
- Threats to human health will increase.
- Climate change will interact with many social and environmental stresses.
- Thresholds will be crossed, leading to large changes in climate and ecosystems.
- Future climate change and its impacts depend on choices made today.

### Mitigation vs. Preparation

**Climate Change Mitigation:** actions taken to reduce emissions and enhance carbon sinks (natural or built systems that sequester carbon) in order to slow climate change.

**Climate Change Preparation:** anticipating possible consequences of climate change and actively taking steps to build resistance and resiliency in human, natural, built, economic, and cultural systems.

## What is my community doing?

Although some state and local governments have developed, or are developing, climate action plans, most focus on emissions reductions and only recently are beginning to cover preparation strategies. Preparing ourselves and our communities means that we will be safer and more comfortable during weather extremes, be better protected against diseases and epidemics, and our homes and property will be properly insured and protected. We may even save money on food, water, and energy through resource conservation that could strengthen local economies.

Communities developing climate response strategies are evaluating their risks and taking actions to reduce vulnerability to those risks. They are assessing their operations, infrastructure and policies, making changes to reduce emissions, and developing programs to assist businesses and citizens both mitigate and prepare for climate change.

For example, increased incidents of drought are causing cities and towns across the U.S. to adopt water conservation policies and invest in new supply and distribution facilities. Cities that are prone to flooding are improving infrastructure and updating emergency preparedness plans.<sup>4</sup> Check with your local city, county, and state planning agencies to find out what your government is doing and to find helpful resources. If your local government has not developed a climate change mitigation and preparation plan, contact the planning department and find out what you can do to encourage your government to begin planning now. For help with preparedness planning, you can also contact:

- Climate Leadership Initiative at [info@trig-cli.org](mailto:info@trig-cli.org) or [www.theresourceinnovationgroup.org/](http://www.theresourceinnovationgroup.org/)
- ICLEI-Local Government for Sustainability at [www.iclei.org](http://www.iclei.org)
- Center for Clean Air Policy (CCAP) at [www.ccap.org/index.php?component=programs&id=6](http://www.ccap.org/index.php?component=programs&id=6)

## Preparation or Adaptation?

**Although the term *adaptation* is often used to describe the process of coping with the unpreventable consequences of global climate change, we believe the terms *preparation* and *preparedness* are more appropriate. By this, we mean taking proactive steps to anticipate and consciously build for the range of climate change-induced stresses that can reasonably be expected to occur during this century. Adaptation describes change within organisms over time. In contrast, preparation connotes conscious effort and a willingness to alter thinking and behavior.**

While climate change preparedness plans are relatively new for state and local governments, many developing countries have been working on climate change preparation (or adaptation - see text box) for years. This is because many developing countries are more vulnerable to the impacts of climate change and are already experiencing severe drought, flooding, disease outbreaks and food shortages. For more information on international preparedness efforts, visit [www.weadapt.org](http://www.weadapt.org).<sup>5</sup>

## What can I do?

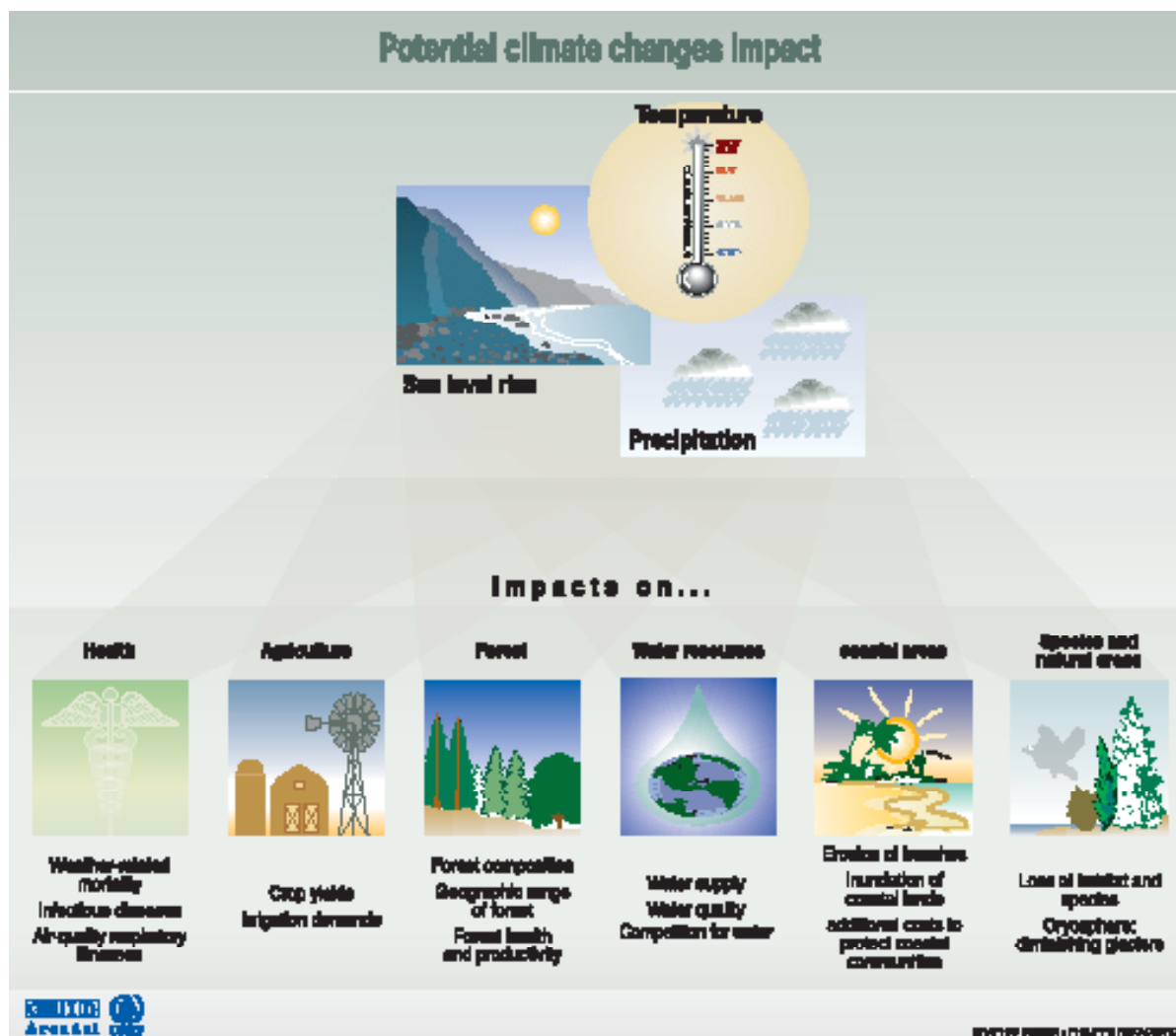
Well-prepared individuals, businesses, nonprofits and other organizations can contribute to community level resilience by reducing their own risk from climate impacts. Consider working with local entities to apprise them of likely impacts and help them integrate preparation for climate impacts into their strategic planning.

Preparing for local impacts starts with assessing your risk. Different parts of the country will experience varied climate impacts. Learn what impacts are projected to occur in your region on the US EPA's website or in the box on local impacts.

Interested in seeing what a community preparation strategy looks like? Check out these web sites:

- King County, WA: <http://your.kingcounty.gov/exec/news/2007/09/12globalwarming.aspx>
- Keene, NH: [www.ci.keene.nh.us/sustainability/climate-change](http://www.ci.keene.nh.us/sustainability/climate-change)
- New York City, NY: [www.nyc.gov/html/planyc2030/html/challenge/greenyc.shtml](http://www.nyc.gov/html/planyc2030/html/challenge/greenyc.shtml)

Figure 10-2.



Source: United Nations environmental pollution agency (UNEP).

Source: UNEP/GRID-Arendal Maps and Graphics Library. Cartographer: Philippe Rekacewicz, UNEP/GRID-Arendal  
<http://maps.grida.no/go/graphic/potential-climate-change-impacts>

With greater awareness of what risks are at hand, invest in resilience to withstand those impacts. Read on for specific actions to protect against risks that in many cases existed before climate change, but now are increasing in severity or frequency.

## What Can We Do to Prepare?

**Extreme Heat:** If you live in an area that is already experiencing, or projected to experience, extreme heat, be sure to have access to a cool space, especially if you live with the elderly, sick, or disabled.

- Insulate and shade your home, following the guidelines covered in the Energy section of this handbook. Create a space cool enough to meet your needs in the most energy efficient manner possible.

- Know where your community cooling centers are. Most communities make air conditioned spaces open to the public in extreme heat.
- Identify elderly, sick, or disabled neighbors who may need your help, especially those with respiratory and heart ailments. Make sure they are able to stay cool and have access to a cooling center. Check in with them a couple of times a day during heat waves and ensure that they are using air conditioning if available.
- Educate yourself and neighbors about the symptoms of heat illness (dizziness, weakness, nausea and vomiting) and seek help when needed. Your local public health department can provide education and prevention pamphlets.
- Prepare for power outages due to energy overloads as described below.

**Weather Extremes:** Climate change will impact rainfall, wind patterns, and storms. While some areas may see little change in annual rainfall, it is likely that rain events will be more intense, increasing the possibility of flooding.<sup>6</sup>

- Make sure your gutters are clear to facilitate runoff.
- Make sure water runs off your property and into storm drains to avoid erosion.
- If you live in a wooded area or have trees on your property, assess the health of your trees and trim or remove any trees that may fall in a severe wind event.
- If you are in a high wind, hurricane or tornado prone area, windproof your house, paying special attention to windows and roofs.
- Make sure your property has adequate insurance to cover wind and water damage. Many insurance companies offer discounts for wind protection improvements.
- Check water quality, especially well water, after extreme weather events.
- Prepare for power outages, as described below.

**Fire:** Scientists predict an increase in forest fires, especially in the Southeast, Gulf coast, and western states, resulting in property damage and destruction, smoke and pollution-related illness, and potential loss of life. To protect your home in wildfire prone areas:<sup>7,8</sup>

- Learn to recognize the natural conditions that increase the chances of wildfires.
- If possible, roof and side your home with Class A rated (fire resistive) roofing and siding materials.
- Cover your chimney outlet and stovepipe with a nonflammable screen with an inch or smaller wire mesh.
- Windows and skylights should be tempered glass or multi-layered glassed panels for protection against breakage due to the heat from fires.
- Install and maintain smoke alarms in your home.
- Install, maintain and teach everyone in your family to use fire extinguishers.
- Clear debris and maintain a “survivable space” about 30 feet wide around your home.
- Keep your yard and gutters free of pine needles, leaves and other flammable debris.

## Climate Changes in the Upper Willamette Valley River Basin

From *Preparing for Climate Change in the Upper Willamette Valley River Basin of Western Oregon, Co-Beneficial Planning for Communities and Ecosystems*, March, 2009, by the Climate Leadership Initiative, National Center for Conservation Science and Policy, and MAPSS Team at the U.S.D.A. Forest Service: Pacific Northwest Research Station. Available at <http://www.theresourceinnovationgroup.org/public/>

### Temperature

- Annual average temperatures are likely to increase from 2-4°F (1-2° C) by around 2040 and an additional 6-8° F (3-4° C) by around 2080.
- Average summer temperatures are likely to increase 4-6° F (2-3° C) by 2040 and an additional 4-8° F (2-4.5° C) by around 2080, while average winter temperatures may increase 1-2° F (0.5-1° C) by 2040 and an additional 2-4° F (1-2° C) by 2080.

### Precipitation and Snowpack

- By 2080, the wet periods will get wetter (potentially even reaching monsoon like rainfall) and drier periods will get drier.
- Snowpack across the Pacific Northwest is likely to decline by 60% by 2040 and 80-90% by 2095 from current levels.
- As snow melts earlier in the spring, stream flows may peak earlier, impacting not only stream-dependent species, but also the availability of summer storage for hydropower, irrigation and municipal water supply.

### Storms and Flooding

- Storm events could increase in intensity, resulting in more flooding in all rivers in the Willamette Valley.

### Vegetation Change

- Because of temperature change as well as increased likelihood of fire in some areas, conditions may best support more hardwoods by the end of the century. Growing conditions in the eastern portion may best support ponderosa pine and Douglas-fir. However, it may take many decades for vegetation to shift.

- Reduce the number of trees in heavily wooded areas, and plant new trees or shrubs 10 feet apart.
- Remove dead branches and keep close, overhanging branches from the reach of your roof and 10 feet away from your chimney.
- For trees taller than 18 feet, keep lower branches pruned 6 feet above the ground.
- Keep stacked wood at least 30 feet from your home or other buildings, and keep vegetation cleared away from the woodpiles.
- Enclose the underside of balconies and above ground decks with wire mesh.
- Know your evacuation route(s) and identify alternatives.
- Contact your local fire department or emergency planner for more guidelines on protecting yourself and home from wildfire.

**Power Outages:** Extreme heat and storms may lead to power outages and enforced brownouts. Below are strategies for more comfortably and safely living without power.

- If you have a fireplace or wood stove, maintain a supply of firewood.
- Generators as well as solar panels and wind turbines with batteries can provide backup power in an outage, which may be important if you have elderly, sick, or disabled persons living with you. If you have a backup power source, have at least one portable heater.
- Stock three to seven days worth of dry or canned food, water, and supplies in case of power outages and impassable roads.
- Keep a fully stocked emergency first aid kit.

**Coastal and Inland Flooding:** Flooding along the coasts and inland is expected due to the rise in sea levels caused by warmer oceans and melting glacial ice, the loss of storm-buffering wetlands and dunes, and an increase in the number and severity of storm events.<sup>9</sup>

- Know your evacuation route(s), and if a storm is predicted, leave in plenty of time.
- Include your pets in evacuation plans. Most emergency shelters will not take pets, so plan ahead for their safety.
- Prepare for power outages and impassible roads.

- Be sure your home and property are adequately insured for flood and storm damage.
- If you have a private well, have it tested after storms, as the water may be contaminated from salinity or polluted runoff.
- Prepare your home by:
  - » Collecting emergency building supplies
  - » Securing water heaters and shelves to walls
  - » Raising electrical system components
  - » Installing check valves in your plumbing to prevent floodwater backup
  - » Avoid building in a floodplain, near cliffs or in areas that may be impacted by sea level rise.

## Preparing Your Yard & Garden

Growing food at home or in a community garden and supporting your local food growers and suppliers has many benefits in relation to climate impacts, including reducing your food's transportation carbon footprint, supporting your local economy, and ensuring food availability in case of agriculture and transportation disruptions. However, the way we grow our food and what we grow may need to be adjusted based on climate change impacts.

- Hotter temperatures, heat waves, and drought may result in water shortages, so shift to drought tolerant crops and provide shade during the hottest times of the year.
- Adapt your landscape to become more drought tolerant (see the Water Conservation and Yards sections) to reduce your reliance on watering and to prepare for drier summers. Use native plants and eliminate invasive species as possible to guard against the increased potential for invasives.
- Increased heat, rain and flooding may create conditions for an increase in vector-borne diseases such as West Nile virus and Lyme disease. To protect against such diseases, keep your property free of standing water (where mosquitoes breed), stay covered when outside, use insect repellent, and keep your screens repaired. Check with your local public health department about areas of outbreak and other protection measures.
- Because climate zones are shifting northward, try out fruits and vegetables that may not have been viable before. Consider growing heirloom



varieties of vegetables to help protect genetic heritage that may prove increasingly important in highly variable climate. But remember that higher average temperatures don't ensure the absence of unusually cold temperatures as well. Protect vulnerable and valued plants against swings in temperature with shade cloths or insulating fabric.

- If your yard tends to hold water, explore stormwater management solutions to protect against flooding and vector-borne diseases.
- Plant shade trees on the south and west sides to cool your house and property and absorb water and plant tall evergreen shrubs and trees on the north to protect your house from prevailing winds.

## Transportation

Extreme weather may impact transportation infrastructure and fuel availability.<sup>10</sup>

- Know your public transportation options
- Know your evacuation routes and leave as early as possible.
- Have a back up plan for commuting or travel.

## Protect Your Health

According to the Centers for Disease Control and Prevention (CDC), climate change is predicted to impact our health due to:<sup>11</sup>

- Heat related illness, respiratory disease and allergies from increased temperatures and ground level ozone that accompany heat waves.
- Injuries and structural collapse from flooding.
- Malnutrition from the decreased agricultural productivity from droughts
- Increased water- and food-borne diseases that accompany higher temperatures and precipitation levels.
- Disruptions in long-term care from extreme weather events.
- Migration of vectors that bear diseases such as West Nile Virus and Lyme disease.
- Increase in stress related mental health illnesses

## Finance

In some cases, the way you spend your money helps with the broader effort of preparedness, or may put your finances at risk. Consider:

- Do your insurer and retirement manager consider climate risk?
- If you invest in individual companies, are they considering the physical and regulatory risks of climate change?
- If you own properties, how will they be impacted by climate change over the next several decades?
- Is your business at risk?

## Sample assignment

Find out if your local government (city or county) has a climate change plan. Does it include both mitigation and preparation strategies? If not, request initiation of a planning effort, and ideally, support your request with information on the importance of such an initiative.

## Resources

Climate Leadership Initiative Climate Preparedness program: <http://www.theresourceinnovationgroup.org/>

Center for Clean Air Policy (CCAP): [www.ccap.org/index.php?component=programs&id=6](http://www.ccap.org/index.php?component=programs&id=6)

The United States Environmental Protection Agency, Climate Change, Health and Environmental Effects: Find regional impacts: [www.epa.gov/climatechange/effects/usregions.html](http://www.epa.gov/climatechange/effects/usregions.html)

Federal Emergency Management (FEMA), Disaster Planning Information: [www.fema.gov/plan/index.shtm](http://www.fema.gov/plan/index.shtm)

Federal Emergency Management Administration (FEMA) Are You Ready Guide: [www.fema.gov/areyouready/index.shtm](http://www.fema.gov/areyouready/index.shtm)

National Oceanic and Atmospheric Association (NOAA): Avoiding Wind Damage: A Checklist for Homeowners: [www.nhc.noaa.gov/HAW2/pdf/avoid\\_wind\\_damage.pdf](http://www.nhc.noaa.gov/HAW2/pdf/avoid_wind_damage.pdf)

National Oceanic and Atmospheric Association (NOAA): Hurricane Supply Kit: [www.nhc.noaa.gov/HAW2/english/prepare/supply\\_kit.shtm](http://www.nhc.noaa.gov/HAW2/english/prepare/supply_kit.shtm)

State Farm Insurance, Wildfire Precautions: [www.statefarm.com/learning/disasters/learning\\_disas\\_wildfire.asp](http://www.statefarm.com/learning/disasters/learning_disas_wildfire.asp)

Centers for Disease Control and Prevention (CDC), Coping with a Disaster or Traumatic Event: [www.emergency.cdc.gov/mentalhealth](http://www.emergency.cdc.gov/mentalhealth)

## DISASTER SUPPLY KIT

From: The National Hurricane Center [www.nhc.noaa.gov/HAW2/english/prepare/supply\\_kit.shtml](http://www.nhc.noaa.gov/HAW2/english/prepare/supply_kit.shtml)

- ☐ **Water:** at least 1 gallon daily per person for 3 to 7 days
- ☐ **Food:** at least enough for 3 to 7 days
  - \_\_\_ non-perishable packaged or canned food/juices
  - \_\_\_ foods for infants or the elderly
  - \_\_\_ snack foods
  - \_\_\_ non-electric can opener
  - \_\_\_ cooking tools / fuel
  - \_\_\_ paper plates / plastic utensils
- ☐ **Blankets / Pillows, etc.**
- ☐ **Clothing:** seasonal / rain gear/ sturdy shoes
- ☐ **First Aid Kit / Medicines / Prescription Drugs**
- ☐ **Special Items for babies and the elderly**
- ☐ **Toiletries / Hygiene items / Moisture wipes**
- ☐ **Flashlight / Batteries**
- ☐ **Radio:** Battery operated and NOAA weather radio
- ☐ **Telephones:** Fully charged cell phone with extra battery and a traditional (not cordless) telephone set
- ☐ **Cash** (with some small bills) and **Credit Cards:** Banks and ATMs may not be available for extended periods
- ☐ **Keys**
- ☐ **Toys, Books and Games**
- ☐ **Important documents:** in a waterproof container or watertight resealable plastic bag - insurance, medical records, bank account numbers, Social Security card, etc.
- ☐ **Tools:** keep a set with you during the storm
- ☐ **Vehicle fuel tanks filled**
- ☐ **Pet care items**
  - \_\_\_ proper identification / immunization records / medications
  - \_\_\_ ample supply of food and water
  - \_\_\_ a carrier or cage
  - \_\_\_ muzzle and leash

## SECTION ELEVEN: CONSULTATIONS AND OUTREACH

### Key Learning Points

- Major emission sources: transportation, food and material goods consumption, space heating
- Communication strategies for motivating climate-change action
- Consultation protocol

### Consultation basics

The household consultation should increase the resident's awareness of the “big ticket” greenhouse-gas emitters in their life: typically these include transportation, home energy use, and consumption of food and other resources. However, some residents may have a high level of awareness and may already have done a great deal to reduce their emissions and energy use. The consultant must communicate in a way that meets the needs of the resident and focuses on their needs and interests.

### Communication

Effective communication is a two-way street that invites the resident to ask questions and learn from the consultant. You must be respectful, nonjudgmental, and open-minded as you step into a home consultation. Be supportive and always praise and acknowledge the efforts they are already making. As a guest in their home, you are there to educate and recommend, but never to lecture or pressure people into making changes they aren't ready or willing to make. If met with resistance, back off!

Provoking shame or guilt is likely to lead to defensiveness, while evoking fear often will result in a complete shutdown on the part of the recipient. Providing realistic information about the problem and feasible solutions is most likely to achieve behavior change.

Some good questions to ask about home-energy use might include the following:

- What do you perceive as the biggest energy users in your household?
- What would you like to get out of this session?
- Who uses energy and how? (e.g., kids, showers and laundry)
- Are you a renter or an owner? How long have you lived here? Has the dwelling been weatherized?

While you are in their home, be an astute observer:

- Don't be afraid to do a “walk through” of the home, checking water temperature at the faucet farthest from the water heater. Give them the chance to do the measuring.
- See if there are water leaks in the bathroom sink and tub or the kitchen. Are they hot or cold leaks?
- Is furniture blocking vents or heaters?
- Are thermostats old and inaccurate? (showing “comfort zone” or “high, med, low” instead of degrees)
- Do appliances look dated and in poor repair or newer and well-sized for their needs?
- Are there outbuildings that house power tools, extra refrigerators, and freezers? Is there a hot tub or security lighting?

While finding answers to the questions above, use the resident as a resource and, above all, do not forget that you are entering another person's home—a space in which they may feel vulnerable or defensive with a consultant's eye sweeping the place. To avoid liability issues, talk the resident through any changes like lowering the water heater temperature, rather than doing it yourself.

On the next page, an Australian home consulting manual for their Cool Communities program provides further details on communication.

### Tools

All consultants will use a checklist and a series of consulting worksheets to perform the consultation. The checklist begins with the highest greenhouse-gas emitters (transportation, home heating and cooling, water heating) and moves to what are typically lower emitters for a household. The consultant should focus on the portion of the checklist (transportation, home energy use, food consumption and waste, or yard emissions)

and those worksheets that the resident is most interested in.

The worksheets are designed to guide the consultant through the process. These provide questions to ask, recommendations, and resources. Use these as a guide, but, where appropriate, feel free to ask additional questions and include other sound recommendations and resources. The worksheets can be left with the resident at the end of the consultation.

Other useful things to bring with you on your consultation include the following:

- Plate Pal thermometer for measuring air temperature
- Meat thermometer to measure water temperature

- Refrigerator and freezer thermometer
- Screwdriver
- Rag
- Flashlight
- “Freebies” for the resident, if available

## Additional resources for home consultations

Cool Communities Home Greenhouse Audit Manual: [www.environment.gov.au/archive/settlements/local/publications/pubs/audit.pdf](http://www.environment.gov.au/archive/settlements/local/publications/pubs/audit.pdf)

## Sample assignment

Conduct a practice consultation with another participant in the Climate Master class.

## How to conduct a consultation

1. Introduce yourself and the Climate Master program—a project to help households reduce their greenhouse gas emissions. Thank them for their participation and tell them that you’re in training through the Climate Master class and are learning how to do this.
2. Double check their area of greatest interest for the consultation.
3. Administer the survey and get utility release forms signed, if necessary. These are all voluntary, but will help us evaluate the program.
4. Proceed through the consulting worksheets for areas of greatest interest. Give the resident a “master checklist” and worksheets so they can follow along with you and jot down strategies and tasks for their Action Plan.
5. At some point during the consultation, discuss priority areas for emission reduction:
  - a. Transportation: reducing flights and car trips
  - b. Home heating, cooling, and water heating
  - c. Consumption and embodied emissions
6. Secure a commitment for one or more changes.
7. Leave any resources that the resident is interested in.
8. Mail the commitment and survey to your organization to be recorded in the database.
9. After the consultation, you or the volunteer coordinator should contact the resident to see if they have followed through on their commitments. If not, we will find out why and see if there are any additional resources or assistance we can provide. If they have carried out their commitments, we will see if they are willing to make any other commitments. With additional commitments, we will follow up a second time to see how they did on the second round of commitments.

## Consultation Tips

*From Home Greenhouse Audit Manual by Moreland Energy Foundation Limited for the Australian government's Cool Communities*

### **When talking to someone at their home, you should:**

Always use plain English language and explain any jargon that needs to be used. This can be quite empowering.

Draw out as much information from the householder as possible about how they use and conserve energy. Please note that people may be a bit embarrassed about how much energy they use and therefore may underestimate their consumption.

Make every effort to make the householder comfortable with having you in their house. This means being relaxed no matter what the surroundings are like and being careful about how you talk about their home. Ask the householder if they can show you around. Use this as an opportunity to talk about energy-efficiency practices, explain what the issues are, and answer any questions they might have.

Remember that all people are different and what may not bother one person could make another feel uncomfortable or annoyed. Comments about your views of the world are unnecessary and could have a negative effect on what you're trying to do. Sticking to the issue at hand is generally advisable.

Be aware of people who are angry and looking for someone to blame – especially if they think their energy bills are too high. This could be anyone from a member of their household to their energy supplier or the government. Provide them with the facts and your observations, but don't get too involved.

### **When talking to a group, you should:**

Gather as much information from the group members as possible about how they use and conserve energy. This helps other group members understand that there are different ways of doing things, different energy usage within the group, and different options for solving problems.

Use the group dynamics positively by guiding people to practice sharing knowledge in an empowering way. Be aware of the potential for a high-energy user to be stigmatized if they are in a group of energy conservers. The group's knowledge and enthusiasm should be harnessed to support that person.

### **Practice good communication:**

Some examples:

Instead of just stating that west-facing windows should have external blinds, a good communicator might put it this way:

"Do you find this room heats up in summer? That is because west-facing rooms get the hot afternoon sun. If you put external blinds on the windows, that will keep the sun off and stop the room from heating up."

Rather than announce the thermal efficiency percentage of draft blockers, a good communicator might use an incense stick around doorways and windows and say:

"See how the smoke is being blown into the room? I bet you can feel the drafts in here in winter. When you add up all the spaces where air is moving in this room it can add up to a lot of unnecessary heating."

### **Family Participation:**

If possible, try to find ways the whole family can be involved in energy-conservation consciousness. For instance, you could discuss plotting kilowatt or therm usage and making it a family challenge to lower the energy usage this month compared to the same time last year based on their utility bills. Ask them to jot down strategies and tasks on their Action Plan while you're presenting suggestions.

**As you talk to people about these issues, we hope you will come up with your own list of effective communication strategies.**

## Approximate Total Personal CO<sub>2</sub>e Emissions for a Typical Eugene Resident



### Assumptions:

- US average annual miles traveled in vehicle getting US average mileage (Honda Accord, Ford Taurus and Toyota Camry are in this range).
- Flight is for approximate return trip to Santa Fe, NM, which is the average round trip distance in US.
- The household uses natural gas and electricity.

In the United States, annual greenhouse-gas emissions are about twenty tons of carbon dioxide equivalent (CO<sub>2</sub>e) per person. The Oregon per capita average is closer to seventeen tons CO<sub>2</sub>e per year.<sup>1</sup> The Eugene per capita greenhouse-gas emissions, as calculated by the City of Eugene, amount to 8.6 metric tons of CO<sub>2</sub>e.<sup>2</sup> However, the Oregon and Eugene numbers do not reflect the emissions associated with freeway travel, air travel, and those emissions associated with the production of food and other goods brought in from other communities and consumed here. Therefore, at the Climate Leadership Initiative we have created the profile of a “typical” Eugene household, which includes a broader scope of personal emissions than does a standard community-level greenhouse-gas inventory.

A resident in this typical Eugene household is responsible for the emission of 13.8 tons of carbon dioxide equivalent. This person heats with natural gas and drives a Honda Accord for 12,000 miles a year. He or she takes one

round trip flight to Santa Fe, NM from Eugene, Oregon each year to get some extra sunshine.

The majority of our typical resident’s 13.8 tons of greenhouse-gas emissions derive from transportation. The emissions embodied in food and other consumables are difficult to accurately calculate, but we conservatively estimate that they could amount to 5.5 tons per person per year. Most of the emissions from home energy use for this resident, living in a two-person household, derive from the natural gas they use, rather than the electricity. Of their home emissions, the majority are from space heating, then lighting and appliances, followed by water heating.

There are still many emissions sources not included in our calculations, such as those embodied in existing buildings we live in, in petroleum-based pesticides and fertilizers we use in our yards that emit nitrous oxide, and the emissions from waste decomposing in landfills (excluded because about 80% of methane is captured for creating electricity at Short Mountain Landfill).



## SECTION TWELVE: OFFSETS

### Key Learning Points

- Offsets are carbon credits purchased to offset the production of GHGs from energy use and other activities.
- Common offset projects: reforestation, renewable energy, efficiency—pros and cons
- No single regulatory body or standards

Carbon offsets are carbon credits purchased to offset the production of greenhouse-gas (GHG) emissions from energy use and other activities. Carbon offsets are intended to reduce the impact of your carbon footprint although their true impact is controversial. After reducing emissions in all areas possible (or not), some people choose to offset their GHG emissions by reducing an equal amount of carbon somewhere else in the world. This is achieved by purchasing carbon credits equal to the amount produced—taking into account the differing warming potentials of the various greenhouse gases. All carbon credits represent the reduction of GHG in metric tons of carbon dioxide (CO<sub>2</sub>), the most common GHG. Methane has a warming potential 25 times that of CO<sub>2</sub>, and therefore a ton of methane gas has the warming potential of 25 tons of CO<sub>2</sub>.

### Common carbon offset projects

Most carbon offset retailers support a variety of mechanisms for reducing carbon. Reforestation, investing in renewable energy, and increasing energy efficiency are some of the most common practices utilized to offset emission production.

#### Reforestation

Carbon sequestration through replanting forests is one of the most frequently used methods used by carbon-offset organizations. Carbon is captured and removed from the atmosphere and stored by the planted trees. Reforestation often occurs in areas decimated by large-scale deforestation. Projects are often initiated in areas of high biodiversity to ensure the perpetuity of ecologically sensitive regions.

#### Renewable Energy Credits

Renewable energy credits (REC), also known as green tags or green power, represent the environmental benefits of the creation of electricity derived from renewable energy sources. One REC is equivalent to the benefits associated with

one megawatt of renewable power. By investing in renewable energy technologies, individuals and companies may help increase demand for renewable energy and spur new development.

#### Energy Efficiency

In the Chicago Climate Exchange's voluntary carbon-trading market, carbon credits are created when businesses increase their energy efficiency by consuming less energy. The exchange functions as a "cap-and-trade" program, where companies tabulate their emissions from a 1998–2001 baseline. These companies are required to reduce their emissions over time. If companies have achieved increased efficiency, they can sell their credits. If their usage has increased, they must purchase credits from within the market. (If we had a national cap-and-trade policy, it would function in this manner.) Energy efficiency can be achieved through the development of new technologies or changes in processes and practices that were energy inefficient. Carbon credits may be purchased from the exchange by carbon-offset retailers. Some carbon-offset retailers "purchase and retire" the credits in order to lower the total amount of carbon available to be traded.

### Controversy in carbon offsets

Reforestation is controversial as an effective tool in reducing the amount of carbon dioxide in the atmosphere. Reforestation projects lack permanence, as the trees may potentially be felled or catch fire, releasing stored CO<sub>2</sub>. Many opponents of tree planting as a primary mechanism in carbon trading markets argue that it fails to address our dependence on fossil fuels and that the actual project size and completion can be difficult to validate. Promoters of reforestation maintain that these projects mitigate the ramifications of deforestation and may help provide indigenous

peoples with a sustainable economic and environmental incentive to perpetuate forests. Reforestation projects can be certified by the Climate, Community, and Biodiversity Alliance, which ensures that the project protects and restores endemic species and biodiversity.

There is long-standing debate about whether renewable energy credits (REC) should be used as an equivalent to carbon “additionality” offsets (i.e., the offset revenues having clearly made another energy-saving project possible that would not have happened otherwise). The amount of carbon dioxide displaced by a REC is generally determined by calculating the amount of CO<sub>2</sub> emitted by local fossil-fuel-burning power plants per kilowatt hour. The main debate on RECs is whether they can satisfy the greenhouse-gas offset requirements. Critics argue that many renewable energy projects would have come to fruition regardless of prospective REC sales because of the high price of fossil-fuel energy, various tax breaks, existing desire for more diversified energy, and availability of renewable energy sources. Advocates argue that RECs are an important offset tool because they change the energy mix by displacing the use of fossil-fuel energy and can be more reliable than some other offset projects, such as reforestation.

Some critics maintain that carbon offsets pose serious moral questions; purchasing an offset is merely a means of assuaging the guilt of producing emissions with little beneficial effect. Critics also point out that many of the carbon sequestration markets are in developing nations, which creates a “carbon dump” effect. In other words, developing nations are becoming responsible for dealing with the carbon waste we produce in the North. With corporations funding large offset projects in the developing world, this has even been called “eco-imperialism.” Finally, many feel that offsets simply distract from the real goal of mitigating greenhouse gas emissions.



### **Retail voluntary carbon market: upstanding supply and demand**

Federal greenhouse-gas (GHG) emission regulations were under consideration in the United States at the time of this publication. However, voluntary carbon markets are playing an increasingly significant role in both citizen and business efforts to show leadership in addressing global warming. Going “carbon neutral” refers to the idea of reducing one’s GHG emissions and ultimately neutralizing one’s carbon footprint through purchasing offsets. Unlike the compliance-based market, the voluntary market does not rely on mandated reductions to generate demand. Voluntary credits do not have to be registered with any central body, thus the market remains fragmented and unregulated. In the voluntary market, both for-profit and nonprofit organizations sell a range of offset types certified to an array of standards. Due to this fragmentation, prices in the voluntary market vary widely from \$1 to \$35 per ton of CO<sub>2</sub>. Prices are affected by two main factors: 1) the cost of the offset (technical reduction cost plus administrative fees) and 2) the market price, which varies with supply and demand. Today the voluntary carbon market is driven by several factors including rising consumer concern about climate change, institutional investors who view a firm’s carbon footprint as a business risk, and by governments addressing their constituents’ desire for action on climate change.

## Accounting for and verifying reductions in the carbon market

### Project Creation

Project creators vary widely from nonprofits interested in combating climate change to public agencies interested in seeding the market for private companies who seek to profit in the carbon market. Project types include reducing emissions at the source or reducing atmospheric GHG levels in the atmosphere (sequestration).

### Examples of Project Types

- Methane capture from landfills, livestock, coal mines (sequestration)
- Soil or geological sequestration
- Direct fossil-fuel reduction
- Indirect fossil-fuel reduction (RECs)
- Reforestation or avoided deforestation

### Product Verification

In the absence of quality standards, accounting methods in the voluntary market vary widely. A number of third-party certifiers are being developed, such as the Gold Standard (requires offsets to meet the Kyoto Protocol Clean Development Mechanism), the Greenhouse Gas Protocol for Project Accounting (developed by the World Resource Institute and the World Business Council for Sustainable Development), ISO 14064, Voluntary Carbon Standard, and Climate Neutral Network (developing the “Climate Cool” logo).

The major considerations with offset quality are:

**“Additionality”**—Offset revenues clearly make a project possible that would not have happened otherwise.

**Baseline determination**—A credible approach must be used to calculate the emissions that would have occurred in the absence of the project.

**Benefit quantification**—A credible quantification of a project’s GHG-emission reductions.

**Permanence**—The project must be able to guarantee GHG mitigation that is not subject to potential reversal in the future.

**Double counting**—A project must avoid being claimed and sold multiple times.

**Offset timing**—Ex-ante and ex-post accounting, where credits are sometimes sold before or after they are produced. In the former, there is a risk of nondelivery; in the latter, a risk of not being able to prove “additionality.”

**Co-Benefits**—While the primary purpose of a project is to reduce GHGs, sometimes projects have additional benefits such as contributions to local communities or habitat protection.

**Redundancy**—The project must not already be required by some other law or regulation.

**Carbon leakage**—Project implementation doesn’t create an increase in emissions outside the project.

### Product Distribution

Once a project has been developed and verified, middlemen often step in as buyers or facilitators of transactions on a fee-for-service basis. Today there are about thirty-five retail providers of offsets vending emissions-reduction and sequestration credits. While there are, at present, only a small number of providers, as the voluntary carbon market matures more investors and brokers will join the market, often with a portfolio of projects. Currently the Chicago Climate Exchange is the only voluntary carbon-trading exchange, and trading is restricted to CCX-registered members. Some registries have been created recently for corporate buyers and sellers of carbon credits, including the Bank of New York, My-Climate, Green-e, and the U.S. Department of Energy Voluntary Reporting Greenhouse Gases Program.

### Product Consumption

Consumers in the voluntary carbon market come in all shapes and sizes, from individual households to large corporations and municipal governments. There are dozens of online carbon calculators that have been developed to estimate how many credits must be purchased to offset particular activities.

Common offset purchases include the following:

- Institutions purchase carbon credits to offset their internal emissions generated by their activities, facilities, and employees.
- Companies may purchase carbon credits to offset the life cycle of their services or products in order to develop “carbon neutral” branding.
- Organizers of high-profile events may choose to make the events carbon neutral through the purchase of offsets.

To see a rating of various offset programs, visit Clean Air, Cool Planet at [www.cleanair-coolplanet.org](http://www.cleanair-coolplanet.org) and click on the link to Consumers’ Guide to Retail Carbon Offset Providers. The report ranks the Climate Trust and Native Energy as among the top three offset providers.



# END NOTES

## Section One

- 1 IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge and New York.
- 2 Ibid.
- 3 NOAA, [www.esrl.noaa.gov/gmd/ccgg/trends](http://www.esrl.noaa.gov/gmd/ccgg/trends), World Meteorological Organization
- 4 The World Meteorological Organization and the United Nations Environment Programme established the Intergovernmental Panel on Climate Change in 1988 to provide credible assessments of scientific knowledge of global climate as a backdrop for international agreements concerning climate change. The body's first report, issued in 1990, served as a foundation for the U.N. Framework Convention on Climate Change. Subsequent reports were published in 1995 and 2001. One of the largest scientific enterprises in history, the new Fourth Assessment Report (AR4) presents the work of 1,200 scientific authors and 2,500 scientific expert reviewers from 130 countries.
- 5 Working Group I. 2007. Climate Change 2007: The Physical Science Basis. Summary for Policymakers (Geneva, Switzerland: IPCC Secretariat). Available for download from [www.ipcc.ch](http://www.ipcc.ch)
- 6 IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge and New York.
- 7 The Copenhagen Diagnosis, 2009: Updating the world on the Latest Climate Science. I. Allison, N. L. Bindoff, R.A. Bindoff, R.A. Bindischadler, P.M. Cox, N. de Noblet, M.H. England, J.E. Francis, N. Gruber, A.M. Haywood, D.J. Karoly, G. Kaser, C. Le Quéré, T.M. Lenton, M.E. Mann, B.I. McNeil, A.J. Pitman, S. Rahmstorf, E. Rignot, H.J. Schellnhuber, S.H. Schneider, S.C. Sherwood, R.C.J. Somerville, K. Steffen, E.J. Steig, M. Visbeck, A.J. Weaver. The University of New South Wales Climate Change Research Centre (CCRC), Sydney, Australia, 60pp.

## Section Two

- 1 U.S. Environmental Protection Agency, "Green Homes." [www.epa.gov/greenhomes](http://www.epa.gov/greenhomes), (accessed Dec. 11, 2009).
- 2 U.S. Department of Energy Efficiency and Renewable Energy, based on 2005 Building Energy Data Book. <http://buildingsdatabook.eren.doe.gov>
- 3 Based on research by Tom West, Eugene Water and Electric Board (EWEB)
- 4 City of Eugene, "Eugene Community Greenhouse Gas Emission Inventory Report 2007." <http://www.eugene-or.gov/portal/server.pt?open=512&objID=730&PageID=4083&cached=true&mode=2&userID=2>

## Section Three

- 1 American Automobile Association, "Your Driving Costs" (2007 edition). [www.aaapublicaffairs.com/Assets/Files/20073261133460.YourDrivingCosts2007.pdf](http://www.aaapublicaffairs.com/Assets/Files/20073261133460.YourDrivingCosts2007.pdf).
- 2 EPA, [www.epa.gov/OTAQ/climate/420r06003.pdf](http://www.epa.gov/OTAQ/climate/420r06003.pdf)
- 3 U.S. Environmental Protection Agency, "Greenhouse-gas emissions from Transportation and Other Mobile Sources." [www.epa.gov/otaq/greenhousegases.htm](http://www.epa.gov/otaq/greenhousegases.htm) (updated April 25, 2007).
- 4 Ibid. [www.epa.gov/otaq/climate/420f05003.htm#average](http://www.epa.gov/otaq/climate/420f05003.htm#average).
- 5 [www.fueleconomy.gov/feg/driveHabits.shtml](http://www.fueleconomy.gov/feg/driveHabits.shtml) Air filter savings based on: Organization for Economic Co-operation and Development (OECD), 1981, Automobile Fuel Consumption in Actual Traffic Conditions. Paris, France. These tests were performed before the introduction of computer-controlled, fuel-injection engines. Oak Ridge National Laboratory is currently studying the fuel economy effects of clogged air filters on more modern engines.
- 6 [www.fueleconomy.gov/feg/driveHabits.shtml](http://www.fueleconomy.gov/feg/driveHabits.shtml)
- 7 [www.fueleconomy.gov/feg/driveHabits.shtml](http://www.fueleconomy.gov/feg/driveHabits.shtml)
- 8 U.S. Environmental Protection Agency. "Driving More Efficiently." [www.fueleconomy.gov/feg/driveHabits.shtml](http://www.fueleconomy.gov/feg/driveHabits.shtml) (accessed June 18, 2007).
- 9 University of Michigan Center for Sustainable Systems Study "Life Cycle Optimization of Vehicle Replacement" [http://css.snre.umich.edu/main.php?control=detail\\_proj&pr\\_project\\_id=5](http://css.snre.umich.edu/main.php?control=detail_proj&pr_project_id=5)

- 10 Based on a report from CSIRO: Beer T, Grant T, Campbell PK. 2007. The greenhouse and air quality emissions of biodiesel blends in Australia. Report Number KS54C/1/F2.27. August 2007. Report for Caltex Pty Ltd. Prepared with financial assistance from the Department of the Environment and Water Resources.
- 11 More information available from the Stockholm Environment Institute [http://sei-international.org/mediamanager/documents/Publications/Climate/sei\\_air\\_travel\\_emissions\\_paper1\\_27\\_03\\_09.pdf](http://sei-international.org/mediamanager/documents/Publications/Climate/sei_air_travel_emissions_paper1_27_03_09.pdf)
- 12 Intergovernmental Panel of Climate Change (IPCC) Special Report - Aviation and the Global Atmosphere - Summary for Policymakers, 1999, [www.climatechangeconnection.org/Solutions/Airtravel.htm](http://www.climatechangeconnection.org/Solutions/Airtravel.htm)
- 13 1992 IPCC Special Report on Aviation and Global Atmosphere, [www.ipcc.ch/ipccreports/sres/aviation/083.htm](http://www.ipcc.ch/ipccreports/sres/aviation/083.htm)

## Section Four

- 1 Energy Information Admin Dept of Energy

## Section Five

- 1 [www.oregon.gov/ENERGY/RENEW/Solar/docs/solrwater.pdf](http://www.oregon.gov/ENERGY/RENEW/Solar/docs/solrwater.pdf)
- 2 To find biofuel compatible vehicles, see the National Ethanol Vehicle Coalition, [www.e85fuel.com/e85101/flexfuelvehicles.php](http://www.e85fuel.com/e85101/flexfuelvehicles.php), or the EPA's Alternative Fuels and Advanced Vehicles Data Center, [www.afdc.energy.gov/afdc/vehicles/conversions.html](http://www.afdc.energy.gov/afdc/vehicles/conversions.html)
- 3 [www.energy.gov/media/BiofuelsMythVFact.pdf](http://www.energy.gov/media/BiofuelsMythVFact.pdf)
- 4 California Environmental Protection Agency Air Resources Board, "Low Carbon Fuel Standard Program," [www.arb.ca.gov/fuels/lcfs/lcfs.htm](http://www.arb.ca.gov/fuels/lcfs/lcfs.htm). Accessed 22 September, 2009.

## Section Six

- 1 EPA's WAste Reduction Model (WARM) [www.epa.gov/climatechange/wycd/waste/calculators/Warm\\_Form.html](http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_Form.html)
- 2 [www.fs.fed.us/pnw/pubs/pnw\\_gtr614.pdf](http://www.fs.fed.us/pnw/pubs/pnw_gtr614.pdf)
- 3 [www.homeenergy.org/archive/hem.dis.anl.gov/eehem/96/960710.html](http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/96/960710.html)

## Section Seven

- 1 Environmental Protection Agency. "Municipal Solid Waste 2006 Pie Charts." [www.epa.gov/msw/facts-text.htm](http://www.epa.gov/msw/facts-text.htm)
- 2 New Society Publishers, A Guide for Going Carbon Neutral. Available for download at: [www.newsociety.com/Publishers%20CO2%20Template%20Metric.pdf](http://www.newsociety.com/Publishers%20CO2%20Template%20Metric.pdf)

- 3 World Trade Organization Report: [www.reman.org/pdf/WTO-reman.pdf](http://www.reman.org/pdf/WTO-reman.pdf)
- 4 Paul Erlich, NBC's Today, Spring 1989.
- 5 Susan Campbell, "Precycling: Getting Past Trash That's Forever," The Oregonian, July 2, 1991.
- 6 David Morris, "As If Materials Mattered," The Amicus Journal, Fall 1991.
- 7 Daniel Lazare, "Recycled but Not Used," The Amicus Journal, Fall 1991.
- 8 Robert Utcher, Mary Sheil, "Source Separation and Citizen Recycling," Solid Waste Handbook.
- 9 San Francisco Recycling Guide.
- 10 Recycling Advocates, based on the fact (from DEQ) that about seventeen southern pine trees are needed to produce one ton of paper.
- 11 Douglas County's recycling calendar.
- 12 Metro, website for the Portland metropolitan area.
- 13 Recovered Paper Statistical Highlights (1996 edition). American Forest and Paper Association, 1997.
- 14 Master Recycler Manual (Portland Metro Area), 2007, Chapter 3.
- 15 Ibid.
- 16 Society of the Plastics Industry, 1997.
- 17 Earthworks Group, Fifty Simple Things You Can Do to Save the Earth, 1989.
- 18 Aluminum Association, 1997, and Can Manufacturers Institute, 1997.
- 19 Ibid.
- 20 Ibid.
- 21 Oregon Department of Environmental Quality.
- 22 Steel Recycling Institute, 1997.
- 23 Ibid.
- 24 Earthworks Group, Fifty Simple Things You Can Do to Save the Earth, 1989.
- 25 Ibid.
- 26 Ibid.
- 27 Ibid.
- 28 G. Tyler Miller Jr., Living in the Environment, 1990.
- 29 Ibid.
- 30 Earthworks Group, Fifty Simple Things You Can Do to Save the Earth, 1989.

## Section Eight

- 1 Christopher Weber and H. Scott Matthews, "Food-Miles and the Relative Climate Impacts of Food Choices in the United States." *Environmental Science Technology* Vol. 42, No. 10. (1 May 2008), pp. 3508-3513
- 2 Ibid.
- 3 Food and Agriculture Organization of the United Nations. "Livestock's Long Shadow: Environmental Issues and Options." 2006 [www.fao.org/docrep/010/a0701e/a0701e00.HTM](http://www.fao.org/docrep/010/a0701e/a0701e00.HTM)
- 4 Christopher Weber and H. Scott Matthews, "Food-Miles and the Relative Climate Impacts of Food Choices in the United States." *Environmental Science Technology* Vol. 42, No. 10. (1 May 2008), pp. 3508-3513
- 5 Gidon Eshel and Pamela A. Martin, "Diet, Energy, and Global Warming," *Earth Interactions* 10: 1–17, 2006.
- 6 Food and Agriculture Organization of the United Nations. "Livestock's Long Shadow: Environmental Issues and Options." 2006 [www.fao.org/docrep/010/a0701e/a0701e00.HTM](http://www.fao.org/docrep/010/a0701e/a0701e00.HTM)
- 7 Christopher Weber and H. Scott Matthews, "Food-Miles and the Relative Climate Impacts of Food Choices in the United States." *Environmental Science Technology* Vol. 42, No. 10. (1 May 2008), pp. 3508-3513
- 8 Gidon Eshel and Pamela A. Martin, "Diet, Energy, and Global Warming," *Earth Interactions* 10: 1–17, 2006.
- 9 Christopher Weber and H. Scott Matthews, "Food-Miles and the Relative Climate Impacts of Food Choices in the United States." *Environmental Science Technology* Vol. 42, No. 10. (1 May 2008), pp. 3508-3513
- 10 United States Environmental Protection Agency, "Basic Information about Food Scraps," [www.epa.gov/osw/conserve/materials/organics/food/fd-basic.htm](http://www.epa.gov/osw/conserve/materials/organics/food/fd-basic.htm), Retrieved 28 August, 2009.
- 11 Christopher Weber and H. Scott Matthews, "Food-Miles and the Relative Climate Impacts of Food Choices in the United States." *Environmental Science Technology* Vol. 42, No. 10. (1 May 2008), pp. 3508-3513
- 12 Paul Watkiss, "The Validity of Food Miles as an Indicator of Sustainable Development," *AEA Technology Environment*, January 2006. [www.relu.ac.uk/events/Janconf06/Presentations/Watkiss.pdf](http://www.relu.ac.uk/events/Janconf06/Presentations/Watkiss.pdf) Accessed on 23 April 2007.
- 13 United States Department of Transportation, 2000, "U.S. Economic Growth and the Marine Transportation System." [www.mtsnac.org/docs/mtswhite.pdf](http://www.mtsnac.org/docs/mtswhite.pdf)
- 14 Paul Watkiss, "The Validity of Food Miles as an Indicator

of Sustainable Development," *AEA Technology Environment*, January 2006. [www.relu.ac.uk/events/Janconf06/Presentations/Watkiss.pdf](http://www.relu.ac.uk/events/Janconf06/Presentations/Watkiss.pdf) Accessed on 23 April 2007

- 15 Southern Union Trade Association, "Basics of Exporting," [www.susta.org/export/packingetc.html#air](http://www.susta.org/export/packingetc.html#air). Accessed on 4 September 2007.
- 16 D. Pimental et al, "Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems," *Bioscience* 55(7): 573–82.
- 17 Ibid.
- 18 Fair Trade Federation, "Fair Trade Federation Members: Coffee and Food Production." [www.fairtradefederation.org/memcof.html](http://www.fairtradefederation.org/memcof.html) Accessed on 14 September 2007.

## Section Nine

- 1 The Intergovernmental Panel on Climate Change (IPCC). [www.ipcc.ch](http://www.ipcc.ch)
- 2 United Nations Food and Agriculture Organization (FAO). "Media Fact Sheet: Growing More Food Using Less Water." [www.fao.org/fileadmin/user\\_upload/newsroom/docs/water\\_facts.pdf](http://www.fao.org/fileadmin/user_upload/newsroom/docs/water_facts.pdf)
- 3 Environmental Protection Agency, "How We Use Water in These United States." <http://esa21.kennesaw.edu/activities/water-use/water-use-overview-epa.pdf>
- 4 United States Department of Energy: Report to Congress on the Interdependency of Water and Energy, Energy Demands on Water Resources, December 2006. [www.sandia.gov/energy-water/docs/121-RptToCongress-EWwEIAComments-FINAL.pdf](http://www.sandia.gov/energy-water/docs/121-RptToCongress-EWwEIAComments-FINAL.pdf)
- 5 U.S. Government Accountability Office, Freshwater Supply: States View of How Federal Agencies Could Help Them Meet the Challenges of Expected Shortages. [www.gao.gov/products/GAO-03-514](http://www.gao.gov/products/GAO-03-514)
- 6 U.S. Environmental Protection Agency (EPA), Sustainable Infrastructure for Water & Wastewater. [www.epa.gov/waterinfrastructure/bettermanagement\\_energy.html#basicone](http://www.epa.gov/waterinfrastructure/bettermanagement_energy.html#basicone)
- 7 The U.S. Environmental Protection Agency (EPA), Water Sense. [www.epa.gov/owm/water-efficiency/water/benefits.htm](http://www.epa.gov/owm/water-efficiency/water/benefits.htm)
- 8 U.S. Environmental Protection Agency (EPA), Water Sense, Why Water Efficiency? [www.epa.gov/WaterSense/water/why.htm](http://www.epa.gov/WaterSense/water/why.htm)
- 9 The American Water Works Association. [www.drinktap.org/consumerdnn/Home/WaterInformation/Conservation/WaterUseStatistics/tabid/85/Default.aspx](http://www.drinktap.org/consumerdnn/Home/WaterInformation/Conservation/WaterUseStatistics/tabid/85/Default.aspx)



- 10 The U.S. Environmental Protection Agency (EPA), WaterSense, Benefits of Water Efficiency. [www.epa.gov/watersense/water\\_efficiency/benefits\\_of\\_water\\_efficiency.html](http://www.epa.gov/watersense/water_efficiency/benefits_of_water_efficiency.html)
- 11 Mayer, P.W., W.B. DeOreo, et. al. 1999. Residential End Uses of Water. American Water Works Association Research Foundation, Denver, Colorado. [www.aquacraft.com/Publications/resident.htm](http://www.aquacraft.com/Publications/resident.htm)
- 12 The U.S. Environmental Protection Agency (EPA), Water Sense, Outdoor Water Use in the United States. [www.epa.gov/WaterSense/pubs/outdoor.htm](http://www.epa.gov/WaterSense/pubs/outdoor.htm)
- 13 The U.S. Environmental Protection Agency (EPA), Water Sense, Use Your Water Sense. [www.epa.gov/watersense/water/simple.htm#water](http://www.epa.gov/watersense/water/simple.htm#water)
- 14 The U.S. Environmental Protection Agency (EPA), Landscaping with Native Plants. [www.epa.gov/greenacres/nativeplants/factsht.htm#Why%20Should%20](http://www.epa.gov/greenacres/nativeplants/factsht.htm#Why%20Should%20)

## Section Ten

- 1 United Nations Environmental Program (UNEP), GRID-Arendal, The Intergovernmental Panel on Climate Change (IPCC), Climate Change, Synthesis Report, Question 5. [www.grida.no/publications/other/ipcc\\_tar/?src=/climate/IPCC\\_tar/vol4/english/011.htm](http://www.grida.no/publications/other/ipcc_tar/?src=/climate/IPCC_tar/vol4/english/011.htm)
- 2 The Intergovernmental Panel on Climate Change (IPCC), Climate Change 2007: Synthesis Report. p. 8. [www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4\\_syr.pdf](http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf)
- 3 United States Global Change Research Program. [www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/key-findings](http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/key-findings)
- 4 The Intergovernmental Panel on Climate Change (IPCC), Working Group II, Climate Change Impacts, Adaptation and Vulnerability, Fourth Assessment Report, Chapter 14: North America. [www.ipcc-wg2.org/index.html](http://www.ipcc-wg2.org/index.html)
- 5 WeADAPT. [www.weadapt.org](http://www.weadapt.org)
- 6 The Intergovernmental Panel on Climate Change (IPCC), Working Group II, Climate Change Impacts, Adaptation and Vulnerability, Fourth Assessment Report, Chapter 14: North America. [www.ipcc-wg2.org/index.html](http://www.ipcc-wg2.org/index.html)
- 7 Ibid
- 8 Source: State Farm Insurance, Natural Disasters, Wildfire Precautions. [www.statefarm.com/learning/disasters/learning\\_disas\\_wildfire.asp](http://www.statefarm.com/learning/disasters/learning_disas_wildfire.asp)
- 9 The Intergovernmental Panel on Climate Change (IPCC), Working Group II, Climate Change Impacts, Adaptation and Vulnerability, Fourth Assessment Report, Chapter 14: North America. [www.ipcc-wg2.org/index.html](http://www.ipcc-wg2.org/index.html)
- 10 Ibid
- 11 Centers for Disease Control and Prevention, Environmental Health, Climate Change and Public Health, Health Effects. [www.cdc.gov/ClimateChange/effects/default.htm](http://www.cdc.gov/ClimateChange/effects/default.htm)

## Section Eleven

- 1 [www.oregon.gov/ENERGY/GBLWRM/docs/GlobalDraft-AppendC.pdf](http://www.oregon.gov/ENERGY/GBLWRM/docs/GlobalDraft-AppendC.pdf) Oregon Strategy for Greenhouse Gas Reductions [www.sustainableoregon.net/documents/climate/Oregon\\_Strategy\\_Final\\_Report.pdf](http://www.sustainableoregon.net/documents/climate/Oregon_Strategy_Final_Report.pdf)
- 2 The per capita numbers for Eugene are significantly lower than the nationwide average because it relies on hydropower for so much of its electricity. The production of electricity from hydropower does not release greenhouse gases, as it does from fossil fuels such as coal and natural gas.
- 3 We assumed the household uses natural gas at the Northwest Natural Gas residential average for western Oregon and southwest Washington, from conversation with Kip Much, Northwest Natural Gas manager, 15 December 2006. Much stated use was 685 therms per year. A household using natural gas might use less electricity than the EWEB average of 12,000 kilowatt hours per year. To calculate the associated CO<sub>2</sub> emissions, we used the EWEB coefficient of 0.1 pounds of CO<sub>2</sub> per kilowatt hour (100 pounds per megawatt hour) and 12 pounds of CO<sub>2</sub> per therm for natural gas.
- 4 Average miles from U.S. Environmental Protection Agency, Office of Transportation and Air Quality, "Emission Facts: Greenhouse-gas emissions from a Typical Passenger Vehicle," February 2005, p. 4, [www.epa.gov/otaq/climate/420f05004.pdf](http://www.epa.gov/otaq/climate/420f05004.pdf).
- 5 Gasoline coefficient from Energy Information Administration: "Voluntary Reporting of Greenhouse Gases Program." [www.eia.doe.gov/oiaf/1605/coefficients.html](http://www.eia.doe.gov/oiaf/1605/coefficients.html).
- 6 The Climate Trust, "How Was Your Carbon Footprint Calculated? Emissions Explained." [www.carboncounter.org/offset-your-emissions/calculations-explained.aspx#edn33](http://www.carboncounter.org/offset-your-emissions/calculations-explained.aspx#edn33).
- 7 In Oregon, 1.9 million metric tons CO<sub>2</sub>e for commercial sector emissions plus 6.8 million metric tons CO<sub>2</sub>e for industrial divided by 3,436,750 (population estimate July 1, 2000) equals 2.5 metric tons per capita per Oregonian (Oregon Strategy for Greenhouse-Gas Reductions, p. B-3). [www.oregon.gov/ENERGY/GBLWRM/docs/GWReport-Final.pdf](http://www.oregon.gov/ENERGY/GBLWRM/docs/GWReport-Final.pdf)

