Climate Master Handbook

NEW MEXICO

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

Special thanks to the U.S. Environmental Protection Agency for their support of the New Mexico Climate Master Program

Handbook edited by Emily Geery & Jill Turner of the New Mexico Environment Department
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This Climate Master handbook is based on the original Climate Master Program developed at the University of Oregon, Climate Leadership Initiative.

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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 and household 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 embodied emissions as well as emission reduction 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 thirty hours within one year 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 thirty hours of volunteer time.

Fulfilling the Commitment

Volunteers will be responsible for setting up their own volunteer work opportunities. All volunteer work must be pre-approved by staff or the volunteer coordinator, or it will not count toward qualifying hours. Volunteer activities are unpaid. The following choices are acceptable options for fulfilling your obligation.

1. Work as a household GHG emissions consultant

We encourage volunteers to fulfill their volunteer obligation by working 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 ask that you to set up five to ten of your own consultations with people you know. When you schedule your own consultations, please use our materials and return commitment forms and surveys to us.

2. Tabling at events

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

3. Other activities identified or approved by the volunteer coordinator

Other volunteer opportunities include public speaking, writing or editing materials, special events, and other opportunities suggested or approved by staff or 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. Please keep in mind that volunteer activies must be unpaid to honor the spirit and commitment of the Climate Master program.

Reporting Volunteer Hours

We require that participants track their hours and turn in a quarterly time sheet.

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 by debating issues, expounding on your beliefs, or describing 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.

INTRODUCTION

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. In an appendix, you will find resources for each section to deepen your understanding of the topic as it relates to your own life and to help you reduce your personal GHG emissions.

The Climate Leadership Initiative (CLI) based out of the University of Oregon 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 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; however, households are the ultimate end-users of most energy production via home heating, cooling, appliances, food, travel, and embedded energy in household products purchased. Therefore, households, directly or indirectly, produce significant amounts of GHG emissions, yet the general public's understanding of climate change remains shallow, and few people think they personally can do much about the problem.

CLI discovered that a community-based approach can effectively reduce GHG emissions. As of 2009, the program has reduced GHG emissions on average by more than 4,000 pounds per participant, increased regular use of alternative transportation and energy-efficient purchasing, and reduced use of disposable items, among other climate-positive actions.

CLI 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. The program benefits individuals by saving costs, increasing the sense of well-being and empowerment, and promoting good health (some participants say the program changed their life). Communities benefit from reduced GHG emissions, support for climate-positive technology and policy, increased volunteering for climate change and energy efficiency, and leadership training, as a diverse swath of community members unite around a theme: acting locally to curb global climate change.

Visit the Climate Leadership Initiative website at http://www.climateleadership.org.

SECTION 1: CLIMATE CHANGE 101

Key Learning Points

- Greenhouse gases (GHGs) and greenhouse effect
- Sources of carbon dioxide, methane, nitrous oxide
- Forcing, feedback, and delays
- Climate change impacts and the role of humans
- Climate versus weather
- Preparation and mitigation
- Definition of "offsets" and pros and cons of common offset projects: reforestation, renewable energy, efficiency

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.

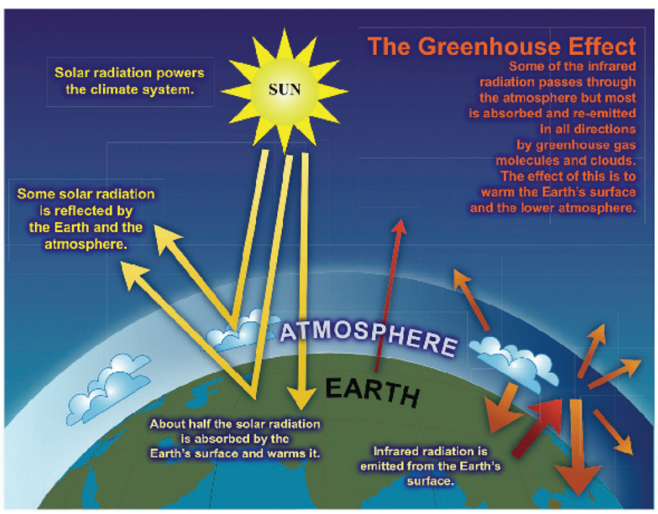

Figure 1-1. Greenhouse Effect

Greenhouse gases in the atmosphere absorb and radiate heat back into our atmosphere.

Source: Intergovernmental Panel on Climate Change Working Group I, "The Physical Science Basis," 2007, <http://www.ipcc.ch/graphics/gr-ar4-wg1.htm.

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 (GHGs) because of their ability to absorb heat, much like 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 GHGs. Scientists now 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_2), nitrous oxide (N_2O) and methane (NH_4) have increased significantly (by approximately 36 percent, 18 percent, and 148 percent, respectively) in the atmosphere as a result of human activity. [1] 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 (animal husbandry). Nitrous oxide is also released from fossil fuel burning and methane is also emitted from natural gas distribution and landfills.[2] Global concentrations of all three of these GHGs, 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 GHG released by human activity, now exceeds by far the natural range over the last 650,000 years (that natural range is 180–300 ppm; June 2008 levels reached 383.9 ppm.). [3]

The bottom line

Perhaps the most important outcomes of the 2007 Intergovernmental Panel on Climate Change (IPCC) report[4] 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 percent likelihood) that most of the increase in global-average temperatures since 1950 can be attributed to human-caused emissions of heat-trapping gases.

(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 GHG emissions must peak by 2015 and decrease by 80 to 90 percent 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. [5] The average temperature of the global ocean has increased to depths exceeding 9,800 feet, and the ocean has been absorbing more than 80 percent 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 1-2 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.[6]

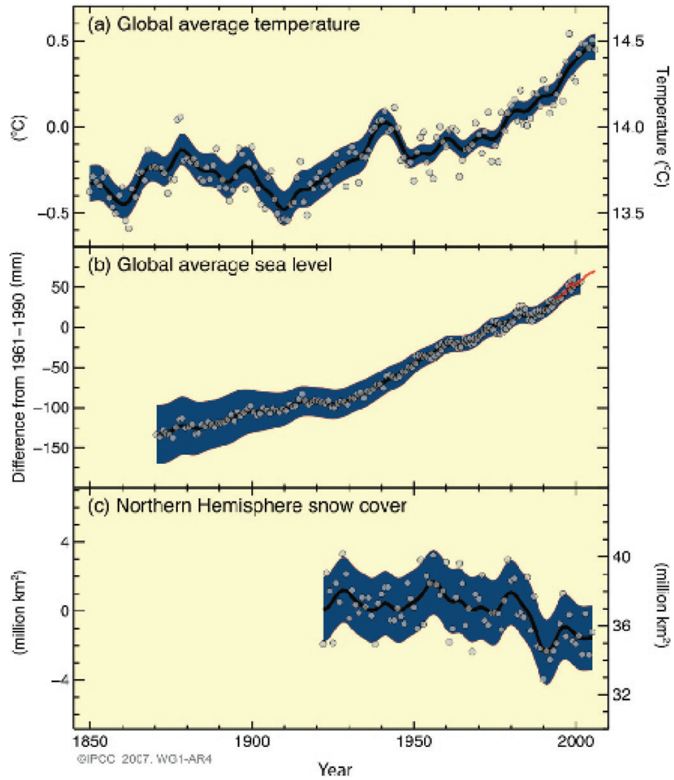

Figure 1-2. Observed Physical Change

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, <http://www.ipcc.ch/graphics/gr-ar4-wg1.htm>

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 IPCC, global-average sea levels are projected to rise between 7 inches and 23 inches, a narrower range than prior estimates. These estimates exclude some factors, including meltwater from the Greenland and Antarctic ice sheets, for which changes cannot be forecast based on current knowledge; however, an increasing number of scientists are very concerned that accelerated rates of melting will greatly elevate sea level and lead to other global climatic changes. If James Hansen, director of the NASA Goddard Institute of Space Studies, is correct and greenhouse -gas emissions are already above the level that can trigger severe climate change, the sea level could rise by several meters within this century.

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

Implications for Southwestern U.S.[7]

Findings from *Abrupt Climate Change*, a report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research (2008)

- Severe and persistent drought in the U.S. Southwest is increasingly likely.
- Semi-arid regions are projected to dry further.
- Droughts and heat waves have been the second most expensive natural disasters in the U.S.

There is no clear evidence to date of human-induced global climate change on North American precipitation amounts; however, since the IPCC AR4 report, further analysis of climate model scenarios of future hydroclimatic change over North America and the global subtropics indicate that subtropical aridity is likely to intensify and persist due to future greenhouse warming. This projected drying extends to the U.S. Southwest, potentially increasing the likelihood of severe and persistent drought in the future. If the model results are correct, then drying may have already begun, but currently cannot be definitively identified amidst the considerable natural variability of the Southwest's hydroclimate.

Hydroclimatic changes are likely to affect all regions in the U.S., and semi-arid regions of the Southwest are projected to dry further. Intensity of precipitation is also expected to increase across most of the country, continuing its recent trend. Drying in the Southwest is a matter of great concern because water resources in this region are already stretched, new development of resources will be extremely difficult, and the population (and thus demand for water) continues to grow rapidly.

Variations in water supply in general, and protracted droughts in particular, are among the greatest natural hazards facing the U.S. and the globe today and in the foreseeable future. According to the National Climatic Data Center, National Oceanic and Atmospheric Administration (NCDC, NOAA), over the period from 1980 to 2006, droughts and heat waves were the second most expensive natural disaster in the U.S. behind tropical storms. The annual cost of drought to the U.S. is estimated to be billions of dollars. Although there is much uncertainty in these figures, it is clear that drought leads to (1) crop losses, which result in a loss of farm income and an increase in Federal disaster relief funds and food prices, (2) disruption of recreation and tourism, (3) increased fire risk and loss of life and property, (4) reduced hydroelectric energy generation, and (5) enforced water conservation to preserve essential municipal water supplies and aquatic ecosystems.

Increases in the frequency of droughts in response to climate change can in turn produce further climate changes. For example, increased drought frequency may reduce forest growth, decreasing the sequestration of carbon in standing biomass, and increasing its release from the soil. Similarly, increasing temperatures and drought will likely promote increased disturbance by fire and insect pathogens, with a consequent impact on ecosystems and their carbon balances.

Offsets

Carbon offsets are credits purchased to offset the production of GHG emissions from energy use and other activities. Carbon offsets are intended to reduce the impact of your carbon footprint. 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 an amount of carbon credits equal to the amount produced—taking into account the differing warming potentials of the various GHGs. All carbon credits represent the reduction of GHG in metric tons of carbon dioxide (CO_2), the most common GHG. Methane has a warming potential twenty-three times that of CO_2; therefore, a ton of methane gas has the warming potential of 23 tons of CO_2.

Climate and Weather

From the Oregon Governor's Advisory Group on Global Warming, "Primer on Global Warming"

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

Weather is changeable day by day. Cool, wet Augusts are not unknown, nor are 70-degree days in February. Local, transient phenomena produce local, transient weather effects. Can the planet truly be warming if we're having a damp and dreary summer? Yes, because climate is "weather" averaged over time.

In general, New Mexico's climate is characterized by little precipitation, lots of sunshine, low humidity, and large temperature ranges from season to season as well as from day to night. Climate also varies with topography, with lower temperatures and higher precipitation totals at higher elevations. The source of the scant precipitation the state receives is the Pacific Ocean—500 miles to the west—or the Gulf of Mexico—500 miles to the southeast. [7]

There are larger temporal climate effects, too. Most of us recognize that El Niño disturbances result in wetter-than-normal weather from October through March, while La Niña years are drier than usual. More expansively, there is a switch (known as the Pacific decadal oscillation) that seems to flip every twenty to thirty years, 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. El Niño might produce even more rainy days, and more intense rain, with the added 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, etc. Some are harder to predict. Will it rain more or less? Will that precipitation come at the same time as now, or will the pattern shift?

Climate change is also changing the arrival of our seasons. The phase of the annual cycle of surface temperature, which is occurring over land not water, shifted towards earlier seasons by 1.7 days between 1954 and 2007. The earlier arrival of seasons plays a role in buds opening earlier, birds migrating earlier, snow melting earlier, sea ice breaking up earlier, natural food chains becoming disrupted, and the timing of pollination, which affects plants and pollinators. [8]

We can't use today's weather to judge how 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.

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 to offset emissions.

Reforestation: Carbon sequestration through replanting forests is one of the most common methods used by carbon-offset organizations. Carbon is captured, 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 in order to ensure the perpetuity of ecologically sensitive regions.

Renewable energy credits: Renewable energy credits (REC), also know 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. Some carbon-offset retailers "purchase and retire" the credits in order to lower the total amount of carbon available to be traded. By investing in renewable energy technologies, 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.

Controversy in carbon offsets

Reforestation is controversial as an effective tool in reducing the amount of CO_2 in the atmosphere. Reforestation projects lack permanence, as the trees may potentially be felled or catch fire, releasing CO_2.

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_2 emitted by local fossil-fuel-burning power plants per kilowatt hour. The main debate on RECs is whether they can satisfy the GHG 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.

Retail voluntary carbon market: upstanding supply and demand

No federal GHG emission regulations exist in the U.S. at this time; 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_2. Prices are affected by two main factors: (1) the cost of the offset, including the cost of technical reduction and 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 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 GHG levels in the atmosphere (sequestration).

Product verification:

In the absence of quality standards, there are a wide variety of accounting methods in the voluntary market. 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).

Offset 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 distribution

Once a project has been developed and verified, middlemen often step in as buyers (with the purpose of reselling credits) or facilitators of transactions on a fee-for-service basis. Today there are about thirty-five retail providers of offsets available on the Internet that vend both emissions-reduction projects and sequestration-project 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 maintaining a portfolio of projects. Currently the Chicago Climate Exchange is the only voluntary carbon-trading exchange, and trading is restricted to 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.

Some examples of 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 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.

Major Considerations for Offset Quality

"Additionality" — The 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 the GHG-emission reductions resulting from a project.

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, there is 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 — The implementation of the project should not create an increase in emissions outside the project.

Preparing for climate change

Throughout this handbook we explore 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. Equally important 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 IPCC 2007 Synthesis Report.[9]

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 rarely 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.

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.

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.[10] 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 http://climlead.uoregon.edu
- ICLEI-Local Government for Sustainability at http://www.iclei.org
- Center for Clean Air Policy (CCAP) at 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 more and more states are developing climate action plans, those plans do not typically involve preparedness plans at this point. On the other hand, 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.

What you can 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. With greater awareness of what risks are at hand, invest in resilience to withstand those impacts.

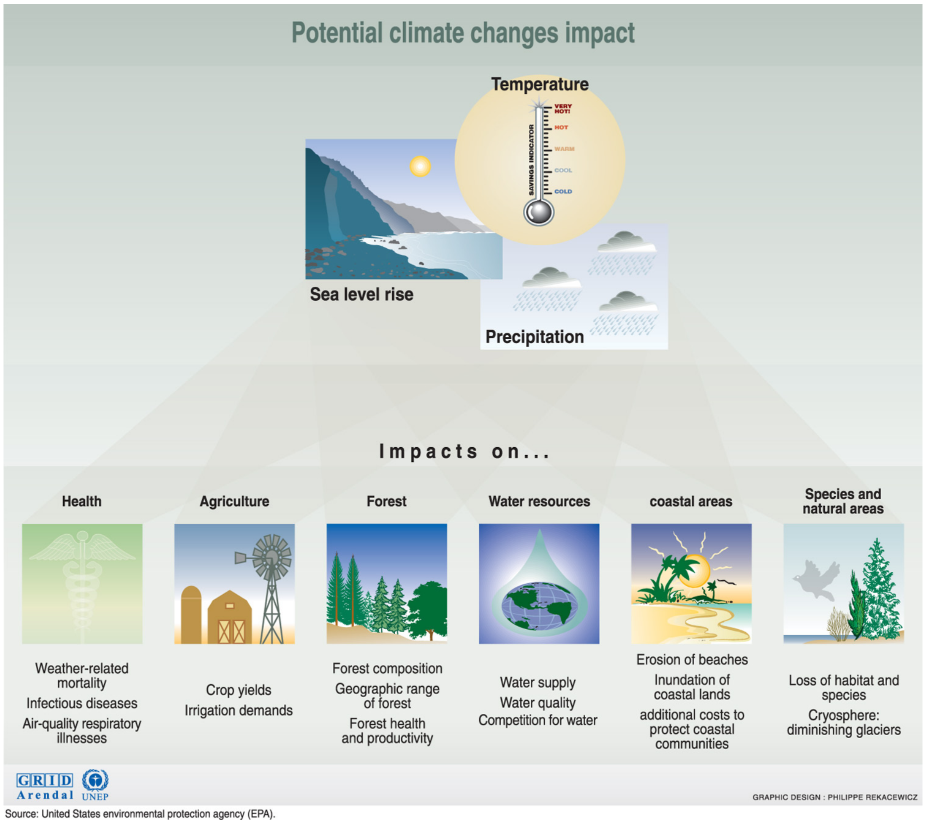

Figure 1-3. Potential Impacts of Climate Change

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

Conclusions for climate change

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, and the focus of the Climate Master course, is working to slow and reverse the trend of warming by decreasing human-produced GHG 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 GHGs. 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 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 GHG emissions.

Tactics for reducing emissions vary from place to place and person to person. Sources of GHGs diverge between communities based on land use, whether people are using hydropower or burning coal 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!

To see what a community preparation strategy looks like, visit these websites:

- King County, WA: http://your.kingcounty.gov/exec/news/2007/0912globalwarming.aspx
- Keene, NH: http://www.ci.keene.nh.us/sustainability/climate-change
- New York City, NY: http://www.nyc.gov/html/planyc2030/html/challenge/greenyc.shtml

Take Action

Visit an online carbon calculator (such as http://www.epa.gov/climatechange/emissions/ind_calculator.html) to assess your personal GHG emissions.

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.

From the Sopris Foundation website. To order a card or learn more about the calculations, visit: http://www.soprisfoundation.org/projects.html

What is a carbon footprint?

Using coal, natural gas, or oil for electricity, heat or transportation releases carbon dioxide (CO2) into the atmosphere. These daily carbon dioxide emissions make up your carbon footprint.

Why Care?
Too much CO2 from our daily activities hurts the planet's climate. Measuring carbon emissions can be tricky. This card lists estimates of the CO2 emitted through common activities.

Add it up:
When you want to lose weight, you count calories. When you want to save money, you count dollars. Want to improve the atmosphere? Count CO2 emissions. Driving, flying, drinking coffee and even eating sushi all have a carbon footprint. Use this guide to count your carbon so you can live lighter!

Put this card in your wallet or on your fridge for reference!

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THE SOPRIS FOUNDATION

www.soprisfoundation.org

303 E ABC Aspen, CO 81611

Sustainability for the Rockies

Carbon Footprint COUNTER

What's *your* total?

Home Energy Use

Lights use natural window light .... 0 lb CO2
Cooling open a window for fresh air .... 0 lb CO2
Washing cold water, air dry .... 0.4 lb CO2/day
Snow shovel by hand .... 0 lb CO2/winter
Bathing hot shower, 5 minutes .... 3.5 lbs CO2/shower
Home energy efficient house .... 3.8 lbs CO2/sf/yr

Lights four 26 Watt CFL bulbs for 12 hours .... 1.7 lbs CO2/day
Cooling electric fan .... 1 lb CO2/day
Washing cold water, electric dryer .... 4.4 lb CO2/day
Snow snowplow truck removal .... 950 lbs CO2/winter
Bathing hot shower, 10 minutes .... 7 lbs CO2/shower
Home average US household .... 10 lbs CO2/sf/yr

Lights four 100 Watt bulbs for 12 hours .... 6.5 lbs CO2/day
Cooling air conditioner .... 7 lbs CO2/day
Washing hot water, electric dryer .... 8 lbs CO2/day
Snow heated driveway .... 6 tons CO2/winter
Bathing soaking in avg hot tub .... 9 lbs/day
Home large size, many amenities .... 51 lbs CO2/sf/yr

Travel | Recreation

Driving take the bus instead .... 0.2 lb CO2/passenger mile
Flights long, extended trip* .... 0.3 lb CO2/passenger mile
Recreation cross country ski .... negligible CO2
Exercise walk, hike outdoors .... negligible CO2
Extra average car idling in traffic .... 12 lbs CO2/hour

Driving hybrid electric car, 41 mpg .... 0.5 lb CO2/mile
Flights medium trip* .... 0.5 lb CO2/passenger mile
Recreation lift-serviced skiing .... 45 lbs CO2/day
Exercise gym workout .... 21 lbs CO2/visit
Extra snowmobiling .... 87 lbs CO2/hour

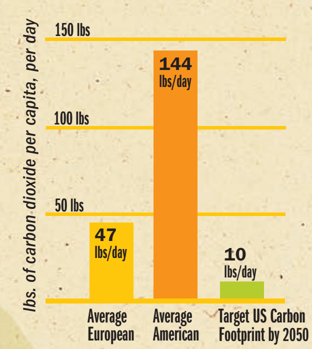
Driving average 23 mpg vehicle .... 0.9 lb CO2/mile
Flights short trip* .... 0.9 lb CO2/passenger mile
Recreation heli-skiing .... 419 lbs CO2/day
Extra private jet .... 3.4 tons CO2/hour

Food | Drink | Work

Water tap water .... negligible CO2
Alcohol New Belgium beer .... 1.8 lbs CO2/12-oz bottle
Food fruits & vegetables .... 1.6 lbs CO2e/lb
Food banana .... 0.25 lbs CO2e/banana
Work laptop computer .... 0.3 lb CO2/day
Extra coffee .... 0.4 lb CO2/cup

Water dispenser with hot/cold .... 3.1 lbs CO2/day
Alcohol domestic wine .... 5.5 lbs CO2/750 ml bottle
Food chicken, fish, eggs .... 6 lbs CO2e/lb
Work desktop computer .... 2.2 lb CO2/day
Extra LCD 40" flatscreen TV .... 0.7 lb CO2/day

Water bottled Fiji water .... 1 lb CO2/liter
Alcohol French wine .... 6.2 lbs CO2/750 ml bottle
Food beef .... 22 lbs CO2e/lb
Food cheeseburger .... 6.6 lbs CO2e/burger
Work send a UPS package .... 4.7 lbs CO2/package
Extra yellowtail sushi .... 0.5 lb CO2e/piece



* In addition to other factors, more fuel is burned during takeoff & landing in a short flight than on long flights.

- The distance a product is shipped from where it was produced, or the specific model of a home appliance or personal vehicle alter the actual carbon footprint. These estimates are based on best available information.
- For a complete explanation of the calculations, refer to "Daily Carbon" at www.soprisfoundation.org

SECTION 2: GREEN BUILDING

Key Learning Points

- Embodied emissions
- Impact of buildings during use
- Passive solar

GHG 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 GHG emission numbers above). Thus the emissions come from the entire life cycle 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 for illumination).

Consider energy-efficient windows. As you need to replace windows in your home, consider investing in energy-efficient windows. 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.

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

- 30 percent of GHG emissions,
- 36 percent of total energy use,
- 65 percent of electricity consumption,
- 30 percent of raw materials use,
- 30 percent of waste output (136 million tons annually), and
- 12 percent of potable water consumption.

Install sufficient insulation. Needs vary depending on your location and the part of your home. Attic spaces need the greatest levels of insulation, as a poorly insulated attic will allow heat to escape your home. Higher R-values (the opposite of U-factors) are more resistant to heat loss.

Install energy-efficient heating and cooling systems. Ensure that ducts are well insulated and sealed.

Plan for shade. A well-placed overhang, awning, or blind can cut the need for summertime cooling dramatically.

Lighten your roof. Light-colored or "living roofs" reduce summer heat absorption. Metal roofs are durable, recyclable, and energy efficient—yet more costly up front than asphalt.

Plan for solar. 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. New Mexico Recyling Coalition is a great place to start your search.

Reduce. Eliminate or reduce construction waste. Contact the New Mexico Recycling Coalition for deconstruction projects.

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 GHG 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 fewer 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 forty-year roof instead of the standard twenty-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 website,

> *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 in order to consider the broad effects of our actions and constructions.

Lower-cost energy efficiency opportunities

Numerous technologies are available to improve energy efficiency. The following ideas have been adapted from suggestions by the Energy Information Administration. Savings in both energy consumption and money can be achieved by installing insulation, maintaining and upgrading existing equipment, and practicing energy-efficient behaviors as described in Section 3 of this handbook.

Thermostat. A two-degree adjustment to the thermostat setting (lower in winter, higher in summer) can reduce heating bills by four to six percent and prevent 500 pounds of carbon dioxide from entering the atmosphere each year.[1] 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, a high-efficiency gas furnace, electric heating, low-intensity infrared space heating, and programmable thermostats.

Insulation and weatherization. Investing in insulation and weatherization can reduce heating and cooling needs. Warm air leaking into indoor spaces during summer and out during winter can waste energy. Insulation wraps indoor spaces in a 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 ways to save money is to caulk, seal, and weather-strip all 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 above. 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.

Electricity and appliances. When you shop for a new appliance, look for the Energy Star label—your assurance that the product saves energy. Energy Star appliances have been identified by the EPA and Department of Energy as the most energy-efficient products in their classes. Appliance manufacturers are required to display Energy Guide labels on most major appliances—another useful way to compare appliances. Labels don't tell you which appliance is the most efficient, but they display the energy usage and operating cost of each appliance to aid in comparing products.

The scope of information on buildings is too vast to encompass in one short chapter, but for those embarking on a project, the resources at the end of the chapter are good starting points, particularly NM sustainable buildings tax credits.

Take action

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).

SECTION 3: HOME ENERGY

Key Learning Points

- Local energy portfolio
- Typical division of home energy use (e.g., space and water heating, appliances)
- Behavioral changes to reduce emissions and save money
- Changes to energy sources, equipment, and appliances to reduce emissions
- Renewable Energy Credits (RECs) or "green tags"

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.

It is difficult to identify the percentage of our personal emissions that come from the energy used in our home, as many are difficult to quantify. For example, if one attempts to include in our personal climate footprint emissions such as those related to our food consumption (excluded by most online and community emissions calculators), then the relative standing of home energy use drops. Home-energy emissions are also highly dependent on what combination of electricity, natural gas, heating oil, and other fuels a household uses, as well as the local energy portfolio.

Typical home emissions

We can, however, identify where energy-related emissions come from within most homes: space heating and cooling typically take the cake, constituting about 45 percent of home energy use. All the heating and cooling systems in the U.S. emit a combined 150 million tons of carbon dioxide annually.[1]

Appliances and lighting follow with a combined 34 percent (with the majority used by appliances). The refrigerator alone uses 8 percent of household energy — more energy than any other appliance in the house. Water heating typically comes in at around 13 percent. Although these percentages vary from household to household, these numbers give us a good idea where to start 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. How does this residential-energy use fit into the bigger picture of local emissions, and what does all this energy contribute in terms of GHGs?

Broader impact

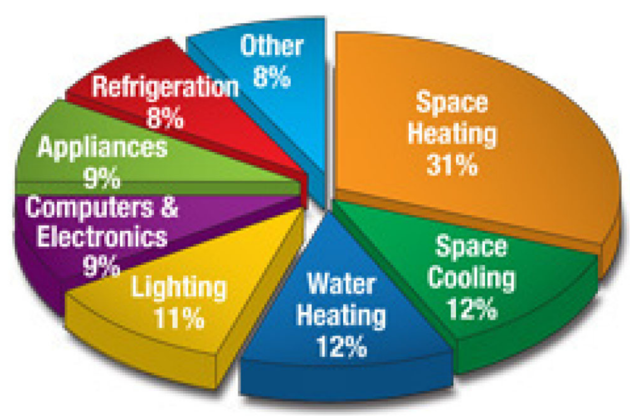
There are many simple changes we can make to cut our home emissions, many of which also will save us money. Moreover, reducing electricity use even in communities with low-emission power frees extra "clean" energy for other users on the regional grid. Utilities buy and sell electricity on a quarterly and even a daily basis.

Specifically, a household 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.

Figure 3-1. 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 2007 Building Energy Data Book, <http://www1.eere.energy.gov/consumer/tips/appliances.html.>



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.

Heating and cooling

The amount of energy used for heating and cooling a home is a function of four 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, and 4) the efficiency of the heating or cooling system.[2] Follow these steps to improve efficiency in each of these areas.

Heating: Keep your house at 67 degrees or less. Each degree over 67 adds three percent to the heating portion of your utility bill.

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

Thermostat:

- 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.
- Digital thermostats are more accurate than nondigital ones. To ensure your nondigital thermostat is accurate, calibrate it by placing a simple digital wall thermometer close by to see if they match.
- 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 heat off completely.

Time (How many hours out of twenty-four do you heat?): 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 degrees for eight hours to cut your annual heating bill by five to 15 percent. That's an annual saving of up to one percent for each degree of a setback that lasts more than eight hours, according to the U.S. Department of Energy.

Longer and larger setbacks save more energy, while shorter and smaller setbacks save less.

Space (How big of a space do you heat? How is your space set up?): 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. For unused areas, heat them 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 your 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.

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.

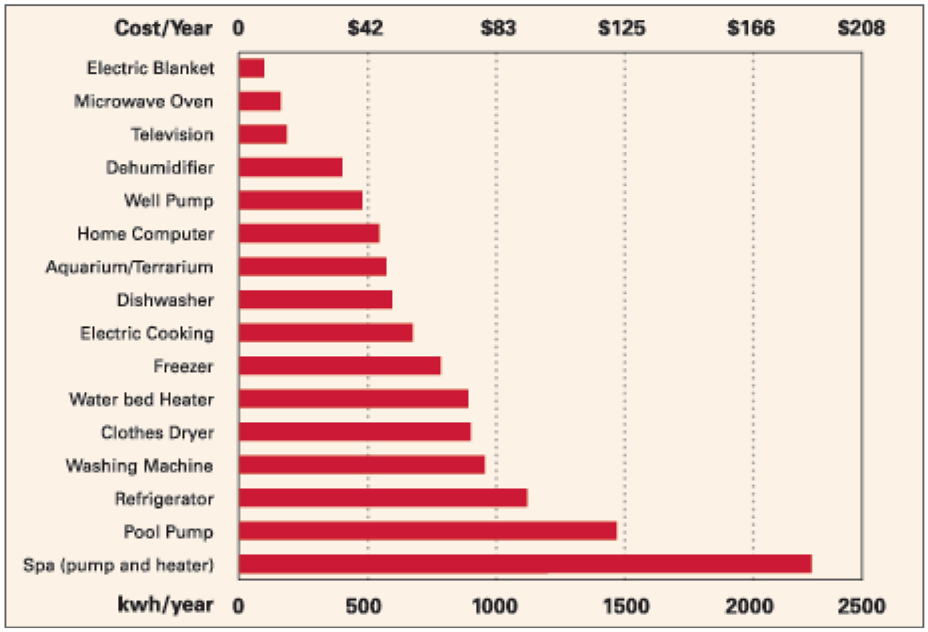
Short ton: 2,000 lbs.

Long ton: 2,240 lbs.

Figure 3-2. Average Annual Appliance Use

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

Source: U.S. Department of Energy, Energy Efficiency and Renewable Energy, "Energy Savers," <http://www1.eere.energy.gov/consumer/tips/appliances.html>



Maintenance and 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 one to two months.

Regular service: Service your heat pump once every year. Furnaces should be serviced at least once every three years.

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

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.

- Have a certified chimney sweep inspect your system every year, preferably before each heating season to make sure all components are functioning efficiently and safely.
- When selecting wood, choose a supplier that uses sustainable harvesting practices.

Woodstoves vs. fireplaces: Woodstoves are at least five times more efficient than fireplaces. Use a fan to distribute the heat. Be aware that wood-burning stoves typically emit large quantities of air pollutants, including nitrogen oxides, carbon monoxide, organic gases, and particulate matter. Consider upgrading your standard woodstove to one of the newer stoves certified by the U.S. EPA. These stoves channel heated air above the fire, which helps burn combustible gases and particulates before they exit the chimney, increasing the efficiency that burned materials are turned into heat and lowering emissions.[3]

- Pellet fuel stoves are the cleanest burning, with combustion efficiencies of 78–85 percent. They burn small pellets made from compacted sawdust, wood chips, bark, agricultural crop waste, waste paper, and other organic materials. Pellet stoves are also offered as inserts to regular fireplaces. Be sure there is a reliable pellet fuel supplier in your area.
- Three other high-efficiency stove options with efficiencies ranging from 60 to 80 percent are catalytic woodstoves (which can be added to a regular woodstove), centralized wood-burning boilers (some of which can switch to oil or gas if the fire goes out), and advanced combustion stoves (often the most affordable, although least efficient, of the options above.)

- Regular maintenance is required to keep any of these stoves working at their highest efficiency. Periodically clean the inside of the stove with a wire, as even one-tenth of an inch of soot can drop the heat transfer efficiency of the metal by 50 percent.

Fireplace: Your 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.
- Consider installing a high-efficiency fireplace insert, which operate like a woodstove and almost as efficiently, fitting into the masonry fireplace or on its hearth, and using the existing chimney. You must install a flue collar that continues from the insert to the top of the chimney. Inserts should be as airtight as possible in order to control the fire and the heat output.[4]

Building "envelope" improvements: 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. 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—and you can save as much as 10 percent on your heating and cooling bill by reducing the air leaks in your home.

- Use plastic storm windows or invest in double- or triple-paned glass or permanent storm windows. They can cut your heat loss in half.
- Insulate your walls, ceiling, and floor.
- Close your fireplace damper.
- 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. A portable heater can cost twenty dollars a month to operate (1,500 watts for five hours/day ave.).

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 and an energy use guide when buying. Check with your local utility for rebates and incentives, state and federal tax credits, and manufacturer's rebates.

Refrigerator (energy hog of the appliance world)

- Set your refrigerator temperature to 38–42 degrees. Measure by placing a thermometer in a glass of water.
- Locate the refrigerator away from heat sources and away from items or walls that could block airflow to the coils.
- Unplug the refrigerator at least once a year to clean the dust off the coils (often located underneath, or on the back in older models). When the coils are dirty, the refrigerator works harder and runs longer.

- Clean the gasket and the face of the cabinet. Test for fit by placing a dollar bill between the gasket and the cabinet. If you can slide it out with the door closed, you need to replace the gasket.
- Cool food before you place it in the refrigerator. 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 rid of your second refrigerator. By eliminating an older, energy-inefficient refrigerator or freezer, you can save ten to twenty dollars a month.
- Refrigerators have become dramatically more efficient over the last thirty years. Find the energy usage of your refrigerator by visiting the Home Energy website at http://www.homeenergy.org/consumerinfo/refrigeration2/refmods.php and choosing your brand and 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.

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.
- 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 the burner pans or in the oven. It decreases efficiency and the life of the elements.

Freezer

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

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 percent of the energy cost.
- Wash full loads only.

Washer

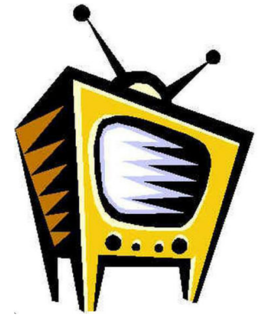
- Wash clothes in cold or warm water. Using cold water reduces your washer's energy use by 75 percent. Always rinse in cold water.
- Try to wash full loads only and don't overload. If you don't have a full load, adjust the water level to fit the size of your load.
- Minimize the amount of detergent used.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

Dryer

- Using a dryer costs approximately twenty-five 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 percent 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.

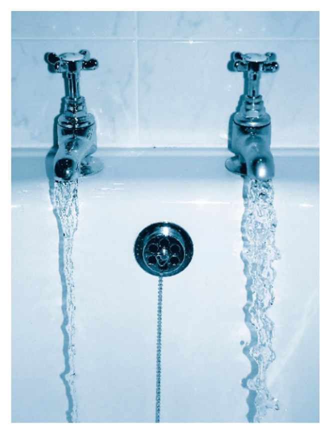
<u>Television and other electronic devices</u>



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

<u>Water heater</u>

- 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.
- Tank location: Placing a "thermal break" between a heat-absorbing concrete floor and your tank can save approximately twenty dollars a year.
- 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).



- 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.
- 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.

Tools for saving energy

<u>Room thermometer</u>: Use a thermometer to measure the actual temperature in the room. The thermostat may be set to 68 degrees, but the actual temperature may be different. Thermostats, especially older models, are frequently off by a number of degrees.

- Be sure to keep the thermometer near an inside wall, not an exterior wall.
- If the thermometer indicates the temperature is 70 degrees or higher, turn the heat down.
- We recommend 67 degrees or less when people are home and awake, and 58 degrees or less at night or when no one is home.

New Mexico has the nation's fourth-largest coal reserve and is the second-largest producer of natural gas. Energy produced in New Mexico is used by New Mexicans as well as residents throughout the Southwest. Public Service Company of NM (PNM) owns all or part of eight power plants, seven of which are in New Mexico. PNM's power plants are fueled by coal (41 percent of total), nuclear power (16 percent), natural gas (22 percent), and wind (8 percent). The remainder of PNM's power comes from power purchases.

According to PNM, the average electricity use for a resident of Santa Fe County is 560 kWh per month, and the state average for residential use is 602 kWh.

As we work to reduce GHG emissions, the first place to start is in buildings. Many people think industrial uses are the biggest emitters of GHG emissions, but according to the Sustainable Santa Fe newsletter, electrical use in buildings actually represent the greatest source of GHG emissions in the Santa Fe area. For GHG from combustion fuels, transportation is the greatest source.[5]

Hot water thermometer: Use a pencil-like thermometer to measure the temperature of your hot water.

- Wait two 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, note the temperature. This is the temperature of your hot water.
- The ideal temperature is 120 degrees. If the temperature level of your hot water is higher—130 degrees or more—turn down the temperature on your water heater. It is wasting energy and could scald or burn you. If the temperature is less than 120 degrees—110 or below—adjust the temperature on your water heater to avoid bacteria growth.

To adjust the temperature on your water heater:

- Turn off the water heater at the breaker in your electrical panel.
- Using a screwdriver, remove the small door that houses the thermostat. Actually, 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 tank operation.
- 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 the refrigerator in the morning (or when the door 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 on exterior walls inside your home, not walls between rooms.

- First, remove the switch or plug plate with a screwdriver.
- Then, install one foam pad for each plate.

Lighting

- Use task lighting to focus light where you need it, rather than brightly lighting an entire room.
- Take advantage of daylight by using light-colored, loose-weave curtains to allow outside light in while preserving privacy.
- 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.
- 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).
- Please remember to recycle your CFLs, as they contain a minute amount of mercury. Check http://www.epa.gov/bulbrecycling or http://www.earth911.org to identify local recycling options.

CFL Bulbs vs. Traditional Bulbs

- 14-watt CFL = 60-watt incandescent
- 20-watt CFL = 75-watt incandescent
- 23-watt CFL = 100-watt incandescent

Take action

Check your refrigerator's energy consumption at Home Energy magazine's site: http://www.homeenergy.org/consumerinfo/refrigeration2/refmods.php or calculate how much money you would save to switch to an Energy Star appliance: http://www.energystar.gov/index.cfm?fuseaction=refrig.calculator

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

Mercury and CFLs

CFLs contain an average of 4 milligrams of mercury (compared to 500 mg in traditional lightbulbs). No mercury is released when the bulbs are intact (not broken) or in use. As with any glass lightbulb, be careful when removing the bulb from its packaging, installing it, or replacing it. Always screw and unscrew the light bulb by its base (not the glass), and never forcefully twist the CFL into a light socket.

The U.S. EPA[6] recommends the following clean-up and disposal guidelines:

1. Air out the room
- Have people and pets leave the room, and don't let anyone walk through the breakage area on their way out.
- Open a window and let the room air out for at least 15 minutes.
- Shut off the central forced-air heating/air conditioning system, if you have one.

2. Clean up broken pieces and dust
- Carefully scoop up glass fragments and powder using stiff paper or cardboard and place them in a glass jar with metal lid (such as a canning jar) or in a sealed plastic bag.
- Use sticky tape, such as duct tape, to pick up any remaining small glass pieces and powder.
- Wipe the area clean with damp paper towels or disposable wet wipes. Place towels in the glass jar or plastic bag.
- If vacuuming is needed after all visible materials are removed, remove the vacuum bag (or empty and wipe the canister), and put the bag or vacuum debris in a sealed plastic bag. Do not use a broom.
- Clothing or bedding materials that come in direct contact with broken glass or mercury-containing powder should be thrown away. Do not wash such clothing or bedding because mercury fragments in the clothing may contaminate the machine and/or pollute sewage.
- You can wash clothing or other materials that have been exposed to the mercury vapor from a broken CFL, such as the clothing you are wearing when you cleaned up the broken CFL, as long as that clothing has not come into direct contact with the materials from the broken bulb.
- If shoes come into direct contact with broken glass or mercury-containing powder from the bulb, wipe them off with damp paper towels or disposable wet wipes. Place the towels or wipes in a glass jar or plastic bag for disposal.

3. Dispose of clean-up materials
- Immediately place all clean-up materials outdoors in a trash container or protected area for the next normal trash pickup.
- Wash your hands after disposing of the jars or plastic bags containing clean-up materials.
- Check with your local or state government about how to recycle the broken or unbroken mercury-containing bulbs. You can also check http://www.epa.gov/bulbrecycling or http://www.earth911.org to identify local recycling options.

4. Future clean-up
- The next several times you vacuum, open a window and shut off your central forced-air heating / air conditioning system before vacuuming and at least 15 minutes after.

SECTION 4: RENEWABLE ENERGY

Key Learning Points

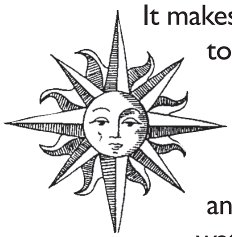
- Transportation and biofuels
- Renewable energy at home: solar water heating and photovoltaic systems
- Buying renewables or "green tags" from your utility

This section complements the home energy and transportation sections, exploring tools and strategies available to reduce individual and household GHG emissions. Once a household implements efficiency measures, renewable energy sources are a means of cutting GHG emissions associated with the burning of fossil fuels.

Renewable energy can be defined as energy derived from sources that can be continually produced without reducing key natural resources or negatively affecting people, e.g., wind, wave, tidal, and solar electric production, solar water heating, passive solar, small-scale hydro, and biomass. Renewable energy eliminates or reduces the need for fossil fuels.

The first step in reducing our home energy climate footprint begins with making our home as energy efficient as possible. The next step is to purchase renewable energy systems (or renewable power from our utility) for what remaining power is needed.

Solar energy



It makes sense to install solar water heaters before installing solar photovoltaic panels: Why make electricity to heat your water when you can just use the sun to heat the water directly?

After taking steps to improve your home's energy 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 9:00 a.m. and 3:00 p.m. year-round. In addition, there must be sufficient room for all the panels. Typically, a solar water heater can provide about 50 percent of a household's needs. The percentage of electricity that photovoltaics can cover depends on the household's energy use and the size of the array.

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

Renewable energy certificates

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

Renewable energy certificates (RECs) are produced by customers who own and operate grid-connected photovoltaic systems. RECs 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 environmental benefits produced when renewable generation displaces fossil-fuels.

RECs document and track 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 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 between residences and utility companies.

Ask your electricity or fuel provider about options for purchasing renewable energy or green tags. Many utilities and independent companies now sell RECs in blocks of 100 or 1,000 kilowatt hours or for an extra charge per kilowatt hour. PNM purchases RECs from customers as part of monthly billing at a rate of 13 cents per kilowatt-hour.

While you will not necessarily be receiving the actual electrons generated by the renewable power plant, your additional contribution provides the funding to support the generation of power from renewable sources.

Biofuels

Biofuels are alternatives or additives to fossil-based fuels made from organic materials. The most widely used biofuels are biodiesel and ethanol. Due in part 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 percent biodiesel is B100, 85 percent 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 reacts with oil to remove glycerin. The resulting 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 carbohydrate portion of 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 U.S., although many of their owners remain unaware of this option.[1] Most gasoline-powered vehicles can run on E10.

Biofuels represent a move toward sustainability because they are a renewable resource, can be produced domestically, are biodegradable and nontoxic, and produce fewer emissions than fossil fuels. Biofuels emit less GHG than fossil fuels—18 percent less for E85 and about 75 percent less for B100, depending on production method and feedstock.[2] Growing feedstocks for biofuels sequesters carbon and decreases tailpipe emissions. While the carbon dioxide emissions released into the atmosphere when biofuels are burned are equivalent to the amount absorbed by the feedstock plants as they grew, there are other emissions to consider. Energy sources other than sunlight are required to grow those feedstocks. Some of those sources include fossil fuels burned in tractors and made into fertilizers and pesticides and fuels needed to transport the final product to consumers.

As the demand for biofuels grow, peat swamps and forests are being cleared for biofuel crops, releasing stored carbon. 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 in which there are not likely to be simple fixes.

Take action

Investigate the feasibility of installing renewable energy in your home.

If you can generate your own renewable energy, sign up to sell your RECs to PNM. 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.

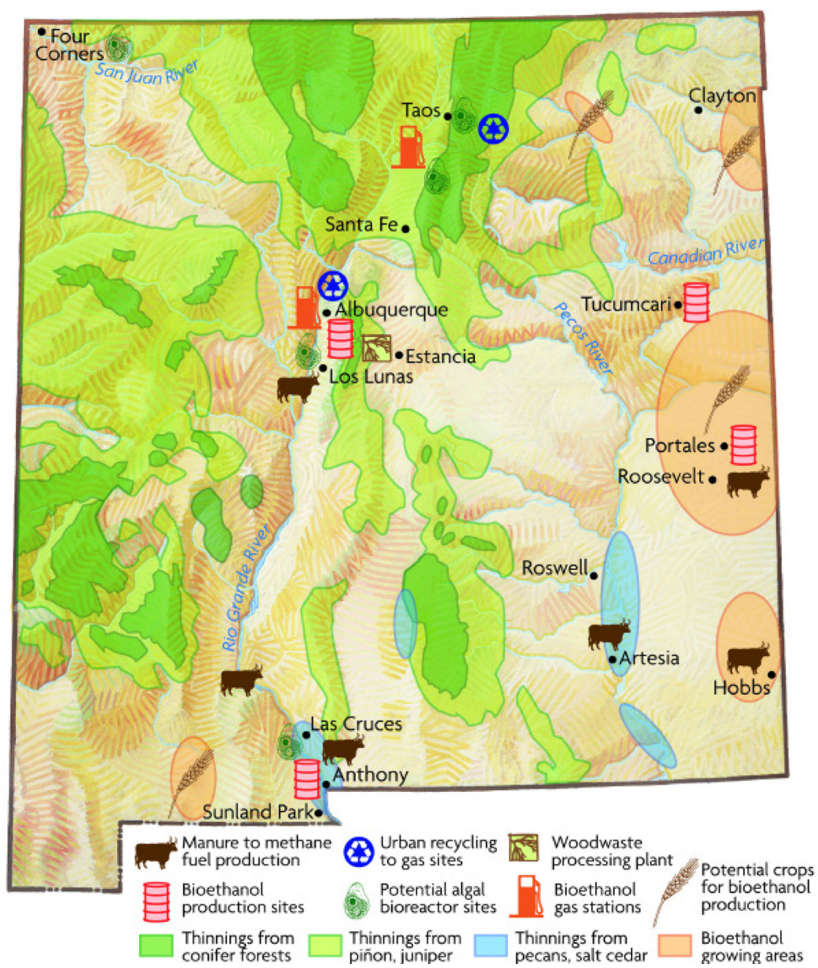


Figure 4-1. Potential for Biofuels in New Mexico

Source: Dreaming New Mexico, "Biofuels," <http://www.dreamingnewmexico.org/the-dream/renewable-energy/energy-sources/biofuels>.

SECTION 5: TRANSPORTATION

Key Learning Points

- Behavioral changes to reduce transportation emissions and save money
- Changes to vehicles for reducing emissions
- Biofuels
- Long-distance travel
- Impact of transportation on climate

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. In the U.S., 65 percent of households own two or more vehicles. Even so, the $6,214 that a household spends annually on an average car does not account for the full social and environmental costs of driving (see Table 3-1 below). [1]

Transportation makes up more than one quarter of our GHG emissions in the U.S.. [2] 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. Transportation is the fastest growing sector of GHG emissions in the country.[3] The CO_2 emissions that result from the burning of gasoline and diesel fuel are on the rise, with CO_2 emissions making up 80 percent of total U.S. GHG emissions, based on global warming potential. 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 greatly reduce emissions.

In the U.S., the average vehicle emits about one pound of CO_2 per mile. Here's why: burning a gallon of gasoline results in the release of about twenty pounds (19.4 pounds exactly) of carbon dioxide into the atmosphere. Diesel burning results in 22.2 pounds of CO_2 per gallon. The average gas mileage in the U.S. is 20.3 miles per gallon, when combining cars and light trucks.[4] A car getting twenty miles per gallon, with each gallon of gasoline emitting about twenty pounds of carbon dioxide, is emitting a pound of CO_2 for each mile driven. Every gallon saved keeps twenty pounds of CO_2 out of the atmosphere.

According to the Rocky Mountain Institute (RMI):

> *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.*

Table 5-1: Driving Costs

Driving costs	Small sedan	Medium sedan	Large sedan	Average
Total cost per mile (if gas costs $3.45/gal)				
10,000 miles per year	per year	per year	per year	per year
Cost per mile x 10,000 miles	$1,240	$1,490	$1,620	$1,450
Cost per day x 365 days	$4,357	$5,636	$6,950	$5,648
Decreased depreciation*	-$550	-$950	-$1,150	-$883
Total cost per year	$5,047	$6,176	$7,420	$6,214
Total cost per mile**	$.505	$.618	$.742	$.621

*decreased depreciation for mileage under 15,000 annually

**total cost per year/total miles per year

Source: American Automobile Association (2007). Your Driving Costs. <http://www.aaapublicaffairs.com/Assets/Files/ 20073261133460.YourDrivingCosts2007.pdf>

Here are some simple ways to save big:

- Carpooling cuts auto 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 as close to where you work and shop to minimize transportation emissions.

Cutting vehicle emissions

When you cannot avoid driving, simple techniques can cut gasoline use and GHG emissions.

- Keeping vehicles well-tuned can increase fuel efficiency by up to 30 percent, particularly if there are significant repair needs.
- Maintaining recommended tire pressure can cut fuel use by three percent.
- Changing air filters cuts a hefty 10 percent. [5]
- Cleaning out the stuff sitting in the trunk is another way to save fuel; every extra 100 pounds you haul takes 1-2 percent off your fuel efficiency. [6] Rooftop storage does not just add weight; the drag costs you money and emissions as well.

You can also drive smarter. Although every car is different, fuel economy typically plummets at speeds higher than 60 miles per hour. Excessive acceleration and braking will also cut your efficiency by about a third on the highway and five percent in town. [7] Idling gets zero miles per gallon, so if you are stopping for more than thirty seconds, turn off the car. Most cars run better when warmed up by driving rather than by idling, so avoid polluting your neighborhood with excess exhaust.[8]

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 (the costs are less per mile, but greater overall, as the annual mileage increases). AAA estimates the total annual cost of driving 12,500 miles is $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 nitrogen oxides. One option is buying a used, fuel-efficient vehicle or one that can run on alternative fuels.

Table 5-2: Benefits of Regular Vehicle Maintenance

TAKE ACTION	SAVE MONEY	SAVE CO_2 (lbs.)
To improve fuel efficiency by up to 30 percent, tune and maintain your car:		
Check tire pressure regularly and inflate as needed to save up to 3 percent of fuel	$38	305
Change air filters to save up to 10 percent of fuel	$128	1,018
Keep engine tuned to save up to 4 percent of fuel	$51	407

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 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 percent gasoline and 85 percent 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 percent biodiesel typically results in 75 percent fewer GHG emissions than diesel; using 85 percent ethanol generally results in 18 percent fewer GHG emissions than gasoline.[9] Remember, the use of biofuels is highly contingent on existing infrastructure. If there's nowhere to fill up on E85, then you're stuck with fossil fuels.

Visit the National Ethanol Vehicle Coalition, http://www.e85fuel.com/e85101/flexfuelvehicles.php, or the EPA's Alternative Fuels and Advanced Vehicles Data Center, http://www.eere.energy.gov/afdc/afv/afdc_vehicle_search.php, to find biofuel-compatible vehicles. See Section 4 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_2e) per passenger mile, or more than 2.5 tons of CO_2e for a roundtrip flight from coast to coast.[10] Compare this to the one pound per mile in the average U.S. vehicle (meaning half a pound 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 average emissions per mile than do long-haul flights, due to the extra energy needed for takeoff and landing.

In 1992, aircraft accounted for two percent of anthropogenic (human-caused) carbon dioxide emissions, or 13 percent of transportation-related emissions, and about 3.5 percent of anthropogenic climate change that year when all aircraft emissions are included.[11] Recent estimates calculate this percentage between four and nine percent.[12] These numbers may not seem like much until you consider the small percentage of the population traveling by airplane and just how vital—or unnecessary—those flights are.

In addition to CO_2 airplanes emit nitrous oxide, sulfur oxides, and water vapors, which appear to have greater warming potential when released high in the atmosphere. Contrails, or the water vapor crisscrossing the sky after planes pass overhead, stop heat from leaving the atmosphere at night but may have a cooling effect during the day by reflecting sunlight away from the earth. Air travel may also contribute to cirrus cloud formation, which also traps heat in the atmosphere. This secondary impact of air travel is not even included in the percentages mentioned above. All told, the IPCC estimates that the total climate impact of flying is about two to four times that of the CO_2 emissions alone.

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

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 GHG emissions. As much as possible, book direct routes with few landings and takeoffs and fly during the day, as night flights contribute more to climate change. 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 can be a point of personal pride.

Take action

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

SECTION 6: CONSUMPTION AND WASTE

Key Learning Points

- Reduce waste at the source
- Reuse items before recycling
- Recycle as necessary
- Compost organics (typically food and yard waste)
- Buy products made with postconsumer recycled content

GHG emissions are associated with material goods at nearly every phase of their life cycle, from extraction to production to use (in some cases), through the methane released from decomposition in the landfill. U.S. 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.[1] If we're tossing that much away, think of all 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.[2]

The U.S. EPA estimates that residential waste makes up 55 to 65 percent 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 percent of the world population but consume 86 percent of aluminum, 81 percent of paper, 80 percent of iron and steel, and 76 percent of timber produced globally. The average American will consume 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 in a lifetime. 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 a wide range of one-time use items created for convenience, which only increases the amount of waste produced.

Local Waste Facts

- Municipal Solid Waste accounts for 54 percent of New Mexico's waste stream in 2007, according to the New Mexico Solid Waste Annual Report.
- Santa Fe's recycling rate in 2007 was 8.76 percent.
- New Mexico had an 11 percent recycling rate in 2007.
- Recycling in New Mexico reduced energy consumption by 4,457,300 million BTUs in 2007. This is equivalent to one year's energy consumption for all the occupied homes in Valencia County or 35,638,032 gallons of gasoline.
- New Mexico's reduction of GHG emissions from recycling was equivalent to removing 115,789 passenger cars from the roadway for one year.

National Totals

Recycling materials reduces GHG emissions. EPA estimates that current national recycling efforts—82 million tons of municipal solid waste in 2006—reduce annual GHG emissions as much as removing over 39.4 million passenger cars from the road each year.[3]

Figure 5 shows the composition of the 250 million tons of waste generated in the U.S. in 2008. Much of what ends up in our landfill could be recycled (glass, metals, paper) in a process that requires less energy and far fewer 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 GHG 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, most of us are used to recycling household waste. But even recycling requires the use of fossil fuels as raw material and for energy in processing—including transporting the waste. 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 GHG emissions, these actions will save us money in the long run.

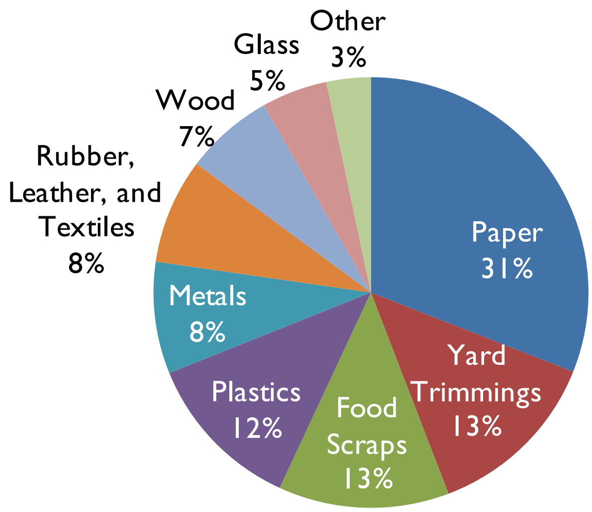


Figure 6-1. Municipal Solid Waste Generated in the U.S. (by Material), 2008

Source: EPA, <http://www.epa.gov/osw/basic-solid.htm>

Reduce

In order to reduce waste before it becomes waste, buy less—an idea known as source reduction.

When making a purchase, consider the following:

- Do I need to buy this?
- Can I buy this secondhand or remanufactured? Remanufactured products use 85 percent less energy in production.[4]
- Is it available with postconsumer recycled materials? Purchasing these products saves energy and raw materials and ensures that the recycling industry will continue by sustaining a market for recycled items.
- Is it reusable?
- Is it durable and repairable? For example: 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 GHGs.
- 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, and 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 GHG emissions, but also the flow of toxic waste from the household to the environment. See the end of this chapter for alternatives.

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 month-long 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 U.S. 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.

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.

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 and 7,000 gallons of water and reduces water pollutants by as much as 35 percent."

Using recycled paper can lessen your impact on the environment. For instance, printing 10,000 copies of a typical 8.5" x 11", 48-page brochure on Mohawk Options Smooth recycled paper versus a virgin fiber paper results in savings equivalent to:

- Not driving 8,629 miles in an average automobile
- 7,900 lbs. of air emissions not generated
- 117,354,400 BTUs of energy not consumed
- 70,375 gallons of wastewater flow saved
- 165 trees saved for the future

Source: Mohawk Paper. <http://www.mohawkpaper.com>

Composting and "grasscycling" are two other ways to reduce our methane emissions associated with landfills. 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.

Take action

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 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 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 thirty times more stress on the world's resources than a child born in a poor nation.[5]

People in the U.S. make up 5 percent of the world's population but use 25 percent of the world's resources and generate 30 percent of its garbage.[6]

The average American consumer uses nearly twenty tons of raw materials each year, twice that of the average Japanese or European.[7]

Paper

The U.S. consumes 734 pounds of paper products per capita versus 212 for West Germany and 127 for the European Economic Community as a whole.[8]

Making paper from recycled fiber generates 75 percent less air pollution.[9]

One person uses and discards two pine trees worth of paper products per year.[10]

Every time you recycle a forty-inch stack of newspapers, you save the equivalent of one southern pine tree.[11]

Recycling one-half the paper used throughout the world today would free 20 million acres of forest from paper production.[12]

The average office employee discards 1.5 pounds of recyclable paper each day, or about 360 pounds per year.[13]

Old corrugated containers account for nearly 50 percent of the total paper that is recycled.[14]

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 U.S. is equivalent to taking 24 million cars off the road.[15]

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 percent less energy than if raw materials were used.[16]

Recycling one ton of glass saves the equivalent of ten gallons of oil.

Plastics

The amount of plastic waste generated has been increasing by about 10 percent per year for the past twenty years.[17]

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.[18]

Aluminum

Aluminum made from recycled cans uses 95 percent less energy than from raw materials.[19]

The average aluminum beverage can in the U.S. contains about 51 percent postconsumer recycled aluminum.[20]

100 percent of all beer and soft-drink cans are made of aluminum.[21]

Steel and Tin Cans

The single largest domestic source of tin is recycling.

The amount of tin ore left in the world will last only thirty-one years if use grows at projected rates.[22]

One ton of steel cans contain 3.8 pounds of tin.[23]

The average American uses 130 steel cans per year.[24]

Tires

Every year Americans throw away 260 million tires. If stacked, they would reach 32,000 miles high.[25]

If all car owners kept their tires properly inflated, we could save up to 2 billion gallons of gas each year.[26]

Batteries

A typical car battery contains twenty pounds of lead and one gallon of corrosive sulfuric acid.

Packaging

Americans throw away twice as much packaging as they did in 1960.[27]

Thirty percent of municipal solid waste is made up of packaging.[28]

Junk Mail

The amount of junk mail received by the average household doubled between 1977 and 1987.[29]

Americans receive almost 2 million tons of junk mail every year.[30]

About 44 percent of junk mail is never opened or read.[31]

SECTION 7: WATER

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 GHG emissions.
- Conserving water both inside and outside the home is an easy way to conserve energy, reduce GHGs, and optimize our water supply.

About 71 percent of Earth's surface is covered in water, but only a tiny fraction (.003 percent) of fresh water is accessible for direct human uses. Nearly 70% of freshwater is frozen in glaciers and icecaps in Antarctica and Greenland. Most of the remainder is present as soil moisture or lies in aquifers not accessible to human use. Although water shifts form and location, there has always been the same amount of water on Earth.

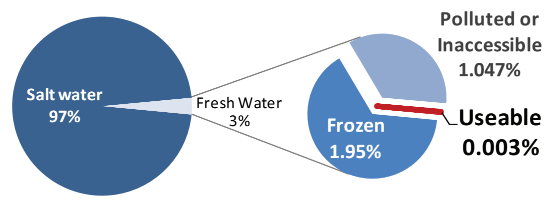


Figure 7-1: All the Water on Earth

Source: NM Environment Department, Water Display, 2006

Everyone in the world lives in a watershed – an area where all water drains to a common waterway, such as a stream, lake, wetland, aquifer, or ocean. Both surface water and groundwater are constantly moving and interacting over long distances. For example, over-pumping of groundwater can reduce the flow of a nearby stream or river. Similarly, when the flow of a river is low, this can reduce the amount of water underground. Most New Mexicans live in the Rio Grande River watershed, which takes up about 336,000 square miles.

Although a lot of surface and groundwater is withdrawn each year, much of it is returned to rivers and aquifers. Only a small percentage is actually lost or "consumed," (i.e. not returned for other uses). Water not consumed is often returned downstream of where it was diverted, often within the same watershed but not in the same place.

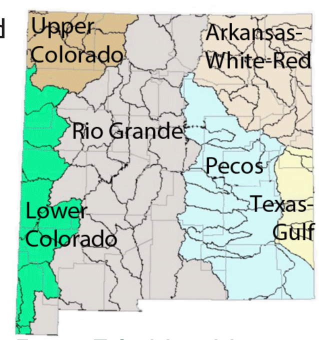


Figure 7-2: New Mexico River Basins

Source: NM Water Resources Research Institute, <http://wrri.nmsu.edu/wrdis/watersheds/nmmap.html>

- Worldwide up to 90% of the water withdrawn for domestic use is returned to rivers and aquifers as treated or untreated wastewater.
- Albuquerque returns about half of its pumped groundwater to the Rio Grande as treated wastewater for users downstream.
- In general, about 95% of water used by industry is returned.
- In comparison, 50% of water used in agricultural irrigation is generally returned. Agriculture "consumes" a lot of water.

Water is transported long distances to meet the municipal needs of various communities. While the precipitation that falls in one area may meet local needs, it also may need to be delivered to elsewhere for other end users. A local example is the San Juan / Chama diversion, which transports drinking water from northwestern New Mexico to residents in Albuquerque. Currently, the U.S. has enough precipitation each year to replace most water diverted from our rivers and groundwater. But increases in population, irrigated agriculture, and power generation are decreasing the overall water supply, and climate change is impacting precipitation.

Figure 7-3: Percent Water Use

* Industrial and commercial percentages include mining, livestock, and rural users.

Source: USGS (2005), <http://pubs.usgs.gov/circ/1344/pdf/c1344.pdf>

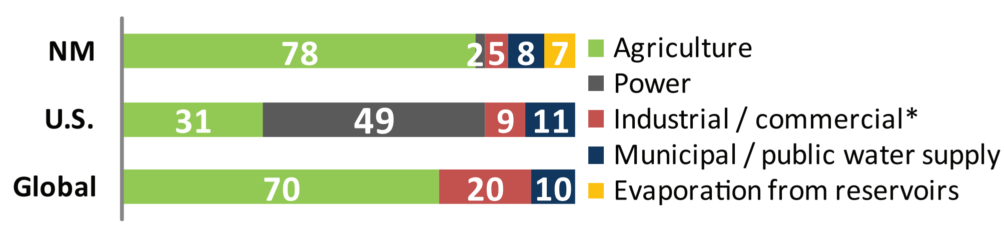
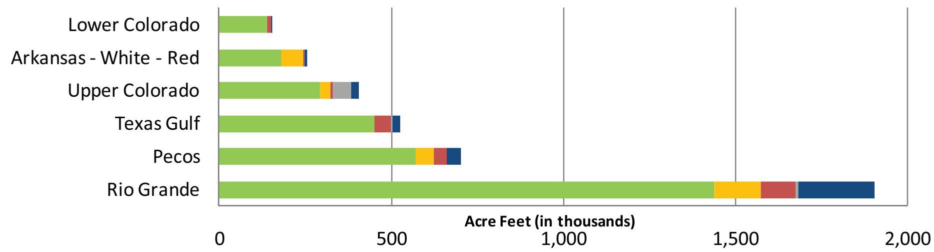


Figure 7-4: Total New Mexico Water Withdrawals by Use, 2005

Source: NM Office of the State Engineer (2005), <http://www.ose.state.nm.us/publications_technical_reports_wateruse_basin05.html>



	Rio Grande	Pecos	Texas Gulf	Upper Colorado	Arkansas - White - Red	Lower Colorado
Agriculture	1,437,783	571,615	452,775	294,559	180,087	138,695
Reservoir evaporation	135,598	50,577	0	29,812	63,306	0
Industrial, commercial, livestock, and mining	103,202	39,579	46,752	5,867	6,387	10,035
Power	7,567	0	4,429	51,633	13	0
Municipal / public water supply	221,815	41,416	21,345	24,217	5,625	5,709

The amount of water used annually in the U.S. declined slightly between 2000 and 2005. Nearly half of the 410 billion gallons per day used by Americans in 2005 was for producing electricity at thermoelectric power plants, up from 40 percent in 2000, even as technology improvements reduced the amount of water used per facility. Similarly, water withdrawals for public supply have increased steadily since 1950, along with the population that depends on these supplies, yet per capita use has decreased in many States.

In New Mexico over three-fourths of our fresh water is used for agriculture. The amount of water lost to evaporation from our reservoirs is almost as much as we use for all our municipal systems.

Climate change

The water cycle and temperature are closely linked.[1] The hydrologic cycle is driven by solar energy. An increase in temperature will effectively speed up the process of the cycle, including evaporation, condensation, precipitation, etc. [2]

Due to complex interactions of changes in the hydrologic cycle with global circulation patterns and local weather patterns, an increase in energy in the hydrologic cycle does not necessarily translate into an increase in precipitation in all geographic regions. It is difficult to predict future changes in regional precipitation patterns. [3]

The challenges related to freshwater include having too much water, too little water, and too much pollution. Each of these problems may be exacerbated by climate change. [4]

Climate change is already affecting the amount of water available for human use and wildlife. Uneven distribution of precipitation causes water shortages in some areas, while other areas see more runoff and less filtration from shorter yet more intense rainfall. Changes in temperature and relative humidity are also influencing the rates that water evaporates, which impacts the amount of water available to replenish groundwater supplies and increases evapotranspiration (i.e. the water from evaporation and plant transpiration that leaves the surface of the earth to become part of the atmosphere). Fresh water could become the single most important natural resource on earth as temperatures rise in the coming years.[5]

Many parts of the country are experiencing water shortages. Cities as diverse as Denver, Las Vegas, and New York have mandatory residential water use restrictions. In 2003, under normal weather conditions, at least 36 states anticipated local, regional, or statewide water shortages within ten years.[6]

In the West, climate change is expected to exacerbate current stresses on water. Warmer temperatures are already leading to less precipitation overall, more precipitation falling as rain instead of snow, and shrinking snowpacks. When snowpack melts slowly, water infiltrates into the groundwater and replenishes aquifers. Reduced and earlier spring runoff leads to lower surface water flows later in the summer when demand is highest and higher demand on aquifers that have been recharged with less water. As temperatures increase and precipitation decreases, water use goes up, particularly for irrigation.[7] More frequent and intense storms challenge our methods for storing and managing water, and flash floods result in more sediment and pollution in the water, which requires more energy to treat it for domestic use. As in other regions, freshwater lakes and rivers are shrinking or drying up, leaving us more dependent on groundwater aquifers that recharge very slowly or are non-renewable.

Changing precipitation patterns will create very challenging political scenarios in the West over already-stressed water resources for competing uses, such as food production, residences, and industry.[8] As rising oceans threaten coastal fresh water supplies, California will have to compete for surface water with other states that share the Colorado River as the lifeline for people and industry – including Wyoming, Colorado, Utah, Nevada, Arizona, western New Mexico, and Baja, Mexico.[9]

Population

Population growth will also create more pressure to meet increasing food, water, and energy needs. By 2025, two-thirds of the world's population faces water shortages. Almost one fifth of the world's population (about 1.2 billion people) live in areas where water is already scarce, and one quarter of the global population live in developing countries that lack the infrastructure to obtain water from rivers and aquifers.[10]

Water use is actually growing faster than the world's population. In the past 100 years, global population has tripled, while water use has multiplied five times over, primarily from increased agriculture and industry. Even though the way we use water is becoming more efficient, global water use will still increase by at least 25 percent over the next 15 years.

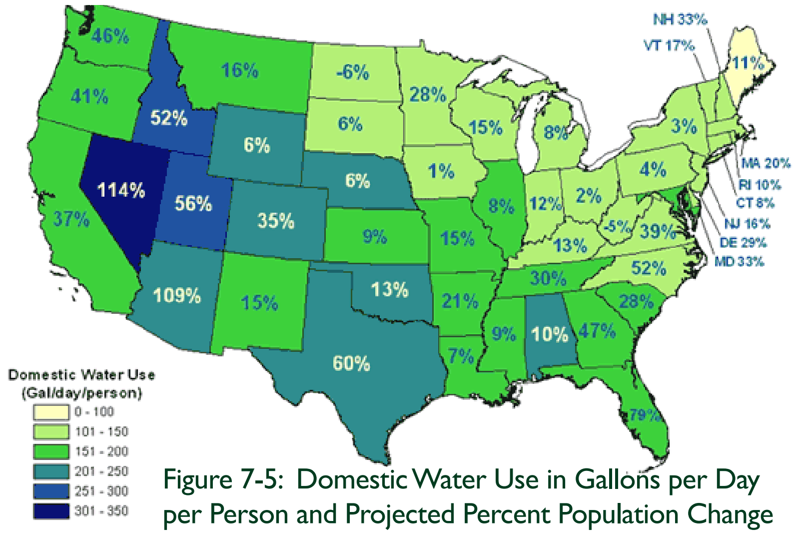


Figure 7-5: Domestic Water Use in Gallons per Day per Person and Projected Percent Population Change by 2030

Source: NM Office of the State Engineer (2005), <http://www.ose.state.nm.us/publications_technical_reports_wateruse_basin05.html>

The U.S. population is projected to grow by about 70 million in the next 25 years and electricity demand to grow by 50 percent. Populations in the West, with the least precipitation and most at risk of drought, are expected to grow the most – by 30 to 50 percent by 2025.[11]

Agriculture

Although humans only need to consume 1½ gallons of water daily, each calorie of food energy we consume requires 2.6 gallons of water to produce. Daily, we consume approximately 528 to 1,321 gallons of water through food production.[12]

Changes in water quantity and quality due to climate change are expected to affect food availability and stability. In the West, demand for irrigation will increase as soil-moisture decreases, run-off increases, and seasons shift. Earlier melting of snowpack in spring will mean less water is available to divert later in the summer, when demand is higher, which will result in more groundwater "mined" for irrigation.[13]

Figure 7-6: Water and Food Production

Source: NM Environment Department (2008), "Water Wonders" display by Experiential EE

Energy

Water plays a critical role in energy production and vice versa. Water is needed to create energy and energy is needed to deliver water. The interdependence of water and our current energy sources creates a feedback loop, where changes in one will impact the other, which is bad news if consuption continues to rise but offers hope if conservation measures succeed.

The link between energy and climate change is clear, but there are also GHG emissions associated with fresh water consumption. Energy is required by water utilities to produce and distribute water to homes. Once home, without a solar hot water system, heating water requires still more energy, resulting in more GHG emissions. Water conservation presents us with an opportunity to both prepare for the impacts of climate change and reduce our own impact on the climate.

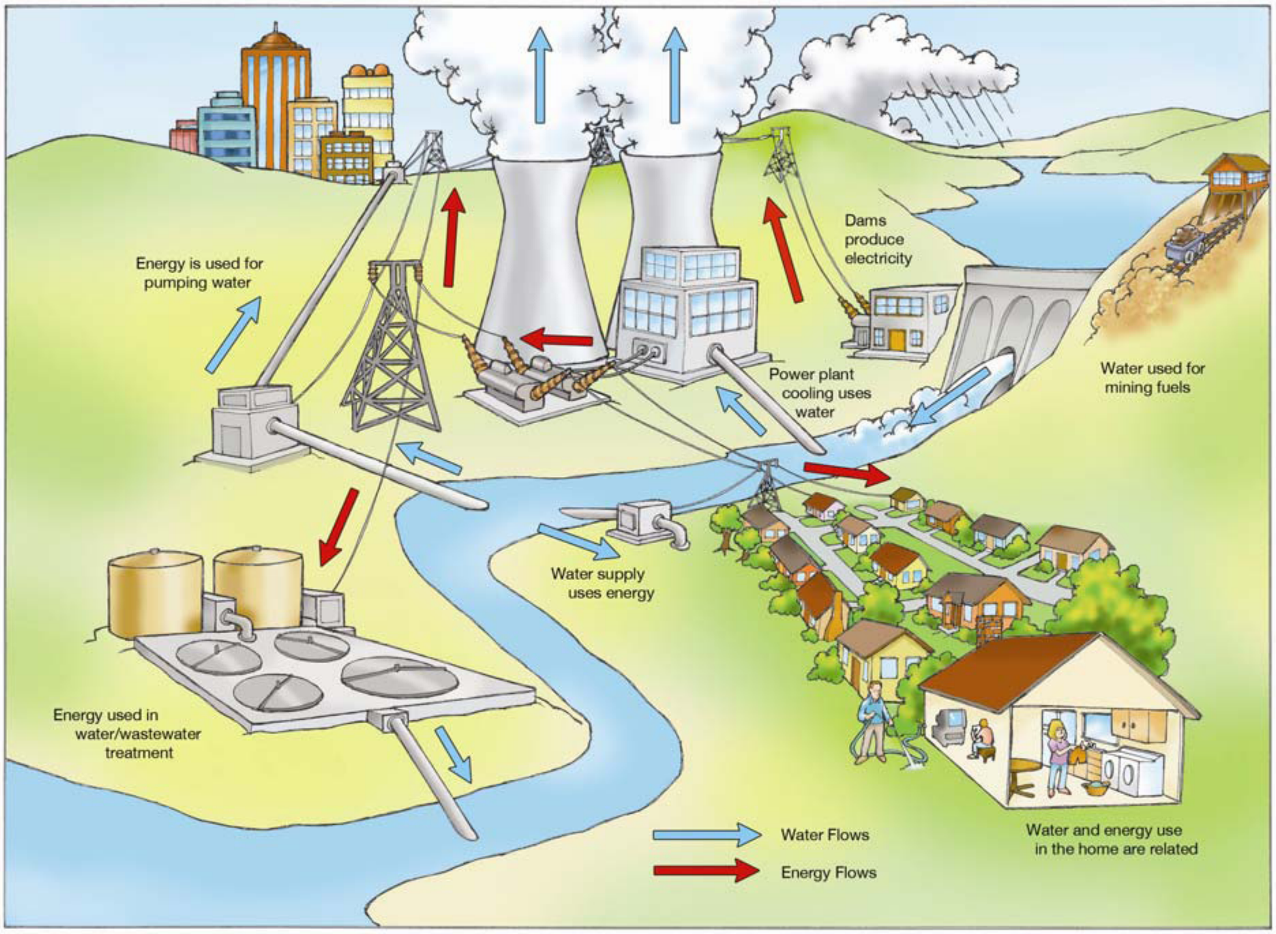


Figure 7-7: Water and Energy

Source: U.S. Department of Energy (2006), "Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy and Water." <http://www.sandia.gov/energy-water/docs/121-RptToCongress-EWwEIAcomments-FINAL.pdf>

Water for energy

Water is used in electric-power generation, energy-resource extraction, refining and processing, and transportation.[14]

About 80 percent of all the electricity in the world is generated by steam turbines. For thermoelectric generation, coal, oil, or natural gas is burned in large furnaces to heat water to make steam, which spins the blades of large turbines to create electricity. Water is also used to cool equipment and clean emissions. All but three percent of the water withdrawn is returned to the source.[15]

Thermoelectric Power = .5 Gallons of Water = 100 watts for 1 hour

Almost half a gallon of freshwater is lost to evaporation for each kilowatt hour (kWh) of power produced. The average house in New Mexico uses about 632 kWh per day. On average, we consume 316 gallons of water a day for lights and power.

Hydroelectric power plants commonly use a dam on a river to store water that, when released, flows through a turbine to produce electricity. About 6.5 percent of electrical power in the U.S. is produced by hydroelectric plants.

Hydroelectric Power = 18 Gallons of Water = 100 watts for 1 hour

Although hydrodroelectric power is our most common "renewable" energy resource in the U.S. today, about 18 gallons of reservoir water is lost to evaporation for each kilowatt hour (kWhs) of electricity provided to consumers.

Nuclear power requires great amounts of cool water to keep reactors operating at safe temperatures. If the rivers and reservoirs that many power plants rely on for water are hot or depleted because of steadily rising air temperatures, then a safety concern arises. Peter Gleick, President of the Pacific Institute, says "Far more water is required for nuclear and fossil fuel energy systems than for most renewable energy systems. Water availability will increasingly limit our energy choices as climate change accelerates and population continues to grow."[16]

Figure 7-8: Municipal Water Cycle

Source: National Resources Defense Council (2004), "Energy Down the Drain: The Hidden Costs of California's Water Supply." <http://www.nrdc.org/water/conservation/edrain/contents.asp>

Oil and gas drilling use extensive amounts of water to help break up rock and cool the drill bit. Once crude oil has been extracted, it takes huge quantities of water to refine it into gasoline, diesel, and fuel oils. In the U.S., it takes 1-2 billion gallons of water per day to refine petroleum, or approximately 1-2.5 gallons of water for every gallon of crude oil processed.[17] New Mexico produces 3 percent of the U.S. total crude oil.[18]

Mining coal requires only 1-3 gallons of water per MMBtu (a measurement of the energy in 1,000 cubic feet of natural gas) for extraction, but slurry pipelines typically require 11 to 24 gallons per MMBtu to transport it, and only 70 percent of the water can be recycled at the power plant.[19] Coal produces 80 percent of the state's electricity.[20]

By comparison, the water required to extract natural gas is negligible. New Mexico contributes 10 percent of the natural gas produced in the U.S., consuming about 10 percent in the state and exporting the rest. Two-thirds of New Mexico's households use natural gas as their primary energy source for home heating.[21] Extraction requires approximately one gallon of water per 1,000 cubic feet (or MMBtu) of natural gas in the San Juan Basin (Colorado and New Mexico), two gallons per 1,000 cubic feet for processing, and another one gallon per cubic feet to operate pipelines.[22]

At the same time these power sources use water, they emit GHGs that escalate climate change and worsen the impact to the West of drought, early runoff, and intense storms. Unfortunately, alternative fuels like ethanol require even more water to produce. Because of irrigation needs, it is estimated that converting corn into one gallon of ethanol requires 3-4 gallons of water.

Energy for water

Drinking water and wastewater treatment in the U.S. consumes three percent of the energy we generate, equal to approximately 56 billion kilowatt hours (kWh) and adding 45 million tons of GHG to the atmosphere.[23] The Albuquerque Bernalillo County Water Utility Authority provides drinking water and wastewater treatment for about 520,000 water users. Cleaning the drinking water alone requires 9 million kWh of power per month.

In order to use water in our cities, we pump it from its source, convey it to treatment plants, clean it, transport it around our communities, heat it, move it to treatment plants, clean the waste from it, and return it to the environment. The energy required for the treatment and delivery of municipal drinking water accounts for as much as 80 percent of its cost and 30-40 percent of its total electricity use in mid-size cities.[24]

If the water source is groundwater, the energy required to pump it to the surface ranges from 540 kWh per million gallons from a depth of 120 feet to 2,000 kWh per million gallons from 400 feet. The energy required to pump surface water depends on how far it must travel to users, ranging from very little to 15,000 kWh per million gallons or more. The farther we have to transport water, or the deeper we have to go to pump it in declining aquifers, the more energy it requires.[25]

Almost half of the U.S. population and 90 percent of New Mexicans depend on groundwater for drinking water, which can take centuries, or even millennia, to replenish, especially when surface water levels are reduced. The result – especially in the arid West – is a pumping rate that far exceeds the rate of natural recharge, which leads to declining aquifers, problems with sinkholes, and more expensive "brackish" (salty) water that requires more treatment to be useable.[26]

As climate change affects precipitation, water quality, and the earlier arrival of seasons, we can expect to see changes in the picture of where we draw water from, where it goes, and for what purpose.

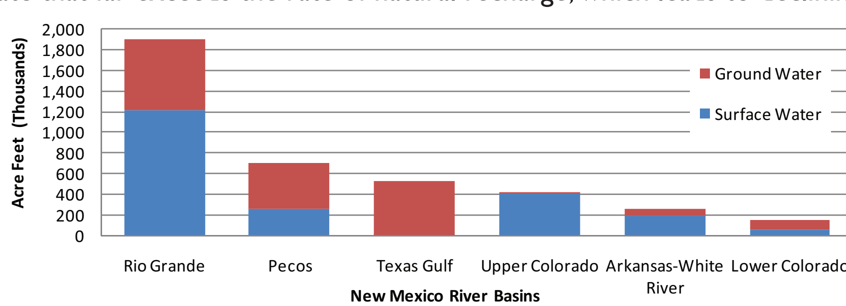


Figure 7-9: Water Withdrawal by Type, 2005

NM Office of the State Engineer (2005), <http://www.ose.state.nm.us/publications_technical_reports_wateruse_basin05.html>

When surface water levels are low, many municipalities and farmers will turn to groundwater to supplement their needs. When groundwater aquifers are depleted, people turn back to surface water, as a more "renewable" source.

Albuquerque is turning now to the San Juan-Chama River for its drinking water. The San Juan-Chama Project will require energy to clean and pump the water. Minimal energy is needed to purify groundwater, but surface water requires as much as 1,500 kWh/million gallons. Sophisticated control systems will help assure that power use rises only minimally.

Households

The World Health Organization considers 13.2 gallons of water per person per day as the minimum required for basic needs associated with drinking, sanitation and cooking, with the optimal being 26-53 gallons per person per day. Over 1 billion people currently lack access to even 5.3 gallons per person per day.

As people become richer and enjoy a higher standard of living, their domestic water use increases. A typical household in Africa uses 12.4 gallons of water indoors and outdoors per person per day. In Asia, the average is 25 gallons. The U.S. leads the world in consuming 151 gallons of water per person per day.

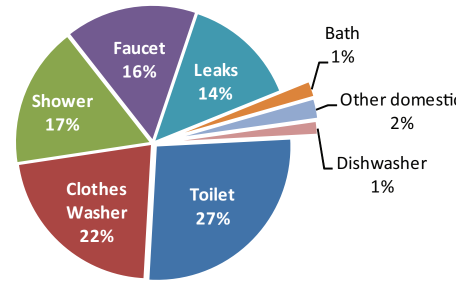


Figure 7-6: Indoor U.S. Household Water Use, 2005

Source: NM Environment Department (2008), "Water Wonders" display by Experiential EE

One flush of a standard American toilet (3-7 gallons) uses as much water as the average person in the developing world uses for a whole day's washing, drinking, cleaning, and cooking. Nearly 14 percent of residential water use is wasted through leaks.

Domestic water use can be much higher in the arid West because of irrigated landscaping.[27] According to the American Water Works Association Research Foundation, nearly 60 percent of water goes to outdoor uses.[28] Of the water used for irrigation, the EPA estimates that up to 50 percent may be wasted due to poor watering practices.[29] Ironically, high water use occurs in the hottest months, when surface water sources such as lakes, rivers, and reservoirs are at their lowest, further straining our water supplies.

Preparing for climate impacts to water resources

Water priorities: Although population and economic development are currently the biggest drivers of water use, changing views on the value of water can change the balance of our priorities.[30] As competing users clamor for decreased water resources, we will have to make choices that weigh the importance of agriculture vs. industry, city residents vs. rural dwellers, human consumption vs. natural habitats. Water-saving technologies exist to change water use once our priorities are clearly established.

Water management: Policy makers must focus on managing water and energy jointly, since their impact on each other cannot be avoided, although it is often ignored. This joint management will be the only way to ensure predictable, reliable, and desired supplies, especially in the face of uncertainties sure to accompany climate change in future decades.[31]

Strategic management practices will need to be robust enough to cope with the impacts of climate change on water supply reliability and security, flood risk, agriculture, energy, and natural watershed habitats. Managers, planners, and conservation groups will need better data on water quality, watershed health, and groundwater quantities, to gauge climate variability (including socio-economic factors) to respond appropriately.[32]

***Power*:** Production of electrical power represents one of the largest uses of water worldwide, and therefore the biggest potential for water savings. As our need for power continues to grow, the demand for water will grow unless we find ways to make electricity that do not rely on water, such as wind and solar power.

Conservation and energy: Domestic use of hot water—especially washing clothes and taking showers—consumes more energy that any other part of the public water supply cycle. Conserving hot water may be the most cost-effective way to save significant amounts of energy, both during "end use" as well as energy required "upstream" to pump and convey water from its source.[33] To gain this double energy savings, economic incentives, such as metering and pricing, should be implemented to encourage water conservation.

Re-use: Reusing water is also highly energy efficient, requiring far less energy than pumping it from its source. The energy costs include treating the water appropriately for its intended use and conveying the water to its destination.[34]

Wastewater treatment: In the late 1980s, Albuquerque converted its sewage stream into electricity to operate the liquid waste plant. The process, known as cogeneration, uses methane gas produced by the wastewater treatment process to generate the electricity and heat needed to operate the Southside Plant. The co-gen plant generates about half of all the power the facility needs, saving about $70,000 a month in energy costs.

Desalination: Although its high cost and energy requirements limits its use today, desalination may become an important source of water in arid regions. Using desalination to treat brackish groundwater requires less energy and cost than ocean desalination.[36]

Water storage: In order to address the risks of drought coupled with more intense precipitation events and flooding, our water storage methods – on a regional, local, and household level – will become vital. On a regional level, we will not be able to continue to lose almost 10 percent of our water in New Mexico to evaporation from reservoirs. On a local level, storm water management will need to be able to handle flood conditions with methods that improve water's ability to percolate back into our groundwater or rejoin surface water without being polluted with too much sediment or contaminants from our streets or industries. At the household level, rain barrels and landscape catchments should be able to help water our yards during dry weeks and months.

Agriculture: Whether cropland is rain-fed or irrigated, good land management and improvements in irrigation efficiency will be needed to significantly reduce the amount of water needed to produce food for increasing populations.

Using Water More than Once

The City of Alamagordo conducted a pilot program for Multiple-Use Water Conservation (MUWC). With MUWC, water "used, reused, then used again," first for municipal, commercial, or industrial uses, then reclaimed for agriculture as the final use. In this way, 31,000-gallons of water from an agricultural diversion provided 93,000-gallons of water uses. An associated study found that 25,000 acres of MUWC program-participating farms can create 100,000 acre-feet of new municipal water supply.[35]

What you can do

Installing water-efficient appliances (clothes washers, dishwashers, etc.) can save about 11,000 gallons of water and 600 kWh per person per year. Devices that reduce hot water use save even more because they consume less energy. If one out of every 100 American homes retrofitted with water-efficient fixtures (toilets, showerheads, faucets, etc.) we could save about 100 million kWh of electricity per year and avoid adding 80,000 tons of GHG to the atmosphere – equal to removing nearly 15,000 cars from the road for a year.[37]

By regularly checking for leaks, replacing plumbing fixtures (faucets, shower heads, and toilets) with low-flow devices and older appliances (washing machines, dishwashers, and refrigerators) with ENERGY STAR or WaterSense rated appliances, we can reduce our consumption by about 35 percent.[38] 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.[39]

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.

When landscaping your yard, choose native plants with low-water needs. Not only are native plants already adapted to this climate and soil conditions, they also require less maintenance, water, fertilizer, and pesticides than non-native plants once they're established. Group plants in zones appropriate to your landscape based on their water needs. Use several inches of mulch to retain moisture lost to evaporation, protect your plants, prevent erosion, and limit weeds, which compete for moisture. If you have a large property, consider leaving part of it wild. Limit the size of your lawn and use efficient irrigation. Include permeable paving materials, rain barrels, cisterns, landscape contouring, and water gardens to help retain water for irrigation, slow down surface runoff, and prevent erosion.

Take action

Change one water- and/or energy-wasting habit this week. Challenge your family and/or friends to a water savings contest.

More Ideas to Save Water

Indoors

- Flush the toilet less frequently.
- Reuse potable water (from cleaning vegetables, for example) for house & garden plants.
- 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.

Outdoors

- Do not use the hose to clean patios, driveways, sidewalks, gutters, or downspouts. In addition to wasting water, using a hose on these surfaces sends dirts, oils, and pet waste into storm drains and waterways.
- Wash your car at a commercial car wash. They recycle the water, which also keeps chemicals from storm drains.
- Water to the weather. Avoid watering in windy conditions.
- Improve your soil's drainage and water holding capacity by adding organic material or loosening soil. You can have your soil tested by your local county extension office in order to match plants with appropriate soil types.
- 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 percent less water than overhead systems.40 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 automatic watering systems to run at night between 9 p.m. to 3 a.m. to avoid watering when many other people are using water and reduce demand on the water distribution system. Your watering system will also function better because it will be operating under full pressure.

SECTION 8: FOOD

Key Learning Points

- Sources of food-related emissions along the food chain
- Complexities of transportation emissions
- Emissions related to omnivorous versus vegetarian or vegan diet
- Emissions related to conventional versus organic agriculture
- Strategies for reducing food emissions

The average U.S. household is responsible for about eight tons of CO_2e emissions annually related to their food consumption.[1] 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 percent) derive from the production phase, with transportation accounting for just 11 percent. 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.[2] 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 percent of the world's surface land area and accounts for a whopping 18 percent of CO_2e emissions, including from land use changes, fertilizers for feed, and energy use.[3] Unlike the other components of our personal climate footprints where CO_2 is the major offender, half of our food emissions are in the form of methane and nitrous oxide.[4]

Cows raised for dairy and meat belch methane (which has twenty-one times more warming potential than carbon dioxide) as their four guts digest the fibrous grass that makes up their diet. Cows raised on corn (of which there are more and more these days) belch even more methane than grass-fed cows. According to the Worldwatch Institute, this methane makes up 16 percent of all methane emissions produced each year.[5] The U.S. Department of Energy estimates that 94 percent of the methane emissions from agriculture are directly related to livestock.

Food-related nitrous oxide (N_2O) emissions derive primarily from fertilizer application and other cropping practices. Globally, livestock use 78 percent of agricultural land and 33 percent of cropland, as livestock do not efficiently transform plant energy into animal-based energy.[6] As a result, 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_2—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 fewer than one day a week has the same impact on emissions as eating a pure "local" diet.[7] 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 to catch, store, and transport 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 to marine ecosystems.[8]

Eat whole foods

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

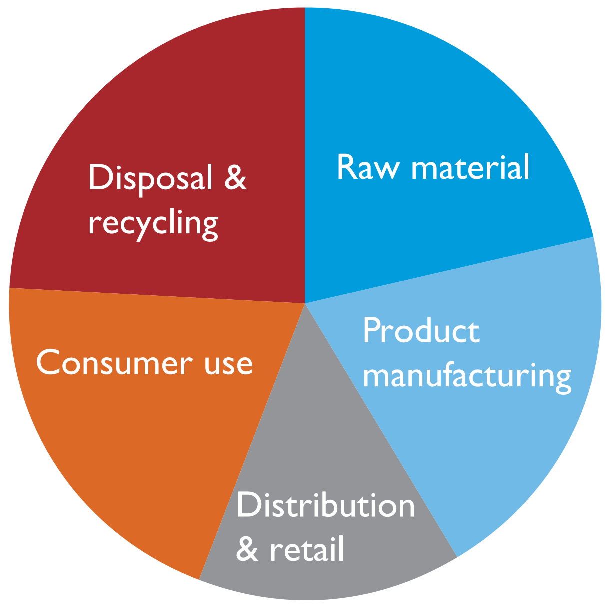
For example, a can of cola purchased at the market embodies the emissions for extraction of raw materials for the can and the cola, soda and can manufacturing, and distribution. This all happens before the can makes it to your refrigerator (the appliance that uses more energy than any other in your home). 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 U.S., about 16 percent is consumed by the food production system. Of that 16 percent, nearly a third is used for processing, 10 percent for transportation, and 17.5 percent for agriculture.[9]

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).



Avoid waste

Americans throw away about a quarter of the food we prepare, at a cost of a billion dollars a year, according to the U.S. 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 percent of the solid waste generated by American households in 2007.[10] 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 U.S. 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.

Transporting food

Despite the recent focus on transportation from farm to store, these so-called "food miles" account for only 4 percent of our food-related emissions, with transportation as a whole making up 11 percent of food related emissions.[11]

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 toward incorporating more local foods into your diet, 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.[12]

The trip from the supermarket to our home can contribute among the largest expenditures of energy in the food's 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 descending 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.[13] 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.[14] Foods commonly transported by air include asparagus, avocadoes, cherry tomatoes, citrus, lettuce, specialized and processed meats and fruits, strawberries, and seafood.[15]

Go organic

Modern conventional agriculture relies heavily on fossil fuel and results in GHG emissions in almost every aspect of production.

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

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.[16] 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.[17]

Preparing for Climate Change

- Grow food at home or in a community garden and support your local farmers to ensure food availability in case of agriculture and transportation disruptions.
- 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.
- 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.
- 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.

Buy fair trade

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.[18]

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

Take action

Make one or more shifts in your eating and purchasing patterns to reduce GHG emissions. Cut out meat, fish, or dairy from one meal this week. Buy one or more food staple produced organically, rather than by conventional methods.

SECTION 9: YARDS

Key Learning Points

- Composting reduces emissions from waste
- Trees cool the home in summer and sequester carbon dioxide
- Push mowers and rakes reduce emissions
- 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 your 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

We can reduce emissions around our home and at the landfill 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 further reduce our food-related emissions by growing some of our food at home, discussed in Section 8 of this handbook.

Composting food waste at home reduces .86 tons of CO_2e per ton of food waste.[1] Bacteria inside the compost pile prevent methane emissions from entering the atmosphere. The compost pile releases CO_2 rather than methane as the organic matter decomposes. Although both are GHGs, methane has 23 times the warming potential of carbon dioxide.[2] 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. 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.

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, about a ton over their lifetime.[3]

When placed correctly, trees can shade the home or, at the very least, the home's air conditioning unit, which 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.[4] Planting deciduous trees will allow 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 lawnmowers, 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.[5] 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. Native 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. Adapting your landscape to become more drought tolerant now not only reduces your reliance on watering, it also prepares you for drier summers to come. Using native plants and eliminating invasive species as much as possible helps guard against the increased potential for invasives as the climate changes. If you are working with a landscaper or landscaping company, ask them to take up climate-friendly practices.

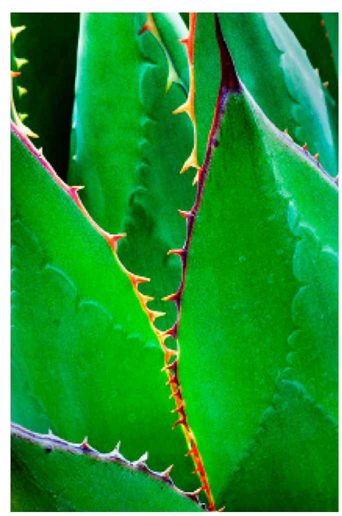
If you are barbecuing, lump charcoal produced from sustainably managed forests offers an alternative to briquettes. If charcoal is your fuel of choice, use a chimney tower instead of lighter fluids, which contain volatile organic compounds. These compounds contribute to ground-level ozone pollution, which can cause health problems. Chimney towers are easy to use, reduce the amount of time needed to prepare coals, and require no lighter fluid. If you've already got a charcoal grill and want to switch to gas or propane, try to find a used one to decrease the emissions involved in mining and manufacturing. For no-emissions meals, consider building a solar oven outside to use during summer.

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 8.9 kilowatts of energy. That means for every hour an outdoor heater is used, 495 compact fluorescent lamps could be powered up instead. Wear a sweater or jacket instead of firing up your heater.

In general, the more new items we purchase to fill out outdoor living spaces, the more embodied emissions we rack up. Each chair, table, umbrella, hammock, fire pit, or bench has GHG 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.

Take action

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.



SECTION 10: 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

A household consultation should increase the resident's awareness of the "big ticket" GHG emitters in their life: typically these include transportation, home energy use, and consumption of food and other resources. 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, non-judgmental, 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.

An Australian home consulting manual for a "Cool Communities" program provides further details on communication on page 38.

Tools

All consultants will use a checklist and a series of consulting worksheets to perform the consultation. The checklist begins with the highest GHG 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.

Take action

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

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:

- Room thermometer for measuring air temperature
- Meat thermometer to measure water temperature
- Refrigerator and freezer thermometer
- Screwdriver
- Rag
- Flashlight
- "Freebies" for the resident, if available

How to conduct a consultation

1) Introduce yourself and the Climate Master program—a project to help households reduce their GHG 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.

When talking to someone at their home, the consultant should:

- Always use plain English language and explain any jargon that needs to be used.
- 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 resident comfortable with having you in their house. This means being relaxed no matter what the surroundings are like and not making disparaging remarks about the house or the householder.
- Ask the resident if they would like to accompany you. Use this as an opportunity to engage the householder in energy-efficiency practices, explain what the issues are, and answer any questions they might have.
- Remember that all people are different and what is likely to make one person feel uncomfortable or annoyed may leave another unabashed. Comments about your views of the world or religion have the potential to go down like a lead balloon. Sticking to the issue at hand is generally advisable.
- Beware of people who are angry and looking for someone to blame. If they perceive 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.
- For instance, when trying to convey the need to put external blinds on west facing windows, a poor communicator might say:
- "Since these windows face west, they need blinds."

A good communicator might say:

"Do you find this room heats up in summer? West-facing rooms get the hot afternoon sun. What are you doing currently to reduce the heat? Putting external blinds on the windows will help keep out the sun."

When trying to convey the need to install draft blockers, a poor communicator might say:

"Installation of draft blockers will improve your thermal efficiency by X percent."

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 would be about the same as having a hole the size of a basketball in the wall."

You may also want to think about ways to get the whole family involved in energy-conservation consciousness. For instance, you could discuss plotting kilowatt usage and getting other household members involved in this activity. Encourage the participation of everyone and make it a family challenge to reduce energy usage lower this month than the same time last year (refer them to their utilities bills). Ask them to jot down strategies and tasks on their Action Plan while you're presenting suggestions.

When talking to a group, the consultant should:

- As with a home consultation, always use plain English language and discuss any jargon you use. This can be quite empowering for group members.
- Draw out as much information from group members as possible about how they use and conserve energy. This helps others understand that there are different ways of doing things, different bill levels, and different options for solving problems.
- Use group dynamics positively, being aware that groups can operate negatively. For instance, there is potential for a high-energy user to be stigmatized if they are in a group of energy conservers. The group's knowledge and energy should be harnessed to support that person.

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

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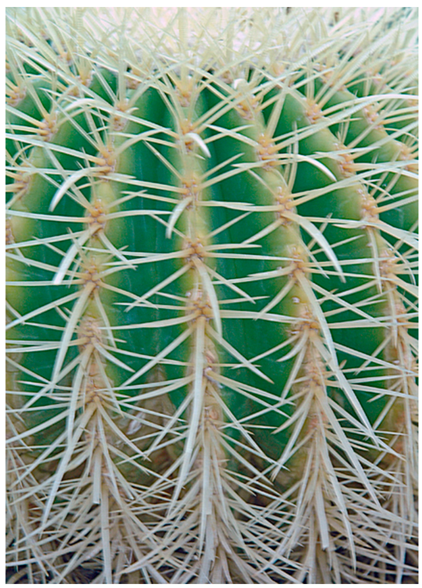

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